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Identifying Barriers and Expectations in MaaS: Users' and Stakeholders' Perspective

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Abstract: Mobility as a Service (MaaS) is an innovative urban mobility concept that aims to provide a competitive alternative to the use of private cars, by integrating various transportation services. Until today, limited MaaS schemes have been implemented and, in most cases, without succeeding to justify the hype. For achieving the goals of MaaS it is essential to capture holistically the expectations and barriers, as perceived by both the end-users and the various involved stakeholders. This paper aims to bridge this gap, by conducting two surveys in the city of Thessaloniki, Greece; the first survey targeted local authorities, organizations and mobility providers, while the second survey focused on (potential) end-users. The responses of stakeholders were analyzed through the Analytic Hierarchy Process (AHP) method, in order to identify the importance of barriers and expectations. On the other hand, the responses of end-users were analyzed statistically and two ordered logit models were developed for identifying the characteristics of those that are more likely to adopt MaaS. The results of the analyses indicate that there is a loop between MaaS and private car usage; on the one hand, the dominance of private cars hinders the adoption of MaaS, but on the other hand, MaaS can be a "tool" for encountering car domination. The results also enhance the idea that public transport is an essential component of MaaS.

Keywords: mobility as a service (MaaS); digital integration; urban mobility; users' intention; stakeholders

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1. Introduction

In urban areas, particularly those with reduced mobility options, a high reliance on privately owned vehicles is being observed [1]. Various concerns, such as air pollution, congestion, social exclusion and health problems, are associated with the excessive use of privately owned motorized vehicles [2]. Therefore, there is a growing demand for smart mobility solutions that can reduce the negative social, environmental, and economic externalities of private car usage and replace them with more environmentally friendly and inclusive alternatives [1]. The traditional approach to urban transport planning is changing and smart mobility has become an emerging field that has already concentrated great research attention [3]. At the same time, the need for better management of urban transport demand has contributed to the emergence of new concepts such as micromobility, and shared and on-demand mobility, as well as to the concept of "Mobility as a Service" (MaaS).

MaaS is defined as a "user-centric, intelligent mobility distribution model in which all mobility service providers' offerings are aggregated by a sole mobility provider, the MaaS provider, and supplied to users through a single digital platform" [4]. The concept of MaaS was first introduced in 2014 by Sampo Hietanen [5]. After the ITS Europe Congress in 2014 and the Whim App's successful testing in Helsinki, Finland, in 2016, the idea of MaaS started to gain interest on a global scale [1]. The rapid evolution of technology made possible the further development of MaaS, by providing the possibility of a dynamic interaction between supply and demand [6,7]. Over the past few years, this new service model has been implemented in many countries, including the United Kingdom, Canada,

Finland, Australia, Singapore and others [8]. In addition to Whim's App, there have also been international implementations of other MaaS schemes, such as Ubigo in Gothenburg, Moovel in Germany, WienMobil Lab and SMILE in Vienna, Optymod in Lyon, Mobility 2.0 services in Palma, Spain, Mobility Shop and Switchh in Hannover, My Cicero in Italy, Qixxit in Germany, Tuup in Finland, SHIFT in Las Vegas and SkedGo in Australia [9,10]. Also, several MaaS pilots have been implemented in the framework of EU-funded research and innovation projects [11].

Similarly to the concept of monthly mobile phone contracts, MaaS integrates a variety of forms of transport to provide a customized mobility package. It also offers additional services, such as trip planning, reservations and payments, through a single interface [5]. MaaS is an integration of a wide range of mobility services, such as bike-sharing, scooter-sharing, car-sharing and car-pooling, and, of course, public transport. By integrating all of these mobility services, MaaS seeks to provide a unique value proposition to the users by offering a substitute for private car use that may be just as practical, less expensive and more environmentally friendly [12]. Thus, it becomes understood that, except for the added value to the users, MaaS can also contribute in achieving societal goals, such as traffic congestion and emission reduction [13].

Based on experience to date, it seems that for the effective adoption of MaaS, there are three crucial factors; it is essential to have (a) a reliable public transportation system, (b) a variety of shared mobility services and (c) seamless co-operation between the different modes. In other words, according to Matyas and Kamargianni [8] and Ho et al. [14], public transportation should be the backbone of MaaS, as it is the key factor for establishing integrated urban transportation systems [9]. Furthermore, shared mobility modes such as car-sharing, bike-sharing, and individual and collective demand-responsive transport can provide flexibility and choice freedom, through their access-based logic [15,16]. Finally, seamlessness is the differentiator of MaaS, which, according to Hensher, is the key for increasing utility and adopting MaaS [17].

The MaaS literature can be separated into six categories [18]: (a) MaaS ecosystem, (b) services integration, (c) MaaS suppliers, (d) pilot implementations, (e) MaaS simulations and (f) MaaS challenges. Considering challenges, but also opportunities, Alyavina et al. built a thematic map that identifies 11 critical areas, namely: vehicle utilization, accessibility, data gathering, market visibility, digital access, affordability, market shares, modal shift, financial support and environment, as well as health and well-being [19].

Also, previous research related to the challenges that MaaS adoption faces identifies that various barriers from various perspectives exist; these barriers are related to the service design, the establishment of the appropriate business model, data sharing and the existing travel attitudes and behaviors, as well as the system impacts that are still unclear [20]. Van den Berg et al. investigated different types of business models and identified that MaaS profits, as well as consumer surplus and welfare, are really sensitive to the way that the MaaS system is organized [21]. Data availability, sharing, standardization and interoperability are essential for ensuring seamless integrations of different transportation services and providing a comprehensive travel experience to the users [22,23]. Regulatory challenges also exist, since MaaS providers need to obtain licenses and adapt to the local regulations [24]. It has become understood that MaaS is a complex sociotechnical system and it therefore requires the investigation of all stakeholders, including end-users' perceived barriers and needs [20].

Significant barriers also exist from the side of users; it seems that, at least in some cases, (potential) users are really engaged with private cars and they feel reluctant to shift towards other modes, and, at the same time, many users could be less keen on adopting new technologies [25]. Car dependency seems to be an issue when it comes to MaaS adoption, since as previous studies identify, MaaS can be more appealing to those that mostly use public transport [26,27], who do not own a private car [28], and are already used to rely on shared mobility services [29]. Yet, these are not the only barriers related to the users. An additional critical issue that concerns many users is data privacy and security when

sharing personal data [22]. Also, in these first steps of MaaS, it has been identified that users lack awareness regarding MaaS and, therefore, they cannot fully realize the potential and the benefits that MaaS can provide [30]. These challenges underscore the significance of addressing end-users' needs and apprehensions in the design and implementation of MaaS systems. If users' individual needs are not considered, MaaS acceptance becomes much more difficult [31], especially for some travelers who are categorized as having special travel needs [32].

As the main inspiration behind the development and implementation of MaaS is a user-centric view [12] and the design of customer-centered supply [33], this paper aims to capture holistically the perceived barriers and expectations by examining not only the perspective of stakeholders, but also the perspective of end-users. Moreover, the intention of potential users to adopt MaaS is being investigated, for identifying those that are most likely to use it. Optimizing the interaction between the user and MaaS is really challenging, as many different personal attitudes are considered [34]; yet, it is expected that the outcomes of the present paper can shed some light on this topic and assist both policy makers and MaaS providers to understand what needs to be carried out for fostering the adoption of MaaS in a way that can fulfill the expectations of the relevant stakeholders. Thus, this paper contributes to the topic of Sustainable MaaS, which has been extensively discussed by other researchers [35,36]. The paper also focuses on an interesting case study, where, on the one hand, MaaS is relatively unknown and sounds unusual, since even shared mobility options are still limited, and, on the other hand, it sounds promising, since the existing transportation system does not provide attractive alternatives to the use of private cars.

2. Description of the Undertaken Research

2.1. Study Area

The case study in this paper is the city of Thessaloniki, which is the second-largest city in Greece. For a long time, Thessaloniki's transportation practice has been predominately car-focused, as most daily trips are being made by private vehicles, and the levels of car ownership are considered very high [37]. On the other hand, active mobility, and especially cycling, concentrate a limited percentage of the modal share [38]. Thessaloniki's public transportation system only consists of buses. Before the pandemic, public transport modal share was at relatively high levels [37]; yet, during the pandemic, public transport usage was significantly decreased and it has not yet fully recovered [38]. Also, an underground metro line is under construction and is expected to be operational at the end of 2024. It is anticipated that the new metro line will enhance the role of public transport in the city of Thessaloniki and it will motivate Thessaloniki's residents to make a shift towards sustainable modes of transport.

Regarding shared mobility, in Thessaloniki, a dock-based bike-sharing system has operated since 2013, which is mainly used for recreational purposes. Yet, the pandemic appeared as an opportunity for increasing bike-sharing usage rates, especially among those that were already registered in the system before the pandemic [39]. Also, some dockless systems have appeared during recent years. Initially, shared e-scooter services were launched and they rapidly managed to become a trend; however, this trend gradually declined and led to the elimination of shared e-scooter services from the city. Shared e-scooters were also used mainly for recreational purposes and, in most cases, they replaced walking trips [40]. Despite the fact that shared e-scooters are widely accepted as an ideal mode for the first/last mile of trips, it seems that in Thessaloniki, where unimodality dominates, the willingness to combine shared e-scooters with another mode is limited [41]. In the framework of a National research project, called eMaaS, a MaaS scheme is being piloted for a first time in the city of Thessaloniki. This scheme integrates, both digitally (i.e., in a single mobile app) and physically (i.e., in shared mobility hubs), electric bike-sharing, scooter-sharing and car-sharing; the latter will be launched for the first time in the city as a part of the eMaaS pilot.

2.2. Data Collection

To have a better comprehension of the stakeholders' and end-users' preferences, expectations and needs regarding MaaS, two questionnaire surveys were designed and conducted. The first survey was addressed to the MaaS stakeholders and the second one was addressed specifically to (potential) end-users.

MaaS, by definition, requires the co-operation of several bodies and, therefore, it can be characterized as a multi-stakeholder environment. Based on previous related studies, e.g., [9,42,43], MaaS stakeholders include the following: (a) MaaS operator, (b) mobility services providers, (c) public authorities, (d) researchers/academia, (e) information and technology (IT) companies and (f) insurance companies. In the framework of this research, 12 stakeholders participated in an event with the primary aim to inform them about the concept of MaaS and the related initiative in the city of Thessaloniki. These stakeholders were then interviewed and asked to fill out a structured questionnaire. This questionnaire consists of two main parts. The first one includes more general questions such as which body/organization is best suited to manage a MaaS scheme in Thessaloniki, how important is the participation and the role of different categories of actors in MaaS and which mobility services are considered important to be included in a MaaS system in Thessaloniki. The second main part of the questionnaire included two questions. Each question included pair-wise comparisons and their aim was to assign weights and priorities in several barriers and expectations related to MaaS adoption. The pair-wise comparisons utilized Saaty's 9-point scale [44]. It should be noted that the 12 stakeholders represented the following categories of actors:

- Local authorities: representatives of 4 Municipalities of Thessaloniki's Metropolitan Area participated in the survey.
- Mobility service providers: representatives of 2 shared mobility services participated in the survey, as well as a representative of an IT company specialized in shared mobility. This IT company also operates by its own bike-sharing systems in various Greek cities and it also has developed expertise in digitally integrating mobility services
- Other organizations: this category includes a representative of a public transport authority, as well as 2 representatives of research/academia and 2 representatives of professional organizations that serve as technical advisors in issues related to transportation engineering and planning.

On the other hand, the questionnaire referring to the end-users consists of 4 separate sections:

- Section A: Questions regarding the socioeconomic characteristics of respondents are included (gender, age, monthly household income, place of residence). It also includes questions about the access/possession of a private vehicle and car driving license.
- Section B: It consists of four questions concerning the mobility profile of the respondents. In particular, this section examined the frequency of usage of specific transport modes, the average number of trips and transfers, and the number of kilometers traveled by the respondents daily.
- Section C: This is the most important part of the questionnaire, as it attempts to identify the respondents' needs and preferences related to the implementation of a MaaS scheme in Thessaloniki. More specifically, its questions refer to the implementation scenario of a MaaS scheme with only shared electric mobility services. The intention of using this system is, therefore, examined, as well as the factors that would lead the respondents to use it. In addition, the citizens are asked about the ideal way of paying.
- Section D: The last part of the questionnaire contains questions regarding the future expansion of the MaaS system. In particular, respondents are asked about which modes they consider essential for integrating in a MaaS scheme in Thessaloniki and about their willingness to use a MaaS system with various modes of transport (not only shared electric services, as asked in Section C).

The questionnaire was designed and distributed in electronic form via popular local websites, as well as via partners' social media and communication channels. The study was conducted for about a month between 16 February and 18 March 2022. In total, 220 valid replies were gathered in the online questionnaire survey.

3. Results

3.1. Stakeholders' Analysis

According to half of the stakeholders, a public transport authority is the most suitable actor for operating a MaaS scheme. Yet, there is also an opinion among some of the stakeholders that an IT company specialized in shared mobility services and digital integration could be the ideal MaaS operator. Regarding the importance of the role that different actors have in MaaS, it is identified that public transport authorities and public transport operators are absolutely essential. The role of shared mobility services providers, IT companies related to mobility solutions and research organizations also seems to be considered essential. On the other hand, the stakeholders who participated in the survey consider the role of taxi companies and insurance companies to be less important. To the question "which mobility services are considered important to be included in a MaaS system in Thessaloniki?", the unanimous response was that public buses and the metro should be integrated. Shared mobility vehicles were found to be really relevant as well. On the other hand, taxi services, ride-hailing and maritime urban transport were given less priority.

Emphasis is given to the last two questions of the questionnaire, which were analyzed using the Analytic Hierarchy Process (AHP) method. Using this method, the responses of stakeholders, with regards to the pair-wise comparisons, can be translated in values (weights) that express the importance of each criterion. Actually, in the AHP, the preferences are determined on the basis of these pair-wise comparisons, where each criterion is being compared (regarding its importance) with all other criteria, using Saaty's 9-point scale. In this way, a comparison matrix is being generated, where the number of rows and columns is equal to the number of criteria. Using this comparison matrix, a vector that expresses the weight of each criterion can be derived; this vector is the normalized Eigen vector of the comparison matrix (further details about how weights are calculated based on participants' responses can be found in [45]).

Regarding the barriers for adopting MaaS, the primary barrier was found to be the insufficient collaboration among the involved organizations (see Table 1). The widespread use of private cars and the high numbers of private car ownership that are identified in the city of Thessaloniki comprise an additional significant barrier. The absence of a common view among the organizations involved (e.g., different mobility service operators) and the possible feeling of deficient security of the users of the system (e.g., personal data, online transactions) were given the least importance as potential barriers. Also, it should be noted that while local authorities and organizations' representatives acknowledge the reluctance of operators to share data as an important barrier, mobility services providers consider this issue as not an important one. For estimating the validity of the results, the consistency ratio is calculated. In this case, the consistency ratio is equal to 2%, much lower than 10%, which is considered the maximum threshold value for characterizing the analysis as valid.

Regarding the expectations that stakeholders have from MaaS, it has become understood from Table 2 that MaaS is considered as an important "tool" in the efforts that are being made for reducing private car dependency and shift to sustainable modes. In the hierarchy of expectations, the second comes the provision of personalized mobility solutions for users and the third is the mitigation of social inequalities in terms of citizens' mobility. Yet, mitigating social inequalities seems not to be a priority for mobility services providers. On the other hand, mobility services providers identify MaaS as a great opportunity for promoting electromobility, which is still lagging behind in Greece. The economic progress of transport service operators does not seem to be a key expectation, even for the mobility services providers. This might reflect that they do not consider that MaaS adoption is close

to being achieved in Thessaloniki yet. It should be noted that, in the case of this question, the consistency ratio is 2.6% and, therefore, the results are considered valid.

Table 1. Weights of barriers related to MaaS adoption.

Criterion	Total	Local Authorities	Mobility Service Providers	Other Organizations
The widely spread use of cars	22.0%	25.0%	35.2%	13.9%
Insufficient collaboration among the stakeholders involved (e.g., different mobility service providers)	25.7%	21.9%	16.9%	33.7%
Institutional framework for public transport fare	16.0%	14.5%	16.5%	15.9%
The reluctance of operators/companies to share data	17.0%	20.7%	8.2%	19.4%
The possible feeling of deficient security of the users of the system (e.g., personal data, online transactions)	6.6%	4.4%	5.9%	8.6%
Absence of a common view among the organizations involved (e.g., different mobility service operators)	12.7%	13.5%	17.4%	8.6%

Table 2. Expectations of Stakeholders with regards to MaaS adoption.

Criterion	Total	Local Authorities	Mobility Service Providers	Other Organizations
Private car use limitation in Thessaloniki	38.1%	38.7%	20.9%	45.6%
Promotion of electromobility	16.5%	11.6%	35.4%	11.3%
The economic progress of transport service operators	7.5%	7.3%	8.8%	5.6%
Provision of personalized mobility solutions for MaaS users	20.6%	21.2%	29.5%	13.4%
Mitigation of social inequalities in terms of citizens' mobility	17.3%	21.2%	5.4%	24.1%

3.2. End-Users' Analysis

3.2.1. Descriptive Analysis

A total of 220 people participated in the end-users survey, out of which 51.8% are men and 46.4% are women, while a small percentage (1.8%) chose not to answer. Most of the answers came from people aged between 25 and 39, but there is a sufficient sample of both younger and older ages. The sample is well-distributed regarding the monthly household income categories. Most of the respondents either own or have access to a private vehicle while 90% of them have a car driving license. Focusing on the travel behavior characteristics of the respondents, a strong dependence on motorized vehicles, and especially on private cars, is being identified, as 62% of the respondents stated that they use private cars often or very often for their trips. Also, the percentages of respondents who use a bus are high and the percentages of taxi usage are relatively high. In contrast, privately owned and shared bikes and e-scooters are rarely used. According to the participants' answers, it is concluded that 51.8% of them conduct 3–4 trips on average per day, while a large amount of participants conduct 1–2 trips on average per day. Those that conduct more than 4 trips per day are limited. The largest percentage of the participants do not use this to conduct intermodal trips, while only a few are those who make more than 6 mode transfers in a week (i.e., approximately 1 per day). Finally, regarding the distance traveled, it is observed that more than half of the participants commute daily for over 6 km, with 36.3% of them covering more than 10 km.

The third section of the questionnaire refers to the implementation scenario of a MaaS scheme with only shared electric mobility services. A large percentage of the sample responded positively to the possibility of using such a system, with 45% considering it quite or very likely to use such a system for their trips. With regards to users' expectations from MaaS, 65% revealed that they would like the idea of having access to a motorized vehicle without owning it. A large number of individuals also believe that MaaS could assist them reducing mainly the time and, secondly, the cost of their transportation. It also seems that a key expectation of (potential) end-users is to facilitate the conduction of environmental-

friendly trips. Concerning the preferred MaaS payment method, 48.6% of the participants tend to choose a personalized package that would only include the transportation services that each user considers essential. On the contrary, a small percentage of the participants would prefer a package that is predefined by the operator. Finally, it seems that the pay-as-you-go approach is considered ideal for a relatively large part of the respondents.

The participants also expressed their opinion regarding which mobility services (other than shared electric mobility services) they would like to see being integrated in a possible future expansion. The results of their answers are presented in Table 3. Similarly to the findings from the stakeholders analysis, it is deducted that public transport, both public buses and the metro system, have a significant role in a MaaS scheme. On the other hand, ride-hailing and ridesharing were not considered important by the end-users, and even less important compared with maritime public transport. This finding is probably linked with the specific characteristics of the case study, since the citizens of Thessaloniki do not have previous experience from ride-hailing or ridesharing services, while Thessaloniki has a strong connection with the sea and maritime public transport, which was available in the past (and there is a continuous debate about whether it is purposeful to re-operate it).

Regarding the likelihood of using a MaaS scheme, which will include all of the available mobility services (i.e., shared electric mobility services plus the services presented in Table 3), the responses show that the integration of additional mobility services increases the willingness to adopt MaaS. More specifically, 73.2% of the participants gave a positive answer, and it is observed that many respondents who stated that they would not use a MaaS scheme with only shared electric mobility services are much keener on using MaaS in the case of having access to more mobility services, and especially in public transport.

Table 3. Importance of including different mobility services in MaaS schemes.

	Not at All Important	Slightly Important	Important	Very Important
Public buses	6.4%	13.2%	39.1%	41.4%
Metro	5.5%	6.4%	33.2%	55.0%
Taxi	7.7%	25.9%	39.1%	27.3%
Maritime public transport	8.6%	36.4%	34.1%	20.9%
Ride-hailing	12.3%	33.2%	35.5%	19.1%
Ridesharing	20.0%	32.3%	31.8%	15.9%

3.2.2. Modeling Intention to Use Maas

In this paper, two ordinal regression models are being developed with the aim to identify the factors (variables) affecting the intention of using a MaaS scheme with (a) only shared electric mobility services and (b) various means of transport. Ordinal regression is a rather simple form of logistic regression, yet it has highly interpretable coefficients that significantly assist in understanding relationships between variables, and it has been proved efficient in handling ordered dependent variables, and, as such, it has been opted by many studies that utilize surveys (since surveys in many cases incorporate ordinal variables). The general expression of ordinal regression is:

$$\log(\theta_j) = \beta_{j0} + \beta_{j1}{}^* \chi_1 + \ldots + \beta_{jn}{}^* \chi_n \quad (1)$$

where j extends from 1 to the number of categories (J) minus 1 and θ represents the odds of an event, and all of the events that are ordered before it, to occur instead of not occurring:

$$\theta_j = P(Y \leq j)/P(Y > j) \quad (2)$$

where $P(Y \leq j)$ is the cumulative probability of Y less than or equal to a specific category $j = 1, \ldots, J - 1$.

Variables regarding respondents' socioeconomic and mobility characteristics were examined as possible independent variables in the two models. The variable selection was

based on the *p*-values ($\leq$0.1) while trying to maximize the coefficient of determination, R^2. The variables that were finally included in the two models are shown in Tables 4 and 5 along with their coefficient, standard error, wald and *p*-value. It should be noted that the key assumption of ordinal regression models is the proportional odds assumption, which indicates that the relationship between the independent and dependent variables is the same across all categories of the dependent variable. The proportional odds assumption was tested through the test of parallel lines, which actually compares the fit of a model with the proportional odds assumption to a model without this assumption. The test's *p*-values were much higher than 0.05 (i.e., 0.625 for the first model and 0.518 for the second model), indicating that the coefficients of the independent variables are the same across all categories of the dependent variables and, therefore, it can be concluded that ordinal regression is suitable for the data.

The results presented in Table 4 indicate that one of the factors affecting the intention of using MaaS with only shared electric mobility services is age, and, specifically, older people are not so keen on using MaaS; yet, the only statistically significant class was that representing the 55–64 age group. In addition, another factor is the monthly household income. It is found that people with a high income (>2000 €) are more likely to use MaaS compared to people with a low income (<400 €). Additionally, it is inferred that the more a person uses a taxi service, the more willing they become to use MaaS. This finding shows that MaaS, even with only shared electric mobility services, could be an attractive alternative for those who already rely on modes that operate on an "as-needed" basis. Finally, it is identified that there is a greater intention to use MaaS among those that make a limited number of trips per day (up to 6) and those that make a higher number of transfer modes (i.e., intermodal trips). These two findings seem reasonable, since those that make a large number of trips within the day usually rely on private cars, which provide the important advantage of autonomy and those that are already used to conduct intermodal trips are probably more familiar with the MaaS approach, which requires the optimal combination of different transportation modes.

Table 4. Model 1: Intention to use MaaS with only shared electric mobility services.

	Estimate	**Std. Error**	**Wald**	***p*-Value**
Age	-	-	-	-
18–24 (reference)	-	-	-	-
55–64	−1.111	0.521	4.546	0.033
Monthly household income	-	-	-	-
>2000 € (reference)	-	-	-	-
0–400 €	−1.330	0.530	6.291	0.012
Taxi usage frequency	-	-	-	-
Never (reference)	-	-	-	-
Rarely	−0.875	0.400	4.787	0.029
Sometimes	1.452	0.438	10.987	0.001
Often	1.697	0.585	8.417	0.004
Very often	2.743	0.979	7.857	0.005
Number of daily trips	-	-	-	-
>6 (reference)	-	-	-	-
5–6	2.358	0.747	9.972	0.002
3–4	2.033	0.631	10.375	0.001
1–2	2.259	0.660	11.706	0.001
Number of mode transfers within a week	-	-	-	-
0 (reference)	-	-	-	-
1–6	0.507	0.298	2.891	0.089
>14	2.885	1.404	4.222	0.040
McFadden's Pseudo-R2 = 9.3%				

The results presented in Table 5 concern the intention to use a MaaS scheme that integrates various transportation services. The results of this model enhance the finding of the previous model regarding the effect of age and, specifically, that older people show limited interest in using MaaS. This finding agrees with the findings of previously published studies, which identify a strong link between age and intention to use MaaS; this link is attributed to the greater interest and capacity of young people to utilize smart devices and technologies compared with the older ones [1,26,28]. It is also indicated that people of high income are more likely to use MaaS compared with those that belong to the lowest income category. This finding was also identified in a Dutch study, which identified that MaaS early adopters are more likely to be people of higher socioeconomic status and income [27]. This relationship between intention to use MaaS and income is attributed to the higher value of time of people with higher income, since MaaS, in most cases, is more expensive compared with public transit, but it provides greater flexibility [46]. What is similar between the models is also the trend regarding the effect of taxi usage frequency on the intention to use MaaS. A slight effect of car usage frequency is also identified in the second model, showing that those that use a private car are very often less likely to adopt MaaS.

Table 5. Model 2: Intention to use MaaS with various mobility services.

	Estimate	**Std. Error**	**Wald**	***p*-Value**
Age	-	-	-	-
18–24 (reference)	-	-	-	-
25–39	−0.929	0.385	5.807	0.016
40–54	−1.172	0.454	6.659	0.010
55–64	−1.750	0.589	8.839	0.003
Income	-	-	-	-
>2000 € (reference)	-	-	-	-
1600–2000 €	0.734	0.425	2.979	0.084
0–400 €	−1.898	0.570	11.083	0.001
Taxi usage frequency	-	-	-	-
Never (reference)	-	-	-	-
Rarely	0.713	0.418	2.912	0.088
Sometimes	1.439	0.450	10.236	0.001
Very often	4.335	1.334	10.554	0.001
Car usage frequency	-	-	-	-
Very often (reference)	-	-	-	-
Often	0.669	0.373	3.213	0.073
Number of daily trips	-	-	-	-
>6 (reference)	-	-	-	-
0	−2.248	1.099	4.185	0.041
McFadden's Pseudo-R2 = 11.9%				

4. Discussion

The findings of this paper enhance the opinion that public transport is the backbone of a successful MaaS scheme. This, at first, reflected, in the opinions of stakeholders, that public transport services are essential for a MaaS scheme in the city of Thessaloniki. End-users also strongly agree with this opinion and they assign great importance to the integration of both public buses and the metro system. Moreover, it seems that the integration of public transport services can significantly increase the willingness of end-users to adopt MaaS. The great role of public transport in MaaS is also captured through the question about the ideal organization for operating a MaaS scheme in Thessaloniki. According to the majority of the stakeholders that participated in the survey, a public transport authority is the most suitable type of organization for operating a MaaS scheme.

Also, through the results of this paper, a feedback loop between car dependency and MaaS adoption is recognized. On the one hand, it is believed that high levels of car usage and ownership significantly hinder the adoption and success of MaaS. On the other

hand, MaaS is being thought as a "tool" for limiting car dependency and providing a more sustainable alternative to the end-users. Also, one of the main expectations of the end-users from MaaS is to have the possibility to use a motorized vehicle, but without owning a private one.

Yet, it seems that not all stakeholders' categories share the same expectations. More specifically, mobility services providers expect the promotion of electromobility through MaaS. This possibly indicates that they identify that there is a large potential market, considering also that electromobility in Greece is still at a premature level. On the contrary, mobility services providers do not expect to mitigate social inequalities in terms of citizens' mobility. Such an aim could probably have a negative impact on the financial sustainability of mobility services, since it would require efforts to serve areas that do not necessarily have high transportation demand levels, especially for alternative modes of transport. On the other hand, the mitigation of social inequalities is of high importance for all other types of stakeholders. This contrast indicates the conflicting interests that exist with regards to MaaS, which need to be resolved for the success of MaaS.

Another conclusion comes from the outcomes of the two ordinal regression models and, specifically, from the results regarding the taxi usage frequency and the mode transfers. It seems that those already engaged in traveling on an "as-needed" basis are more willing to use MaaS, which follows a similar approach, and also those already engaged in combining modes are more willing to use MaaS, which relies on transport mode combination. Actually, despite the fact that MaaS is an innovative concept, its approach relies mainly on already existing concepts and approaches. More specifically, MaaS heavily relies on the "as-needed" approach and the concept of intermodality. Taxi services are the more traditional transportation mode that provides access to the car usage on an "as-needed" basis. Therefore, it is not surprising that a greater willingness to use MaaS is being observed among those already engaged with taxi services and intermodal trips.

5. Conclusions

The present paper aims to investigate holistically the barriers and expectations with regards to MaaS adoption, by analyzing both the perspective of various stakeholders and (potential) end-users. An additional aim is to identify those users that are more willing to use a MaaS scheme and how the integration of services, other than shared mobility services, can increase the willingness to adopt MaaS.

The results mark the complexity of MaaS schemes, which have to consider and accommodate the needs of various parties with different expectations. Thus, as was identified by Arias-Molinares et al., the progress towards the MaaS adoption mostly requires the resolution of governance issues surrounding MaaS [47]. From users' perspectives, it can be concluded that an efficient MaaS scheme should anyhow integrate public transport services. This way, MaaS adoption can be facilitated and accelerated. Also, the acceleration of MaaS adoption is highly correlated with private car usage culture. Policies that restrict the immoderate use of private cars are essential for triggering MaaS adoption; MaaS itself can also be a tool for motivating the use of more sustainable modes of transport.

The findings of this paper are subject to some limitations. Despite the fact that the stakeholders sample managed to include various categories of stakeholders (including those with the greatest role in MaaS), the sample of both stakeholders and end-users was rather limited and, therefore, the generalization of the results should be treated with caution. Another limitation concerns the previous experience of the end-users with regards to MaaS. MaaS is still unknown in the residents of Thessaloniki and no MaaS service existed in the city when the survey took place. Therefore, there is a possibility that some users were cautious towards MaaS, while some others that are keen on innovative concepts could have stated an over-willingness regarding the use of MaaS, which may not be reflected actually. Moreover, our study is suitable for identifying those that have an a priori positive attitude with regards to MaaS usage, but is missing trip attributes like travel cost and travel duration, which have an impact on mode choice behavior in general, but also in MaaS

adoption specifically [48,49], while it is also missing elements related to the MaaS type and the level of integration. Based on the above, future research in this field could include an analysis of attitudes and intentions after the pilot operation in the city of Thessaloniki, focusing specifically on those that used the MaaS scheme and also investigating how different elements of MaaS supply can affect users' adoption. These analyses can set the ground for examining how rapidly MaaS could be adopted and become a common practice and which parameters can accelerate MaaS adoption.

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