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Drivers and barriers of Mobility-as-a-Service: insights from stakeholders of a middle-size Italian city

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Abstract

Over the past decade, the concept of Mobility-as-a-Service (MaaS) has been gaining popularity as a transportation system able to reduce dependence on private car use. Nevertheless, implementing MaaS may be challenging because its success requires the involvement of various actors and stakeholders, each with distinct goals and constraints. While MaaS has recently captured the attention of Italian policymakers, the roles of different stakeholders and the factors driving or hindering its implementation remain unclear. Hence, in this study, we explore the key elements facilitating the adoption of MaaS in a medium-sized Italian city. To achieve this, a workshop and an online survey were conducted involving representatives of local public administrations, public and private transport operators, and mobility service providers in the metropolitan city of Cagliari. The following themes emerged from the workshop and questionnaire: 1) the problems associated with MaaS governance and regulation, aiming to provide citizens with a reliable service and avoid the formation of an oligopoly of large international companies and agencies. A governance solution based on an open platform was believed to be the most suitable for making information services, ticketing, data infrastructure, and APIs accessible to all. 2) The importance of cooperation among public and private operators. 3) The need to develop a flexible technological platform capable of integrating different modes of transportation and proposing personalized ticket bundles.

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1. Introduction

Recently, in cities around the world, getting from place to place has evolved to include a combination of bus rides, train journeys, bike/scooter sharing, and car sharing. Mobility as a Service (MaaS) is a recent and innovative concept whose main purpose is to ease the use of different mobility services (*e.g.*, public transport, car sharing, bike sharing,

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taxi, *etc.*) by making them flexible, integrated, reliable, and user-oriented (Smith and Hensher, 2020). Different pilot tests have been implemented worldwide at either an urban scale (Strömberg *et al.*, 2018; Matyas and Kamargianni, 2019; Polydoropoulou *et al.*, 2020) or a regional scale (Caballini *et al.*, 2023; Mulley *et al.*, 2023). These early tests showed the benefits of developing a MaaS system, as well as the enabling factors and barriers to its implementation. In particular, given the multitude of actors and stakeholders involved in mobility, different views on the organization and management of the service, the business model, and the societal objectives to be reached may arise (Karlsson *et al.*, 2020; Jittrapirom *et al.*, 2020; Polydoropoulou *et al.*, 2020; Butler *et al.*, 2021).

In Italy, policymakers, local municipalities, and regional governments have only recently shown interest in MaaS as a way to reduce personal use and ownership of individual motorized means of transport. However, different questions should be addressed before MaaS can become mainstream at a national level. First, public transport in Italian cities is often inadequate and ineffective (Carteni *et al.*, 2020), while only efficient and reliable service can facilitate its use. One reason is that, although funded by the same public organization, the different public transport services in many cities are managed by separate public entities, independent of each other, making it difficult to integrate fares (Tuveri *et al.*, 2019) or organize a truly integrated service capable of providing citizens with a seamless door-to-door trip. In Italy, collective public transport systems (buses, trains, metro, trams) accounted for a modal share of 7.6% in 2023 (ISFORT, 2023). Additionally, the share of multimodal trips is only 3.1% (ISFORT, 2023). Second, in Italy, though the recent experiences of MaaS in some contexts, such as BIP for MaaS (Caballini *et al.*, 2023) and MaaS for Italy, there is still a lack of trials providing indications at a national level on the role of different stakeholders, the challenges in system development, and how the system varies depending on its geographic setting.

Given the above discussion, the object of the current study is to investigate, from a quantitative and qualitative standpoint, the factors that can trigger or act as barriers to the implementation of MaaS in Italy. To this end, we conducted in 2021 a workshop and an online survey with stakeholders from the metropolitan city of Cagliari.

The remainder of the paper is organized as follows. Section 2 gives a brief overview of past literature on drivers and barriers of MaaS. Section 3 gives details of the transportation context of the analysis. Section 4 describes the adopted methodology, while Section 5 analyzes the results of the workshop and closed survey. Finally, Section 6 discusses some policy implications.

2. Literature review

In the last decade, various studies have been published investigating the drivers and barriers to the success of MaaS. According to the seminal paper by Karlsson *et al.* (2020), these factors can be classified into macro-level factors, meso-level factors, and micro-level factors.

Macro-level factors include the national and regional legislative frameworks, which can limit the liberal initiative of public transport authorities (Surakka *et al.*, 2018; Karlsson *et al.*, 2020; Butler *et al.*, 2021), and the availability of financial resources needed for the implementation of the service (Jittrapirom *et al.*, 2020; Alyavina *et al.*, 2022).

At the meso-level, the main barrier to overcome is the difficulty in getting the different stakeholders involved in constructing a MaaS—public transport operators, shared mobility operators, taxi companies, IT firms, and public administrations—to cooperate with each other (Karlsson *et al.*, 2020; Butler *et al.*, 2021). Lack of collaboration can manifest as disagreement on how responsibilities should be distributed among stakeholders (Karlsson *et al.*, 2020), lack of leadership (Karlsson *et al.*, 2020; Jittrapirom *et al.*, 2020), different visions on the role of MaaS (Surakka *et al.*, 2018; Smith and Hensher, 2020; Butler *et al.*, 2021), fare integration (Matyas and Kamargianni, 2019, Butler *et al.*, 2021) and concerns about market dominance (Polydoropoulou *et al.*, 2020; Butler *et al.*, 2021). This can mainly be attributed to the different goals pursued by public and private partners (Karlsson *et al.*, 2020). While public entities focus on societal goals like accessibility and reduced car use (Hensher *et al.*, 2023; Caballini *et al.*, 2023), private partners prioritize profit maximization (Butler *et al.*, 2021). Disagreements among private partners can also exist, such as in the case of the type of MaaS governance model to adopt (Butler *et al.*, 2021).

Various experiments in Europe have shown that only the presence of a shared vision among stakeholders facilitates the integration of different objectives, reduces the level of uncertainty, and conveys the message that public entities can support the development of the private sector (Meurs *et al.*, 2020, Esztergár-Kiss *et al.*, 2020). At the same time, several studies indicate that without an economic return for private entities, the goal of integrating different mobility services into a single platform is very difficult to achieve (Polydoropoulou *et al.*, 2018; Smith *et al.*, 2018).

Finally, there are micro-level factors, which are more closely related to travel demand than to supply. A key factor for MaaS is the digital platform, which must be designed to improve the travel experience (Butler *et al.*, 2021). The ability for users to plan their journeys by evaluating, through the platform, multiple transport alternatives, fare integration, and real-time updates on service availability is crucial for meeting user expectations and providing a travel experience that can compete in terms of comfort, monetary cost, and time with private vehicles (Matyas and Kamargianni, 2019; Kriswardhana and Esztergár-Kiss, 2023). User travel habits also influence MaaS adoption. Several surveys have shown that, although current public transport users are an essential target for MaaS success, they may not be interested in the concept of MaaS (Ho *et al.*, 2018). In other studies, however, public transport users have been identified as the most likely to use MaaS, along with those who consider car ownership unimportant or have a high level of environmental awareness (Fioreze *et al.*, 2019). Almost all studies agree that the most reticent people to adopt MaaS are car drivers (Kriswardhana and Esztergár-Kiss, 2023).

3. Description of the transportation context

Cagliari is the capital of Sardinia (Italy), and its metropolitan area has around 432,000 inhabitants. The city is served by the Cagliari-Elmas international airport, located a few kilometers from Cagliari's city center. Cagliari has a port divided into two sectors: the tourist port and the international container terminal. The railway station in Cagliari is served by regional trains linking it to almost all the towns in Sardinia.

The demand for mobility in the metropolitan area of Cagliari primarily consists of individuals who commute daily from neighboring municipalities to the main city (169,815 vehicles/day), while 61005 vehicles/day move within the city center. According to ISTAT (2011), the modal share for regular commuters from home to workplace/school is as follows: private car (63.4%), public transport (16.8%), walking (19.5%), and cycling (0.3%).

The city is served by a large network of public bus and trolleybus lines, operated by two different transport operators, ARST and CTM. Both CTM and ARST are publicly owned joint-stock companies, and their service is subsidized by the Regional Government of Sardinia. ARST manages a dedicated tram service between Cagliari's city center and the suburban university campus of Cittadella. Trenitalia, the main train operator in Italy, runs a metro train service connecting Cagliari central station, the airport, and the city of Decimomannu. Cagliari offers both car sharing (free-floating and station-based) and scooter sharing services.

Different mobility applications for smartphones are available in the metropolitan city of Cagliari. CTM and ARST have implemented contactless electronic ticketing systems. Additionally, various apps provide real-time information on schedules, routes, and stops for public transportation, allowing users to better plan their trips. Currently, it is possible to purchase integrated monthly tickets for ARST-CTM, ARST-Trenitalia, and Trenitalia-CTM.

4. Methodology

The whole research activity is part of the project "MyPass. Mobility as a Service", which aimed to build new business models, promote cooperation between transport operators, construct a technological platform to deliver the service, and develop a series of open APIs that can facilitate interoperability among different transport services in Italy. One of the activities of the project was to understand which factors could drive or hinder the various stakeholders in the implementation of a MaaS system within the context of the experimentation chosen for the project, namely the Metropolitan City of Cagliari.

Following the approach of Jittrapirom *et al.* (2020) and Polydoropoulou *et al.* (2020), our study employed a mixed quantitative-qualitative approach to gather data from MaaS stakeholders. This involved a workshop held in December 2021 with 15 participants. The participants represented various sectors: public authorities (5 individuals, 33.3%), public transport operators (3 individuals, 20.0%), sharing mobility transport operators (3 individuals, 20.0%), academic partners (1 individual, 6.7%), consultancy firms (1 individual, 6.7%), IT companies (1 individual, 6.7%), and ticketing and payment service providers (1 individual, 6.7%). Regarding participant roles, 6 (40.0%) were employees, 4 (26.7%) were executives, and 5 (33.3%) were entrepreneurs/CEOs. The gender distribution was 9 male (60.0%) and 6 female (40.0%) participants.

The workshop began with an introduction to the MyPaaS project and its objectives. In the first discussion session, stakeholders engaged in a discussion on the defining elements of a MaaS service for the Metropolitan City of Cagliari,

focusing on services, stakeholder roles, potential corridors for system implementation, and potential users of the service. This session concluded with a closed questionnaire on the concept of MaaS. In the second session, participants discussed the potential benefits of MaaS for the Metropolitan City of Cagliari, as well as the barriers to MaaS implementation and possible solutions to address these barriers. The workshop concluded with a second closed questionnaire soliciting participants' views on MaaS benefits, barriers, and drivers.

5. Findings

5.1. The concept of MaaS

Concerning the concept of Mobility as a Service (MaaS), workshop results reveal differing perspectives based on stakeholder background and type. Public administrations and public authorities emphasize MaaS as a tool to promote intermodality and reduce car dependence.

“With MaaS, we can increase the sustainable mobility modal share and reduce car usage by enhancing passenger safety.” (Public authority)

“MaaS is the only way to favor intermodality.” (Public Transport Operator)

Private stakeholders, on the other hand, focus more on MaaS as a technological platform that aggregates transportation options, implicitly highlighting its business potential.

“MaaS is a platform that bundles all mobility solutions within a specific transportation context.” (IT Consultancy Firm)

“MaaS is the natural evolution of the urban transport system.” (Payment Service Provider)

When asked about the innovation brought by MaaS, participants provide different answers. Some believe it lies in the possibility to reduce the level of car ownership and usage, focusing on MaaS as a way to steer sustainability. Others think that the innovation stands in the cooperation among different transportation operators. Lastly, some view the opportunity to offer customers integrated tickets for transportation services, almost absent in the research context, as the key innovation of MaaS.

5.2. Benefits of MaaS

Workshop participants identified several potential benefits of Mobility as a Service (MaaS) for the Metropolitan City of Cagliari. For public and private service providers, MaaS offers opportunities to expand their customer base. This feeling was prevalent among private operators. Interestingly, the public administration identified a distinct benefit of MaaS: sharing of data on mobility demand. The chance of having available data on specific mobility needs and targeted areas by data sharing would permit policymakers to inform strategies for addressing existing needs and attracting new users. Concerning benefits for MaaS users, participants agreed that MaaS is able to generate several advantages, including increased accessibility and availability of multimodal travel options, reduced travel times and costs, and improved trip planning capabilities. With regards to the availability of multimodal travel alternative, one of the participants, declared:

“Currently, public transport service does not serve all residential areas. In these contexts, a mixed system between bike sharing and the use of public transport could be proposed. Although MaaS solutions are not strictly original, they fill the operational gap of previously technological platforms.” (Public Transport Operator)

According to one participant, trip planning is a key benefit for tourists visiting the city of Cagliari. Indeed, MaaS makes tourists aware of travel alternatives they might otherwise overlook. Another participant emphasized the

importance of integrated trip planning and booking functionalities, especially for round-trip journeys. This feature would incentivize transportation companies to prioritize return trip planning, which is currently lacking and causes significant inconvenience for users, as most public transportation services operate with high frequency during morning peak hours but offer limited options in the evening.

“Since most MaaS services are for collective use and users often make travel choices based on their return journey, the same availability of vehicles must be guaranteed for both legs of a trip. This is crucial during the travel booking phase, so as to encourage continued use of MaaS and discourage the use of individual vehicles.” (Transportation consultancy firm)

Participants collectively agreed that MaaS can contribute to a modal shift towards sustainable transportation alternatives, considering current car-centric travel patterns in Cagliari. Additionally, one stakeholder believes that actors involved in building MaaS have an interest in maximizing user numbers, so that MaaS can be considered a tool for achieving both economic and societal benefits.

“Each of the stakeholders participating in MaaS has an interest in supporting the system and improving the accessibility of the promoted services to generate as much demand as possible. In this perspective, MaaS can act as a multiplier of economic benefits and help achieve broader public policy objectives.” (Private Transport Operator)

5.3. MaaS barriers

The third discussion section session focused on identifying barriers to MaaS implementation within the metropolitan area of Cagliari.

A consensus emerged among participants that the divergent perspectives of transport operators and public authorities regarding MaaS scope pose a significant barrier. This was summarized by a public transport operator:

“To develop a MaaS system and in the context of opening up the public transport market, it is essential that a deep and shared understanding of specific characteristics of MaaS, advantages, and potential risks be disseminated among stakeholders. This is particularly important with reference to the type of business model to be implemented that should address any concerns or hesitations about joining the platform.” (Public Transport Operator)

Another emerging barrier was the lack of clarity surrounding the governance model. In this regard, transport service providers, especially private ones, expressed concerns that without clear governing rules, each operator would be left to compete independently, potentially leading to the formation of a monopoly or oligopoly. Furthermore, some participants argued that variations in European regulations and taxation could give certain platforms, particularly global industry leaders, an unfair competitive advantage. However, public administration representatives held a contrasting view, emphasizing the importance of large players in providing accessibility to MaaS-unfamiliar users, such as tourists. They also expressed confidence in the ability of local operators to compete effectively against these larger platforms:

“There is a MaaS market segment where local operators can make a difference: in-depth knowledge of the territory, offering personalized travel solutions, and catering to those demand segments that large global operators often overlook.” (Public authority)

The availability and quality of open data and APIs necessary for successful implementation of MaaS emerged as another crucial concern. Closely related to this, attention was also drawn to the issue of data for integrated ticketing and multimodal travel. According to participants, ensuring data quality aligned with service requirements was essential. A representative from the Sardinia Regional Public Administration admitted that the regional government attempted in the recent past to foster the sharing of open data among transport operators but faced challenges. For this reason, rules and circulars were issued in compliance with EU regulations.

Lastly, participants also underscored the importance of user-friendly MaaS platforms, emphasizing the need for intuitive interfaces accessible to all users, including older generations. This aligns with the broader goal of seamless user experience.

The analysis of the closed questionnaire about MaaS barriers confirms the results of the workshop. When asked to express the difficulty of addressing some MaaS barriers using a 5-point Likert scale (from 1 “very easy” to 5 “very difficult”), the most significant barrier identified was the integration of tickets across transportation services: 10 individuals out of 15 (66.6%) rated it as a difficult or very difficult issue to solve. This was followed by concerns regarding existing data exchange protocols (10 individuals, 66.6%), regulatory frameworks (8 individuals, 53.3%), the lack of a defined business model (8 individuals, 53.3%), an unclear governance model (8 individuals, 53.3%). Conversely, respondents expressed minimal concerns about topics such as service integration among different transport providers (6 individuals, 40%), differing stakeholder objectives (5 individuals, 33.3%), technology issues in terms of lack of standards and platform (5 individuals, 33.3%), privacy (1 individual, 6.7%), and digital illiteracy (1 individual, 6.7%).

5.4. Enabling factors of MaaS

After identifying the barriers, workshop participants were asked to identify the potential drivers of a MaaS market in the Metropolitan City of Cagliari. The main driver appears to be the governance model. The decision on which type of MaaS governance to implement requires the convergence and cooperation of all transport operators, who will then need to comply with regulations (service contracts, etc.). Public administration representatives participating in the workshop highlighted that for MaaS to be successful, clear rules need to be established to allow all stakeholders to effectively benefit from MaaS. In particular, they agreed that the open platform governance solution, with rules, is the most suitable one to make MaaS services accessible to everyone.

“Under an open platform governance model, with clear rules set by the Public Administration, a number of applications and service providers would emerge, competing with each other to deliver the best service to users, thereby attracting more demand for public transportation and multi-operator travel solutions.” (Public authority)

Another key driver identified was the selection of MaaS implementation corridors. Some participants suggested that the service should not be limited to the city of Cagliari but should also extend to popular tourist destinations in the surrounding province. Proper planning of MaaS implementation in these areas, according to some, could also help address the revenue-sharing issue between operators, currently considered as a barrier to MaaS adoption.

Other participants emphasized that, if the long-term goal is to achieve widespread MaaS adoption, it is essential to move beyond basic service aggregation and offer flexible subscription plans tailored to individual user needs. While predefined packages can facilitate initial launch of MaaS, some recommended the full potential of the system can be reached only by providing users with the ability to construct flexible and customized plans.

From the answers to the closed questionnaires, where we asked by the means of a 5-point Likert scale (1 = irrelevant, 5 = crucial), which items could be considered as enablers of a broad implementation of MaaS, the majority of stakeholders believe as crucial the integration of transport services in the space and time (12 individuals, 80.0%), the reduction of travel time (9 individuals, 60.0%) and the regularity of the service (9 individuals, 60.0%). At the same time, the implementation of ticket integration (7 individuals, 46.7%), the increase of the level of travel comfort (6 individuals, 40.0%) and flexibility of the service (6 individuals, 40.0%) were considered essential features to convince citizens to use MaaS.

When asked to express the level of importance of transport modes to be included in MaaS on a 5-point Likert scale (from 5 = crucial to 1 = irrelevant), most participants identified public transport services as the most crucial travel alternative (13 individuals, 86.7%), followed by car sharing (6 individuals, 40.0%), bike sharing, carpooling, and parking services (4 individuals each, 26.7% each), scooter sharing (3 individuals, 20.0%); and taxi (2 individuals, 13.3%).

Lastly, when asked about the three most important features for a MaaS, 86.6% of the sample (13 respondents) agreed that journey planning was the top priority. This was followed by a combined ticket/payment service

(encompassing both pay-as-you-go and season ticket options) (60%, 9 respondents) and an information service (53.3%, 8 respondents).

6. Conclusions

Recently in Italy, policymakers, at both national and municipal level, are pushing to implement MaaS services. As a result, a number of programs and experimentations have been financed and implemented. Nevertheless, there is still a notable gap in research investigating the barriers and enablers of MaaS in Italian cities, while a deeper understanding of this topic would be beneficial to increase the efficacy of MaaS systems. Motivated by this gap, in the current study, we investigate which are the challenges and opportunities of the implementation of a MaaS in the metropolitan city of Cagliari, a middle-size Italian city. To achieve this, we conducted a workshop with local public and private stakeholders.

Several results emerged from our analysis. First of all, it was clear that the concepts of MaaS can vary depending on the stakeholder's background. While public administrations tend to think of MaaS as a way to improve integration across transportation services and reduce car usage, private companies focus more on the technological potential of the tool, which can positively impact their revenues. In any case, all stakeholders recognize that the main benefit of MaaS is increasing the number of people adopting more sustainable travel behaviors and making transport services more efficient. In line with past literature, key barriers include ticket integration (Butler *et al.*, 2021), which is considered essential though challenging to achieve, and the absence of clear regulations and a governance model (Meurs *et al.*, 2020; Butler *et al.*, 2021) to manage the system and foster cooperation among MaaS partners. Concerning demand, workshop participants highlighted that for MaaS to be adopted by individuals, it should offer personalized and flexible bundle tickets. This is similar to results reported in previous research (Butler *et al.*, 2021; Kriswardhana and Esztergár-Kiss, 2023). Moreover, the integrated service must be reliable and competitive in terms of travel time and costs. Given the context, tourist demand should also be considered as a potential market segment. We should note that the main findings of the workshop do not differ much from what found in other experiences across Europe, suggesting that the challenges of MaaS, especially in terms of cooperation among stakeholders, governance model and fare integration, are common regardless of the context MaaS must be implemented.

A number of policy implications and suggestions to the policy makers of the context of our study can be derived from our study. The most important element for making MaaS effective and inclusive of a large number of transportation services is a robust legislative framework, particularly in terms of governance. Such regulations can prevent market domination and encourage the construction of a truly integrated and seamless transportation system. According to the results of the workshop, the best governance model for the analyzed contexts should be based on collaboration between public entities and private operators. The Sardinia Region, as the primary funder of public transport, is well-positioned to lead this initiative by defining clear rules and guidelines for a region-wide MaaS system. Any entity, whether public or private, operating in the metropolitan area of Cagliari should have the opportunity to assume the roles of MaaS Operator or MaaS Integrator. This would encourage maximum participation and collaboration among all key sector stakeholders and ensure a wide range of services and mobility options for end users. Another element to consider when designing a MaaS system is the quality of open data and APIs, as they are crucial for providing reliable information to users and supporting the overall system performance.

The current study does not come without limitations. First, we considered only one city in our investigation, so our results cannot be generalized to all Italian cities. Indeed, a one-size-fits-all MaaS model is unlikely to be effective given the diverse urban contexts across Italy. Hence, future research should expand our analysis, interviewing and organizing workshop with stakeholders from cities with different characteristics (north vs south, big cities vs middle size vs small cities). Nevertheless, given the common national framework public administrations and private stakeholders are operating within, some of the issues come out from our context may be common to other cities. Another limitation relates to the number of stakeholders who participated in the workshop and completed the survey. Indeed, some stakeholders refused to participate in the workshop. While this is a limitation, it also highlights the difficulty of involving all relevant partners in a MaaS system.

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