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Mobility as a Service: an Italian MaaS pilot at regional level with public governance

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Abstract

Mobility as a Service (MaaS) is the new mobility challenge. In Italy, the Piedmont Region has been implementing the BIPforMaaS, the first Italian regional MaaS project with public governance, aimed at creating a framework of rules for the full deployment of MaaS in the urban and metropolitan area of Turin and in the whole Piedmont Region. Public governance guarantees fair and non-discriminatory competition, while providing a more effective service for end users. This paper presents the results of the BIPforMaaS pilot project, which involved 67 active users, with the goal of field-testing the use of a MaaS app that allows users to book various mobility services. The results showed that the proposed MaaS system can effectively integrate multiple mobility services while ensuring flexibility and efficiency. An environmental analysis is also presented in order to show how MaaS can contribute to a more sustainable mobility system by reducing CO_2 emissions.

Keywords: Mobility as a Service; public governance; case study; MaaS pilot; Italian case study.

1. Introduction

Recent years have seen a continuous and profound evolution of mobility. Environmental and social issues impose to reduce negative externalities, such as local and global emissions as well as congestion in urban areas. Compared to the past, citizens tend to choose more environmentally friendly and flexible solutions for their mobility. On the supply side, alternative modes of transport are being proposed, particularly public transportation in a co-modal form and shared mobility based on electric or hybrid powertrains. Millennials seem to be less interested in owning a private car (Klein and Smart, 2017) than those born in the last century even though, in Italy private car use is difficult to abandon (Caballini et al., 2022). The COVID-19 pandemic has further emphasized the need for more sustainable transportation systems, in terms of used space,

energy and safety, highlighting the crucial role of technology in improving people's daily lives (Caballini, Agostino and Dalla Chiara, 2021). Mobility as a Service (MaaS) is an answer to emerging mobility needs. It consists of an integrated platform that includes various mobility services, such as planning, booking and paying for a multimodal trip, electric recharging or parking. Based on a pre-existing ITS context (fleet monitoring, traffic light prioritisation, etc.), MaaS can provide real-time information to users and offer the possibility to pay either for a single trip (pay-per-use mode) or take advantage of monthly packages at attractive prices and customized for specific types of users (e.g., students). The MaaS ecosystem is complex and involves many actors that have to interact with each other to develop the service and cooperate to achieve social, traffic and environmental objectives (Arias-Molinares and García-Palomares, 2020). Public and private transport operators constitute the core business of the service, which includes different modes of transportation such as trams, trains and metros, buses, sharing mobility (scooters, cars and bikes), carpooling, car rental, taxis, parking and EV recharging services. Since users are at the center of the ecosystem, user travel preferences and behaviors are widely studied (Ho et al., 2018; Alyavina, Nikitas and Tchouamou Njoya, 2020; Schikofsky, Dannewald and Kowald, 2020; Storme et al., 2020; Zijlstra et al., 2020; Hensher, Ho and Reck, 2021; Kim et al., 2021; Matyas and Kamargianni, 2021; Caballini et al., 2022). User habits are specific to each context in which the service will be developed, as they are influenced by various factors such as geography and culture. Governance and policy are crucial to achieve a high level of service development and spatial coverage (Jittrapirom et al., 2018; Surakka et al., 2018; Sakai, 2019; Smith and Hensher, 2020; Kivimaa and Rogge, 2022).

This work aims to present the results of the pilot experimentation of the BIPforMaaS project, the first Italian MaaS initiative driven by public governance. In the literature there are papers that report the results of pilots (Eckhardt, Lauhkonen and Aapaoja, 2020; Storme et al., 2020). However, unlike other research, this paper provides a comprehensive and detailed view not only in relation to service utilization and user satisfaction, preferences and behavior but also from an economic and environmental perspective. The paper is structured as follows. Section 2 describes the main features of the BIPforMaaS project and its pilot. Section 3 presents the results obtained from the pilot project, while Section 4 analyses the responses collected from the follow-up survey. An environmental analysis is presented in Section 5 and some conclusions are drawn in Section 6.

2. Case study: the BIPforMaaS project

The Italian BIPforMaaS project, implemented by the Piedmont Region in Italy, is characterised by a number of innovative elements, including regional development and public governance. The Piedmont Region is the first public administration in Italy to lead a MaaS project with the goal of creating a MaaS ecosystem with a high level of development that provides a more integrated, accessible and sustainable service to citizens over a large territory. The company in charge of developing MaaS in the Piedmont Region is named 5T, a local in-house company that manages Regional Service Center of the BIP ("Biglietto Integrato Piemonte", i.e. "Integrated Piedmont Ticket") system, which contains information on both the public transportation service and the ticketing system. In addition to 5T, which is coordinating the project, there are other project partners. Many local and international institutional bodies and private companies endorsed the goals and approach of BIPforMaaS by subscribing to the Manifesto drafted by 5T ('BIPforMaaS

Manifest', no date), which advocates an open MaaS platform offering users simple, accessible, environmentally sustainable and tailor-made solutions. End-users are placed at the center of the system and made aware of MaaS benefits on society and the environment. Two aspects are considered distinctive for the success of BIPforMaaS: an active role of public governance and collaborations between public and private entities. To this end, the Piedmont Region, the city of Turin, the Metropolitan City of Turin and the AMP (Piedmont Mobility Agency) signed a Memorandum of Understanding in 2019 to share objectives, actions and commitments related to the development of MaaS on the territory. The final phase of the BIPforMaaS project involved a pilot that aimed to collect real data both to validate the framework outlined in the previous phases of the project and to build a database on which to base the projects following BIPforMaaS (such as BIPforMaaS+ and MaaS4Italy), which involve the actual development of the MaaS platform and the implementation of the service on a national scale. The pilot project started in June 2022 and ended at the end of September 2022. The scope of the pilot included both rural and urban area of the Piedmont Region. To recruit volunteers, 5T published a notice announcing the start of the pilot and explaining its main features, both on the project website and by informing its stakeholders. Before the start of the pilot project, 253 application forms were received. 67 applicants used the pilot services at least once during the pilot period. The users who joined the pilot were predominantly male. 79% of the sample was in the 20-49 age group. Specifically: 26% of the users were between 20 and 29 years old; 24% were between 30 and 39 years old; 29% were between 40 and 49 years old. The pilot provided 5 different services to freely choose from:

- Railway (full integrated service; the user had to specify the origin/destination);
- E-Scooter sharing (full integrated service, two mobility service providers (MSP) combined, available in Turin area);
- Car sharing (light integrated service; users could use a voucher spendable on the car sharing operator's app);
- Taxi (full integrated service, available in the Piedmont area);
- Parking (full integrated service, available in the Piedmont area).

In order to incentivise the use of the service proposed, the use of the cashback tool was included. This instrument provided for deferred reimbursement (the month following the actual expenditure) of 50% of the previous month's expenditure.

3. Results of the BIPforMaas pilot

This Section presents the analysis of the data collected during the experimentation together with the data from a survey administered to users at the end of the pilot. Fig. 1 shows a decrease in the total number of purchases in August - due to summer holidays - and October, due to the fact that cashback for September could be spent in October. In the same months, the number of active users decreases, while maintaining good usage rates. In August and September, 47.8 % of the total active users purchased MaaS services. In October, the percentage dropped slightly to 44.8% due to the end of the experimentation. In September, although active users were less than in the first months of the pilot period, total expenditure appears high and comparable to that of the first months, probably due to the end of the vacation season. Rail transport is one of the most purchased service in the months of experimentation (Fig. 2). This result is in line with the fact that public transport

is the "backbone" of the MaaS paradigm. 46% of users have used rail transportation at least once, either alone or in combination with other transport modes. Another widely used service is scooter sharing, likely used to ride the "last mile".

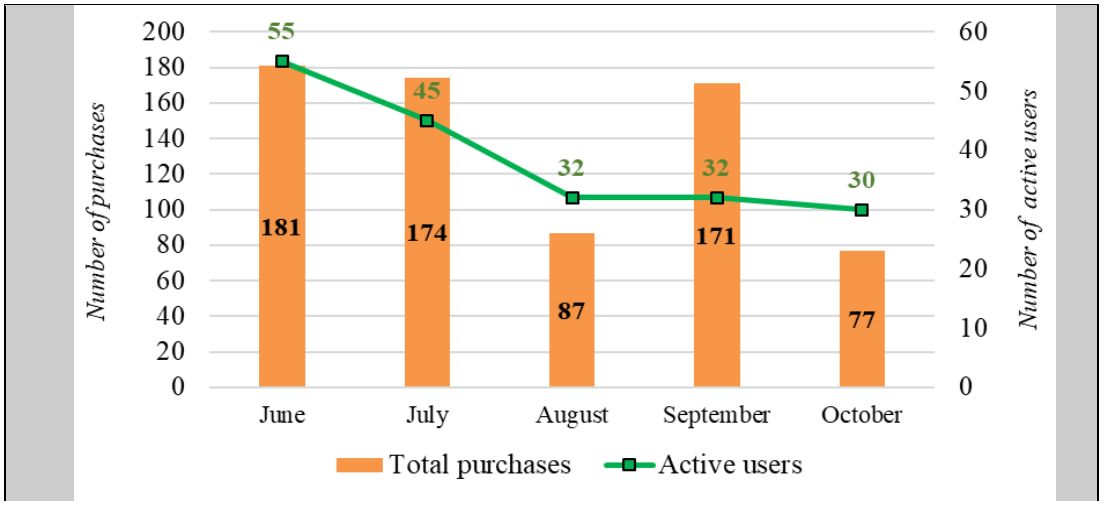


Figure 1: Total purchases and active users, 2022
Source: Authors' elaboration.

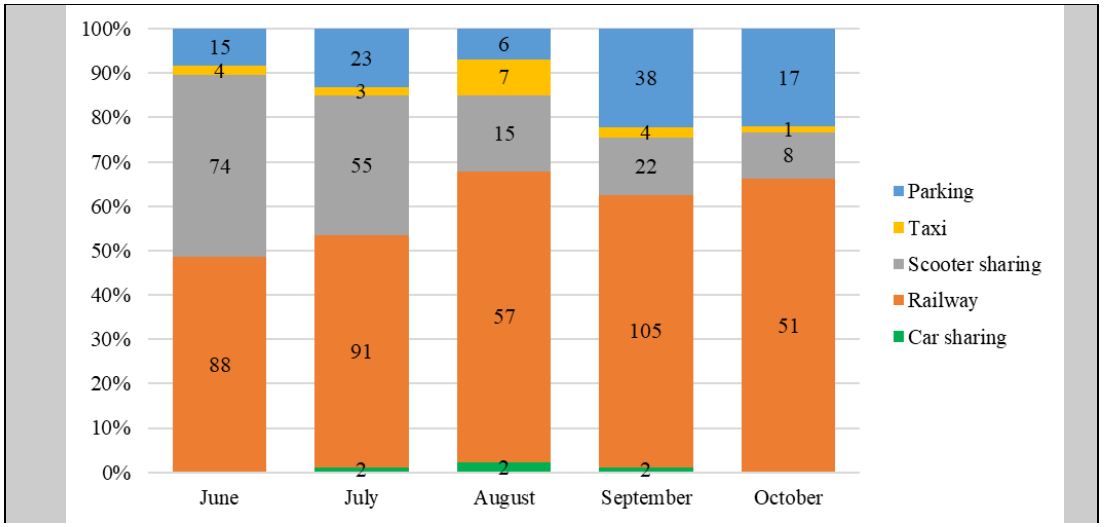


Figure 2: Number of purchases and percentage per service offered.
Source: Authors' elaboration.

The data show that users accustomed to use multiple modes of transportation usually prefer e-scooter sharing in combination with other services such as car sharing or rail transport. The number of e-scooter rides declined after an initial peak, with a slight recovery in September. These results are consistent with other studies in literature (Caballini et al., 2022). As expected, the largest expenditure in all months is on the purchase of train tickets, peaking at € 949.30 in September 2022 (Fig.3). Figure 3 does not show the expenditure on taxis for these months because, due to strikes, the service was

booked but not actually supplied. Consistent with what has been shown in previous analyses, the average expenditure increases in September.

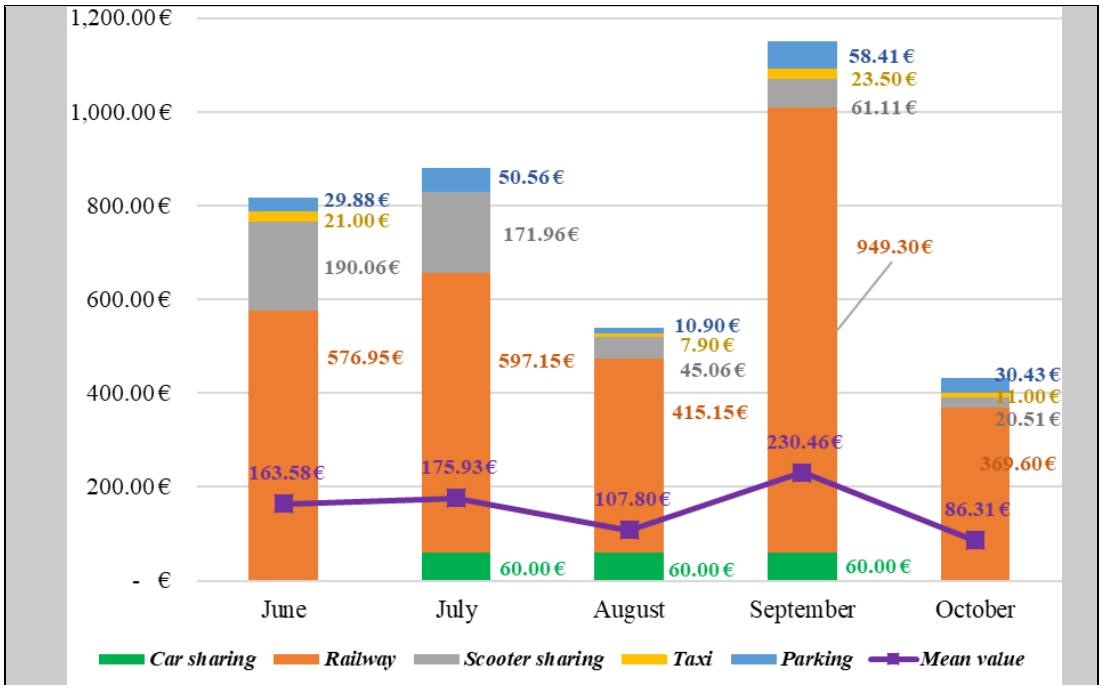


Figure 3: Trend in expenditure per service offered
Source: Authors' elaboration.

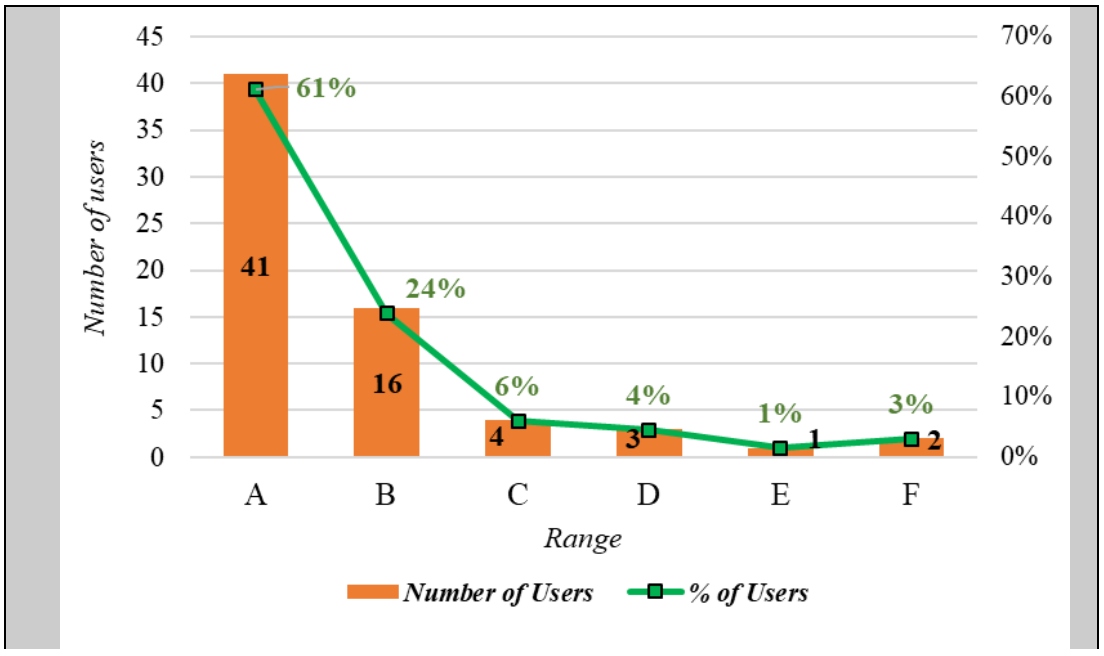


Figure 4: Number and percentage of users per purchase range
Source: Authors' elaboration.

Fig. 4 analyses the 6 ranges related to the service utilization rate by active users where: range A indicates a number of purchases between 0 and 10; B a number of purchases between 10 and 20; C a number of purchases between 20 and 30; D a number of purchases between 30 and 40; and E a number of purchases between greater than 40.

Fig. 4 shows that 61% of the users made up to a maximum of 10 purchases in the months of experimentation. Only 3 users made more than 40 purchases. In order to obtain more details in relation to the use of the services offered in the pilot, it was decided to focus the analysis on users who made more than 15 purchases during the pilot period: fourteen users were identified. The analysis also shows a lack of multimodal approach in the choice of purchased services (Fig.5). Almost all users prefer one or two modes of transportation, very often used on different days. Once again, the extensive use of public transportation represented by rail transport is noticeable. It should be noted that the automated metro in Turin was not yet included in the MaaS options.

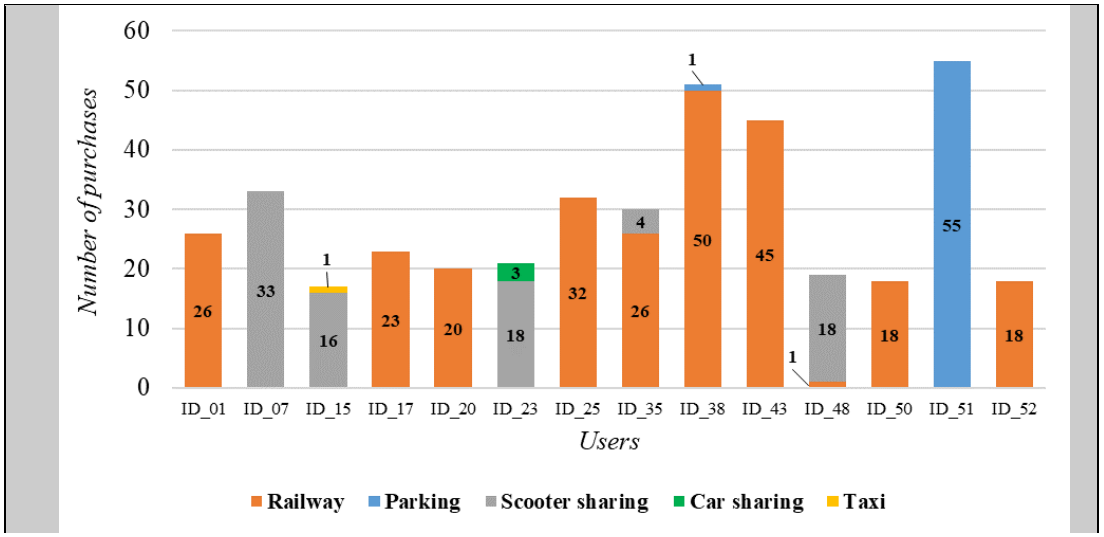


Figure 5: Number of purchases per service for the most active users
Source: Authors' elaboration.

With regard to cashback, the mechanism provided for the recognition of 50% of the amount spent in the previous month, up to € 15,00/month for each user. The amount paid out was about 37% of the user's total expenditure, for a total of € 1,249.60 reimbursed in the 4-month pilot period. The trend in cashback remained almost stable in the first three months (40%), while it decreased in September (29% of total expenditure). The decrease in this value corresponds to the decrease in the number of active users in September. Although total expenditure in the last month has risen sharply, as the number of active users has decreased, the share of cashback also decreased accordingly.

4. Pilot follow-up survey

At the end of the pilot period, a survey was administered to the service users. The survey consisted of 34 questions administered online to which 50 users responded. 76% of the respondents were male and the majority of the sample were in the 20-49 year range. The

majority of the respondents has an income of more than € 1.500,00. 26% of the sample do not have private car, 46% own a car and the remaining 28% own more than one. This confirms a strong attachment to the private car (Alyavina, Nikitas and Tchouamou Njoya, 2020). The first part of the questionnaire aimed to investigate users' travel habits. Travel habits slightly change with the seasons (Fig. 6 (a)). In spring/summer, the use of scooter sharing and bike sharing increases. Regardless of the season, public transport is the most used transport mode together with the private car. The second part of the questionnaire focused on the use of the services made available through the BIPforMaaS pilot. The following aspects were considered for the level of service satisfaction: cost of travel, time of travel, safety, security and parking system. 22% of users believe that the cost of travel has improved thanks to the use of MaaS services. 24% are more satisfied with the parking system and there is a good level of satisfaction regarding safety and security (thefts and vandalism).

The level of satisfaction is almost unchanged regarding travel times. In particular, among users who observed a reduction in travel time (28%), 64% report a reduction from 0 to 15 minutes, while 36% from 15 to 30 minutes. Users seem to prefer public transportation (rail, in this case) or shared transportation (scooter sharing) instead of the private car to avoid issues related to traffic or available parking spaces. In most cases (78%) users changed their travel habits: 36% used scooter for the first time. Only 5% stated they changed their habits by combining several modes of transport in the same trip.

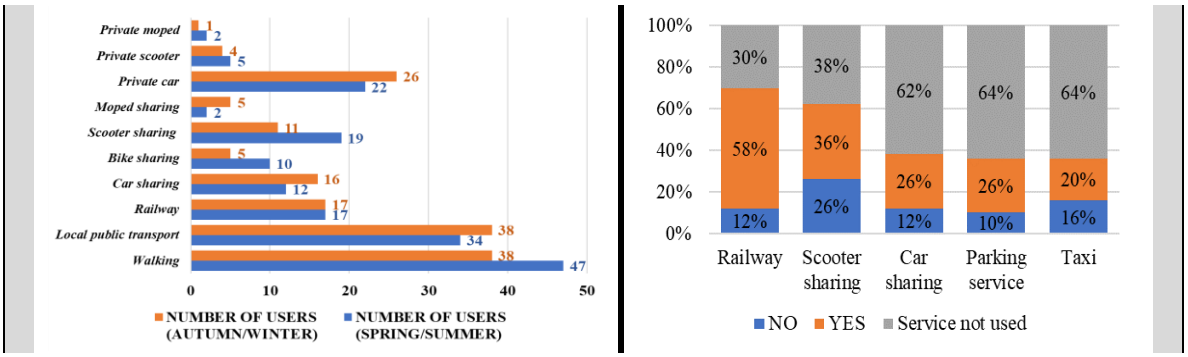


Figure 6: (a) -on the left- Travel habits of the sample, (b) -on the right- Influence of cashback on choice of purchased service

Source: Authors' elaboration.

Fig. 6 (b) summarizes users' responses to the question "For each service used, which would you have used in the same way even if the cashback mechanism had not been provided?" It can be observed that the cashback tool did not substantially influence the choices of the respondents, especially in the case of public transportation (railway). The service for which cashback proved most useful in changing travel habits was scooter sharing. Thanks to the possibility of partial refund, some users who would not have used the service were induced to use it (26 % of those who used scooter sharing). Figure 7 (a) shows that, in general, services were used most during leisure time. Rail transport was the most used for work/study purposes. A section of the questionnaire investigated whether they were interested in purchasing packages of service and whether they were willing to pay for them. 24% of the respondents preferred pay-per-use mode, while 76% showed interest in purchasing bundles of services. This segment of users was offered a typical

package that included: unlimited bus/metro; 5 taxi rides in urban areas and 2 hours of car sharing or e-scooter riding. Users were asked to propose a monthly price they would be willing to pay to use the package described above. No specific price indications were given in the survey; respondents could indicate any price.

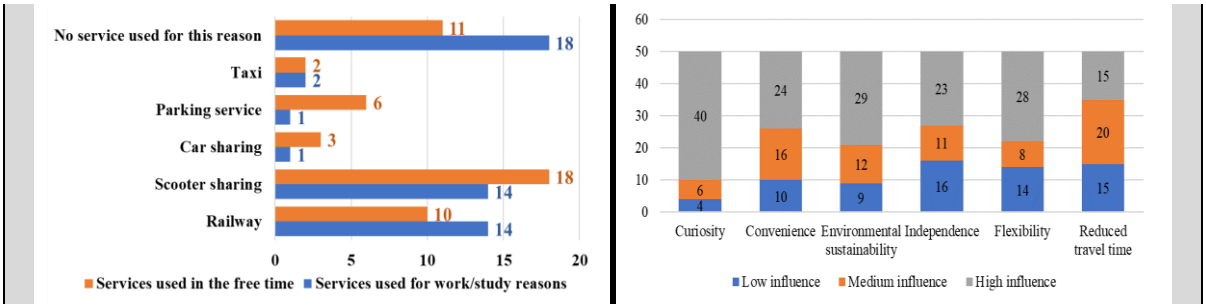


Figure 7: (a) -on the left- Purpose of service used, (b) -on the right- Factors that influenced the decision to participate in the pilot
Source: Authors' elaboration.

The average monthly price suggested was about 51 euros/month. Identifying 3 price ranges (5-30€; 31-50€ and 51-100€) no clear preference for one of the price ranges over the others is reported, thus indicating a high degree of subjectivity and randomness in setting a price. The final part of the questionnaire was useful to understand what motivated users to participate in the pilot. Curiosity appears to be the factor that most motivated users to participate in the pilot (Fig.7 (b)). Other factors that played an incisive role in this choice were flexibility and environmental sustainability, both distinctive features of the MaaS paradigm. Reduction in travel time appears to be an uninfluential factor, probably because users do not expect an improvement in terms of time, although previous analyses partially counter this belief. However, the choice of a vehicle in which the use of time is up to the traveler is typically a prerogative of rail transport, as well as metro systems and automated people movers. In general, participation in the pilot had a positive effect on users, who ultimately showed great interest in using the MaaS application when it will be made widely available. 86% of the respondents declared a high interest, 12% a medium interest, and only 2% low interest. Regarding the user-friendliness of the app, 88% of respondents stated that it took them less than 5 minutes to purchase a service; of these, 35% took less than one minute. Improvement feedback on the pilot project focused on adding further transportation services (mean rating 4.2 out of 5) and adding an integrated notification system to provide information to users (mean rating 3.1 out of 5). In addition, many respondents considered the app an excellent way to try out mobility services they did not use before the pilot (average rating 3.4 out of 5), reflecting the usefulness of a MaaS app in promoting the use of alternative means of transportation.

5. Environmental analysis

With the aim of understanding how much the use of MaaS services can effectively contribute to the reduction of mobility-related atmospheric emissions, creating a benefit for citizens and the environment, a first environmental analysis is proposed below. In the final questionnaire, 33 users stated that they travelled an average of approximately 14 km

– roundtrip – per day. Therefore, starting from this data, the analysis considered the daily kilometers travelled by the 33 users during an entire year (365 days) in their free time. Taking the UK Guidelines as a reference (Greenhouse gas reporting: conversion factors 2022, 2022), the average value of CO_2 emitted by a train can be conventionally assumed as 35gr*km*ps (though this depends on the energy chain and well-to-wheel analysis related to the country where electricity is produced, as in (Dalla Chiara, Ricagno and Santarelli, 2008; Bruno et al., 2015), whereas if one considers a journey by car sharing or taxi the values are 110.6gr*km*ps and 66.4gr*km*ps respectively. In general, cable-driven automated people movers and rail systems (including metros) are the most efficient in terms of kWh/p·km and global CO_2 emissions, particularly in the case of power supply from renewable energy sources. Therefore, considering only the CO_2 emissions emitted during the journey - and therefore not the so-called life cycle assessment (LCA) - only journeys made using local public transport, car sharing and taxis were considered for the estimation. By evaluating the 14km travelled in one year by the users who answered the questionnaire, and considering the percentage distribution of their trips by mode of transport, Table 1 shows an estimate of the total CO_2 they emit in a year.

Table 1: CO2 emissions using MaaS service and private cars

CAR TRAVEL			
Car engine type	Users	Travelled km/year	CO2/year [tons]
Petrol	33	168630	31.5
Diesel			27.5
COMMUTING TRAVELS (LEISURE TIME)			
Mode of transport	Users	Travelled km/year	CO2/year[tons]
PT (train)	10	51110	1.8
E-scooter	18	91980	0
Car sharing (diesel)	3	15330	1.7
Taxi	2	10220	0.7
Total	33	168630	4.2

Authors' elaboration

By inverting the paradigm, it is interesting to note how the same users, using a private car, for the same km travelled in a year, would produce 7.5 times as much CO2 as a MaaS trips. In fact, as shown in Table 2, always referring to the UK Guidelines cited, the same users would produce 31.5 tons of CO2 with a petrol car and 27,5 tons of CO2 with a diesel car. In conclusion, comparing multimodal more sustainable journeys with individual journeys made exclusively by car, MaaS services appear the best choice also in terms of CO2 emissions into the atmosphere: 4.2 tons of CO2 for all journeys per year against 31.5 tons of CO2 for all journeys per year with a petrol car.

6. Conclusions

In this paper the results of the BIPforMaaS pilot project were presented. This is the first Italian project chatacterised by public governance over a large regional territory, including both urban and rural areas. Public governance has several advantages, such as the establishment of a regulatory framework that ensures fair competition and non-discrimination. The pilot objective was to provide a basis on which to develop the current full-scale MaaS platform in the Piedmont Region, which will be implemented in a project named "BIPforMaaS+". The pilot results showed that public transport, here represented by rail transport, remains the most used service, confirming it as the "backbone" of the service. The pilot encouraged experimentation with shared mobility services and other services, including interchange parking. The analyses revealed a poor mix of different modes of transportation, which should instead be encouraged to maximize the efficiency of the service. The survey following the pilot also underlined a strong attachment to the private car by users but also a strong curiosity to try MaaS services, an important symptom of openness. Many users decided to take part in the pilot because they found the service convenient, sustainable, and flexible. Regarding willingness to pay, users do not seem to have clear ideas about the value attributable to a bundle of services. Thus, the composition of bundles and the assignment of an appropriate price to users is still difficult to establish precisely, even if users show great interest in service bundles. Although MaaS has distinct characteristics, there is no single, unambiguous paradigm for the system. The development of MaaS services needs to be customised according to the specific local context. The implementation of the pilot helped to identify the factors that influence the adoption of MaaS in the particular context, so that an offering can be created that effectively meets the needs of users. It is therefore important to stress that the results analysed in the paper are specific to the Piedmont context. MaaS can help break the current car-centric transport system - especially when used by drivers alone - by offering flexibility, comfortable and affordability services. In order to achieve a long-term climate-neutral 2050 strategy, as called by the EU, a key step is to take conventional vehicular traffic off from roads, investing in clean vehicles (including both full hybrid, plug-in hybrid and full electric vehicles, provided they are still used with electric drive within the protected urban environment) and, “15-minute city”, pedestrian areas, shared transport options. Giving to citizens valid tools to choose a better solution than the private car can bring many benefits to the community. MaaS can be a valuable solution, leading citizens to feel comfortable using different modes of transport according to their needs. For example, a bicycle for short trips when it is sunny, an e-scooter when there are no shower facilities, a train for long-distance trip, or a bus to go shopping or carry a stroller. The limitations of this research are mainly related to the reduced availability of data. Implementation of the pilot in the summer period limited participation due to the summer vacations. In addition, some sharing mobility services were not fully integrated and urban local public transport was deliberately excluded from the pilot, perhaps contributing to the limited use of MaaS services.

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ANNEX 1

As mentioned above, in the period October-December 2019, the Piedmont Region developed a survey shared with citizens. The study was aimed at assessing the interest of Piedmont citizens in MaaS and pay-per-use offers, by conducting a survey through the online administration of a questionnaire that also included a choice experiment focused on stated preferences, the basis of which is the Discrete Choice Model (DCM), a model for describing, understanding and predicting people's choices when the choice set consists of a finite number of alternatives.

To achieve maximum dissemination, several local entities were involved: Piedmont Region, Municipality of Turin, Metropolitan City of Turin, University of Turin (UniTO), University of Orient Piedmont (UPO), Politecnico di Torino (Polito).

In particular, for the MaaS topic, questions were asked to understand which mobility services should be included in MaaS packages, which mobility services are most frequently used in daily journeys, and which additional features should MaaS packages have.

The survey showed that the majority of respondents have at least one mobility app installed on their smartphone and would be interested in a single dedicated mobility app. In addition, more than 70% of people would be interested in sharing a MaaS package with family members.

In terms of ideal MaaS packages, respondents prefer packages composed of PT, car sharing, and bike sharing services. In terms of package composition, they prefer packages composed of urban PT/bus/rail, and urban PT with mobility sharing.

PT users prefer packages consisting of urban PT, bus and rail, while car users prefer urban PT (bus and rail), car sharing and bike sharing.

The table below shows the main questions of the questionnaire used in this work. The complete questionnaire is available on request.

A.1	How many trips do you make during a weekday? *roundtrip	0-2 3-4 5-8 More than 8
A.2.2 A.3.2	What means of transportation do you prefer for your trips? What means of transportation do you use for longer trips? In terms of distance and not time	Private car as driver Private car as passenger Urban public transport (bus, tram, metro) Extra urban public transport (train, bus) Moped Bike Kick scooter By walk Other (specify)
A.2.2.1	Do you use public transport at least once a month?	Yes/No
A.2.2.1.1	How many trips do you make by using public transport in a year?	Less than 20 20-40 41-60 More than 60
A.3.1	What area do you often travel to for your trips?	Urban area where I live Different urban area than where I live Different urban areas
A.4	How many mobility applications do you have on your smartphone?	Nothing 1-2 3-4 5 or more
A.4.1	Which kind of applications are they?	Public transport services Journey planning Taxi service Shared mobility services Booked car with driver Parking service Other (if so, specify)
A.4.2	How often do you use applications in terms of time?	Every day At least one time per week Occasionally (one time per month) Rarely (2 times per year) Never
A.4.3	Would you like to have a single application to book all mobility services?	Yes, would be very useful Yes, but I'm also good with the applications I use daily No, I don't need it I don't know
B	Are you interested in MaaS packages?	Yes/No
B.1	If the answer is yes, what modes of transportation would you have available in a MaaS package?	Urban public transport (bus, tram, metro) Inter and sub-urban public transport (bus, train) DRT Taxi Car sharing, Bike sharing, Moped sharing, Kick-scooter sharing, Rent car, Rent car with driver, other (if so, specify)
B.2	How would you like to pay your MaaS package?	At end of the month, grouping my BIP card with a credit card or bank account Loading a predefined credit on my BIP card
B.3	How much would you prefer to pay for your MaaS package?	Open question
B.4 B.4.1	Would you be interested in sharing MaaS package with other members of your family? If yes, how much would you be willing to pay for a shared account?	Yes/No Nothing +5% +10% +15% Other