

The Benefit of Engage the "Crowd" Encouraging a Bottom-up Approach for Shared Mobility Rating

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Abstract. Today transport systems have become multimodal and the evolution of shared mobility has made it possible to define forms of shared and green mobility such as e-bikes or PMVs (Personal Mobility Vehicles) while the supply of cars or van sharing reduces the use of private vehicles, often providing the possibility of renting electric vehicles with low environmental impact. When designing the shared mobility service it is useful to have a global vision that takes into account not only the business and future scenarios of the infrastructure, but also a data support linked to the needs of the users who will have to use it.

Democratic and participatory planning makes it possible to directly involve the crowd and encourage a bottom-up approach to mobility. This provides the basis for different planning and design assessments. This work has focused on a statistical evaluation before and after and the results have been elaborated through a longitudinal approach, comparing the judgement before and after (2018–2020) the advent of car sharing in the city examined. The study highlights the weaknesses generated by the creation of the present car-sharing service implemented in a small town in Sicily (Italy). The results highlight the lack of a preventive analysis of transport demand and this criticality lays the basis for future research aimed at improving the supply of shared mobility by involving the majority of the population in the planning of the service and allowing the combined implementation of the car and bike sharing service.

Keywords: Shared mobility · Crowdsourcing · Participatory planning

1 Introduction

Generally speaking, urban mobility planning and rules (at various scales) need to consider the development of new forms of shared mobility [1].

Several approaches and analyses can help to improve the overall vision of transport. Integrated design through the approach of the Building Information Model for Infrastructures (I-BIM) can improve the transport offer as it considers not only the geometric aspect but also the cost and safety aspects [2].

The use of data that comes not only from inspections but also from the population can make the work at various levels more comprehensive, such as

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- political research (evaluation of tenders and financial resources)
- operations (optimisation of traffic management events and emergencies)
- monitoring action and application (selecting the bottom-up or top-down approach)

In this way crowdsourcing information is useful for the best direct management of shared mobility and indirectly for sustainable mobility.

According to [3] the well-being of each user that is also defined as eudaimonia contains those factors (e.g. comfort, safety, autonomy, self-confidence, physical and mental health) that can influence the choice of the trip and consequently the optimization of the service.

There are several works in literature that show that the development of shared mobility has not been homogeneous in Italy and other European countries. In accordance with [4], between 2010 and 2015 significant progress has been made in sustainable mobility linked to state and international financial support that has facilitated the implementation of smart mobility projects.

Several innovative approaches in the literature show how it is possible to plan traffic scenarios according to vehicular and non vehicular flows, evaluating the service level of the infrastructure [5–7].

This assessment can provide the user with a strict assessment of safety, driving comfort and possible effects of vehicle congestion.

Considering infrastructures with numerous crossings or routes dedicated only to pedestrians, it is necessary to evaluate the possibility of using innovative technology that can make the crossing safer, especially if traffic lights are used [8]; moreover, for pedestrian infrastructures it is useful to calculate the PLOS, thus allowing an evaluation of the areas where cars are excluded and micromobility attached [9].

An optimal urban planning must be linked to a solid technical-scientific basis (top-down approach), but it must also consider a bottom-up approach to mitigate critical issues, monitoring the state of the art through the implementation of survey campaigns such as questionnaires or interviews in accordance with [10, 11]. Local mobility projects are often characterised by strict administrative procedures and are thus often blocked. According to [12], it is therefore considered appropriate to adopt new dynamic strategies so that a bottom-up or external approach can be considered as the key to real change.

Many studies in the literature examine walking accessibility, availability and travel conditions and this is of fundamental importance to understand whether other forms of sustainable mobility can be spread in an urban context considering the able and disabled [13–16].

The development of shared mobility must therefore be based on this dynamic vision. In general, car or van sharing is based on the innovative concept that allows companies, but also private users, to take a means of transport for people in the first case and to transport furniture, bulky objects, household appliances or work materials through a platform [17]. Through a dedicated website, it is possible to book the service guaranteeing flexibility and convenient rates for the user.

This research is based on the evaluation of the development of mobility sharing in a small Italian city. It focuses on the acquisition and processing of data through longitudinal analysis, i.e. before and after the implementation of a car sharing service by a

private company, which manages the service in almost the entire regional territory for car, van and bicycle sharing. The analysis of the period before use, in most cases, is carried out on the basis of the experience described by the respondents and, when possible, by integrating the data with some cross-references (e.g. fuel costs to check the mileage of cars over a given period). The qualifying aspect of this survey method is to accurately assess how the behaviour of the respondent changed after they started using a shared mobility service.

On the other hand, one of the critical points of this survey method is the self-perception accuracy of the interviewees on some mobility habits such as the actual duration of the trips, the time dedicated to them, the frequency of use especially when referring to past experiences, maybe referring to the previous year.

Other weak points are that the evaluation is only about the period of short-term impact and attributing the changes to a single factor, e.g. the availability and use of a given shared mobility service, rather than to a set of factors that are difficult to decipher the individual contribution. This work shows the judgements made by the same sample of users after about 1 year.

2 Sharing Mobility Development

Shared mobility is often a socio-economic phenomenon influenced by the users of the service. In particular, it is clear that sharing mobility consists of a general transformation in the behaviour of people who tend to progressively favour temporary access mobility services rather than the use of their own means of transport and, on this basis, join new lifestyles that promote efficiency, sustainability and sharing. Sharing or renting are among the strategies that are most being implemented in the transport sector to avoid the use of private vehicles.

Proper management of the service makes it possible to:

- facilitate shared mobility and travel;
- create flexible, scalable and original services;
- allow interactivity between users/operators and/or peer collaboration;
- maximise the use of latent resources.

Over the last twenty years, various types of media sharing have evolved, understood as grouping or sharing [18, 19].

The vehicle fleet has evolved with the implementation of vans and small buses and a variation in vehicle fuel systems from classic petrol or diesel to hybrid or current electric vehicles. These services have become almost complementary to the emergence of electric charging stations and car parks dedicated to sharing. The development of micro-mobility is affecting this sector, although legislation is not yet comprehensive in many European countries.

In agreement with [20] it is necessary to examine users' needs to improve services related to shared mobility systems, in order to define the right balance between transport supply and demand in view of the development of Mobility as a Service, understood as an optimal and integrated service.

In accordance with [21] not only the instrumental attributes of the car, but also the psychological disposition, in particular the psychological property, of potential customers must be taken into account when developing measures to stimulate car sharing services in society. Table 1 summarises the characteristics of the various services mentioned above

Table 1. Sharing mobility development and classification

	Sharing mobility				
	Ridesourcing/TNC, Ridesplitting/Taxi, Ehail)	Ride/Car Pooling	Car	Bike	Micromoblity
Vehicle type	Fuel/ diesel cars Hybrid cars Electric cars VAN e-VAN			Classic bike e-bike	Classic Scooter e-scooter Segway Hoverboard Monowheel
Sharing type	Fuel/ diesel cars Hybrid cars Electric cars VAN e-VAN	Urban Extra-urban Dedicated Carpooling VAN	B2C RT OW Free Floating Station based -P2P	Dock based Hub based Pure dockless Electric assist	Low-tech GPS system
Distance	>3miles			* <0,5miles = walking 0,5–3miles	

3 Methodology

The study was conducted by implementing a survey on the evaluation of the service provided with reference to the users' vision before and after implementation and limited only to the local use of car sharing.

The work was then carried out considering a request for ideas, suggestions, opinions, addressed to users pursuing the phenomenon of crowdsourcing, widely used in transport planning, for example to map options for urban and non-urban routes and to consider different transport modes [22, 23].

The evaluation was carried out on a sample of 370 users and the survey campaign was conducted for the first evaluation in the period February-March 2018 and then repeated in the period October-December 2019.

The analysis was conducted in a context where a car sharing service was set up by a private company that manages shared mobility in 12 other cities (in the south-west of the island of Sicily) and was implemented in Enna from April 2019.

The variables taken into consideration and examined concern respectively: socio-demographic attributes, transport habits and judgements on shared mobility.

As far as the socio-demographic variables are concerned, the following Table 2 shows the studied attributes.

Table 2. Socio-economic variable implemented by survey

	Variable	Possible reply	Variable	Possible reply
Socio-economic	Gender	Male Female	Driver licence ownership	Yes only for moped Yes for car and moped No
	Age	30–45 46–65 >65	Driver licence experience	<5 year 6–10 year 11–20year >21year
	Job	Employee Freelance Unemployed Retiree	Car ownership	Yes No
	Residence in Enna	Yes No	Bike ownership	Yes No

The second section of the survey focused on the main reason of travel and previous experience with sharing mobility services as shown in the table below (Table 3):

Table 3. Investigated variable related to transport attitude

	Variable	Possible reply	Variable	Possible reply
Transport attitude	Main reason of travel by car on daily time	H-W (home-work) H-L (home-leisure) other	Main reason of travel by car on holiday- time	H-W (home-work) H-L (home-leisure) other
	Italian car sharing experience	Yes No	Outside car sharing experience	Yes No
	Italian VAN sharing experience	Yes No	Outside VAN sharing experience	Yes No
	Italian bike sharing experience	Yes No	Outside bike sharing experience	Yes No

Through the Likert type judgment scales [24], it was possible to describe the data for the third section.

This approach makes it possible to express a judgment defined by a predetermined interval.

The third section has been divided into two parts, both described by a series of statements and criteria for a one-dimensional scale.

Table 4 below shows the evaluation criteria and the ranges adopted.

Table 4. Investigated opinions and criteria about sharing development in Enna

	Vehicle type	Criteria	Likert scale value
Implementation of a simple car sharing service	Car VAN	1. Advantageous rates 2. Presence of city cars in the fleet 3. Easy booking system 4. Easy search of parking area in each town area 5. Accessible vehicle for all 6. High technology applied	0 = no 1 = partially agree 2 = yes
Possible use of car sharing in Enna	Car VAN	Judgment expressed on a Likert scale before and after the advent of the service in the city	0 = impossible 1 = partially possible 2 = medium possible 3 = high possible

3.1 Before and After Analysis

By comparing the opinions expressed in the two periods of time before and after the advent of shared mobility in Enna, it was possible to apply a transversal analysis to the data and to highlight its evolutions and differences.

The data were collected through online questionnaires and partially through paper questionnaires.

The transversal analysis was based on a reference framework for the study of the implementation components and citizens' attitudes usually found in these transport policies. The cross-sectional (or prevalence) studies are based on the observation of the sample to compare user reviews before and after the use of some transport services.

Prevalence surveys are similar to descriptive studies, but differ from them in that they do not use existing data, but provide the direct survey defined in time. This type of analysis allows to have a general picture in two different time periods but of the same group of subjects under examination (called population or sample), in relation to the studied phenomenon, i.e. the diffusion of shared mobility. The phases of a transversal study can be identified by:

- identification of the problem to be monitored (shared urban mobility with specific reference to car sharing)
- choice of population (i.e. sampling of citizens with preference in this study of people >30 with economic independence living in Enna);
- data collection (through the use of panel-survey)
- data analysis and interpretation (through statistical evaluation and the implementation of appropriate result comparison tables)

3.2 Study Area

The city of Enna is located in a mountain area and consists of 3 large districts, namely Enna Alta which includes the old town on top of the mountain, Enna Bassa on the slopes of the plateau which is home to the university and many shopping centers and finally the district of Pergusa characterized by the presence of the natural lake and green areas and countryside that is a tourist vocation.

The high slope and the climatic and meteorological conditions strongly limit the use of mobility on two wheels for about 5–6 months a year.

The city is inhabited by almost 27 thousand inhabitants and almost 10 thousand students who reside and have their residence 70% in the part of Lower Enna.

The city of Enna has a barycentric position compared to other Sicilian cities, it is characterized from the point of view of transport from a railway station located about 10 km in the outskirts and about 1 h there is the airport of Catania.

Connections with other cities are mainly by private transport or regional buses.

The local public transport is characterized by 5 public urban lines that connect the three districts and the areas most frequented by workers, students and inhabitants. Each bus route is described in Fig. 1.

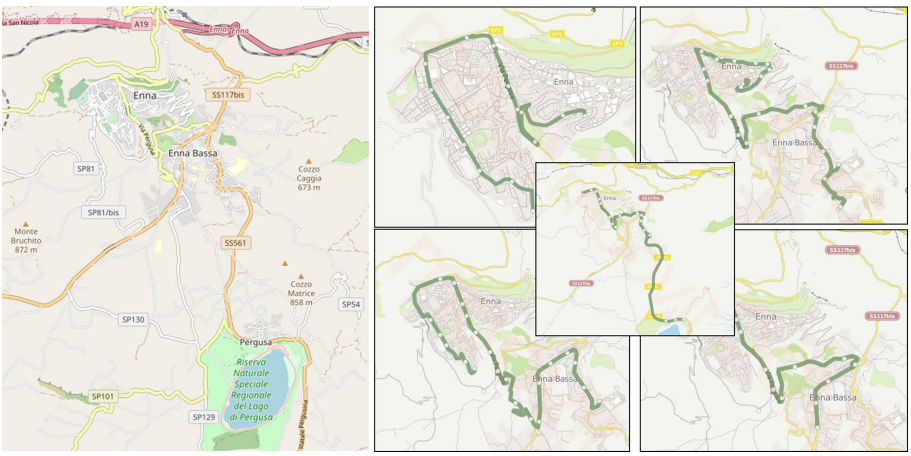

Fig. 1. Local bus service and itineraries (Source: Map data copyrighted OpenStreetMap contributors and available from https://www.openstreetmap.org)

Referring to the terminuses located in the different parts of the city it is possible to observe that generally the Enna Alta/Enna Bassa movement takes place in 30 min (about 6 km) instead the one from Enna Alta/ Pergusa (about 10 km) in 45 min. The urban public transport service ensures only in 50% of the territory one stop every 500 m.

The areas less connected by this type of transport are those of Pergusa and part of Enna Bassa near the railway station. This deficit does not guarantee intermodal transport. The local company offers a discounted season ticket for people over 65 and for high school and university students.

The taxi service with and without driver is rarely used by the local population for travel.

The car and other vehicle rental service is operated by local private companies and is generally preferred by 3% of the population only for occasional activities such as weddings or daily round trips.

Since April 2019 there is a car sharing service with 6 vehicles and a van available for the transfer of people and small goods.

This service managed by a private company (AMIGO-AMAT spa) will also be combined with the bike sharing service that will use pedal assisted bicycles and station based service (Fig. 2).



Fig. 2. Enna with its sub areas and the sharing mobility service

3.3 Data Collection

The survey conducted is therefore configured as a longitudinal survey of panel type on line on google platform and partly of paper type with face to face interview considering the same questions.

The sample was chosen by limiting only the age group or the over-30 s to better assess citizens who tend to have an income and therefore a likely possibility to pay for sharing services.

The interviewed population is resident and therefore excludes commuting workers and university students. The answers were given to a closed questionnaire with single answer to be selected or single answer on Likert scale

- socio-demographic data,
- travel habits
- consideration of the car/van sharing service considering before and after the period.

Through a statistical survey it was possible to compare the judgments as described below.

4 Survey Results

4.1 Descriptive Statistics

Through a descriptive statistical analysis it was possible to obtain results for the different sections of the questionnaire and to prepare an evaluation of the differences in the answers given by the same people before and after the advent of car sharing and van sharing. The data show a homogeneity of data both in terms of gender and age.

4.2 Results

The sample was identified in a causal way and through the compilation of an online survey with the identification of users it was possible to compare the opinions expressed before and after the advent of the sharing service.

The urban context of Enna has been characterized for several decades by the exclusive use of private vehicles.

This phenomenon is linked to the fact that until a few years ago there was no high-frequency urban transport service and its stops were not able to reach certain neighbourhoods.

Moreover, before 2017 the service was marked by long waiting times and delays of more than 15 min per journey. From the point of view of soft mobility, there are several problems related to the absence of sidewalks, high gradients and weather conditions.

The pedestrian area is more widespread in the historic city centre. The socio-demographic data were highlighted in the first section of the survey.

The results show that the totality of the sample lives in Enna (50% Enna high, 40% Enna low and 10% Pergusa). From the working point of view 60% are employees and collaborators.

Gender is defined by 46% of women and 54% of men.

The age group studied covers the range between 30 and over 65 years of age. The first range from 30 to 45 corresponds to 26% of the total sample, the second range from 46 to 65 corresponds to 40% and the third to over 65 with a value of 34%.

Considering the work activities, 59% of the sample works with freelance activities for 36% and employees for 23%.

It has been recorded that over 68% of the sample has a driving licence with over 38% with driving experience between 11 and 20 years and about 25% with 20 years pf experience.

Considering the Italian shared mobility experience, the sample responded positively for 45% as regards car use, 49% as regards bicycle use and about 20% as regards van use. In the foreign sector, on the other hand, there was a reduced value for both the car and the van, respectively 31% and 10% instead of an increase of 55% for the use of bike sharing compared to the national one.

As regards car ownership, it was obtained that 80% of the sample owns a vehicle, while only 25% owns a bicycle.

These data allow us to assume that the ownership of the bike is lower than that of the car is due not only to the travel habits but also to the geographic and geomorphological conditions of the place of residence, which with steep gradients does not facilitate cycling.

Another critical point found in the area is the absence of dedicated lanes. The analysis investigated the travel habits in weekdays and holidays considering the following reasons of home-work (H-W), home-school (H-S) and leisure-time-home (H-L).

During working days about 60% of the population travels by car, 20% by bus and 20% on foot.

On weekdays, the percentage of journeys on foot has risen to 55%.

Among the main reasons for leisure time on weekdays is shopping or going to a hospital/ doctor's surgery, while on public holidays the main reason for leisure is to take a walk in open spaces such as squares and go to church.

The third section analysed the answers of the sample before and after the establishment of the car sharing service in Enna by a private company in collaboration with the Municipality.

The users were asked to express a judgement through Likert scales from 0 to 2 (0 = no, 1 = partially agree and 2 = yes) to see how easy it is to move to Enna with the car sharing service and to evaluate different reasons, a judgement scale from 0 to 3 (0 = impossible; 1 = partially possible; 2 = half possible; 3 = high possible) was evaluated the propensity to use this service.

Table 5 below shows the comparison before and after the judgements in the above section.

As regards the service with a van type vehicle, the results show that the presence of more vans could improve the service as there is higher demand than the current supply. Some criteria marked by (*) have recorded the same values before and after the advent of car sharing in Enna, however, with regard to the tariff, again after the establishment of the service and its use, users agree on the choice of a more advantageous tariff. In the same way, the sample showed a greater need to equip vans with a more innovative technology as described in Table 6.

The judgment of each user regarding the propensity to use the service was assessed as shown below in Table 7.

The shared mobility service is currently used by 15–20% of the population.

The opinion of the sample shows that the sharing mode is not easily used by the inhabitants at the moment.

Table 5. Sample opinion (before and after) about car sharing service

Implementation of a simple car sharing service (enter 0 = no 1 = partially agree or 2 = yes)							
Criteria	Before			After			Comparison
	0	1	2	0	1	2	
Advantageous rates	9 (2%)	79 (61%)	282 (76%)	193 (52%)	177 (48%)	0 (0%)	Increase in negative or partial judgment
Presence of city cars in the fleet	19 (5%)	290 (78%)	61 (16%)	86 (23%)	248 (67%)	36 (10%)	
Easy booking system	14 (4%)	225 (61%)	131 (35%)	9 (2%)	169 (46%)	192 (52%)	Increase in positive judgment
Easy park in each town area	16 (4%)	110 (30%)	244 (66%)	142 (38%)	165 (45%)	63 (17%)	Increase in negative or partial judgment
Accessible vehicle for all	23 (6%)	164 (44%)	183 (49%)	211 (57%)	159 (43%)	0 (0%)	
High technology applied	17 (5%)	245 (66%)	108 (29%)	141 (38%)	210 (57%)	19 (0%)	

Table 6. Sample opinion (before and after) about van sharing service

Implementation of a simple van sharing service (enter 0 = no 1 = partially agree or 2 = yes)							
Criteria	Before			After			Comparison
	0	1	2	0	1	2	
Advantageous rates	69 (19%)	101 (27%)	200 (54%)	110 (30%)	221 (60%)	39 (11%)	Increase in negative or partial judgment
Presence of van in the fleet (more than one)	38 (10%)	160 (43%)	172 (16%)	37 (10%)	103 (28%)	230 (62%)	Increase in positive judgment
Easy booking system*	14 (4%)	225 (61%)	131 (35%)	9 (2%)	169 (46%)	192 (52%)	
Easy park in each town area *	16 (4%)	110 (30%)	244 (66%)	142 (38%)	165 (45%)	63 (17%)	Increase in negative or partial judgment
Accessible vehicle for all*	23 (6%)	164 (44%)	183 (49%)	211 (57%)	159 (43%)	0 (0%)	
High technology applied	39 (11%)	200 (54%)	131 (35%)	51 (38%)	290 (57%)	29 (5%)	

Table 7. Overall opinion on the possible choice of car sharing service

Possible use of car sharing in Enna (0 = impossible −1 = partially possible −2 = medium possible −3 = high possible)			
User rating	Before	After	Before/after
0	14 (4%)	146 (39%)	D < 0 (−132)
1	98 (26%)	191 (52%)	D < 0 (−93)
2	178 (48%)	33 (9%)	D < 0 (145)
3	80 (22%)	0 (0%)	D < 0 (80)

An improvement of the service could be focused on preventive survey campaigns aimed at mitigating the current problems of the service and to enhance its value as a result of the likely demand for local transport.

In contrast to the choice of van sharing as described in Table 8.

Table 8. overall opinion on the possible choice of van sharing service

Possible use of van sharing in Enna (0 = impossible 1 = partially possible 2 = medium possible 3 = high possible)			
User rating	Before	After	Before/after
0	21 (6%)	18 (5%)	D < 0 (3)
1	75 (20%)	105 (28%)	D < 0 (−30)
2	168 (45%)	189 (51%)	D < 0 (−21)
3	106 (29%)	58 (16%)	D < 0 (48)

5 Discussion

This work shows a description of the spread of shared mobility by considering the opinions of the population through a longitudinal before-and-after analysis.

The bottom-up approach in the field of mobility, which involves citizens in judging a service, has shown that it can contribute to the planning phase of a city's transport systems, highlighting some critical issues related to the place of application and providing benefits applicable to future political strategies of the city. The implementation of a car sharing system must include an upstream analysis of users in order to calibrate the service offer and thus increase its attractiveness.

Although the service applied in the Enna context is a mixed station-based and free floating service, there is a serious problem regarding costs and availability of parking in some areas.

The design hypothesis of defining an integrated car and bike sharing service is not easy to implement due to the high gradient of the roads and the lack of dedicated lanes.

The bike sharing service could be implemented only in the lower part of Enna Bassa and Pergusa assuming alternative cycling routes, not related to vehicular mobility (use of secondary roads instead of state and municipal roads). A reduction in

the cost of the subscription and a reshaping of the fare were requested by the sample of users, as well as the desire to have a service with a small engine and manual gearbox.

A positive opinion was expressed about the van service that should be characterized by an increase in the number of vehicles in the fleet managed by the company. This cross-cutting analysis confirms the need to attach great importance to the implementation of participatory planning through the collaboration of citizens, in order to optimize and mitigate the critical issues related to transport decisions taken or to be taken. The inclusion of electric bikes and micro-mobility within the service will ensure short distance journeys where there is no great variation in gradient, reducing the use of private cars. It also highlights some practices that suggest ways of future research, expanding the sample and the time to be analyzed.

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