future transportation

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The New Mobility Data and Solutions Toolkit (nuMIDAS): sharing services planning through a data-driven perspective in the city of Milan

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Abstract: Mobility services and technologies are rapidly evolving and are both a great source of data and, potentially, a great user of data. In order to offer an increasingly efficient mobility service, the city of Milan, pilot city of H2020 nuMIDAS project, has highlighted the challenge of planning its sharing mobility services from a data-driven perspective. Two use cases with related algorithms were co-designed for the Italian city within the project. The two developed use cases represent decision support systems that can help public decision-makers in making resolutions concerning the planning and design of sharing mobility. Specifically, the first use case is mainly concerned with the planning phase of services by identifying some key parameters to be included as requirements in the tenders for service contracts. The second use case, on the other hand, focuses on the extension and conformation of the operational areas of the services.

Keywords: Decision Support Tool, Co-Creation, Data-driven

Citation: Lastname, F.; Lastname, F.; Lastname, F. Title. *Future Transp.* **2022**, *2*, Firstpage–Lastpage. https://doi.org/10.3390/xxxxx

Academic Editor: Firstname Lastname

Received: date
Accepted: date
Published: date

1. Introduction

Mobility is one of the most important Big Data's domains and one of the most important data sources [1]. Moreover, transport implies big volumes of data which have become increasingly diverse over time as they refer to new modes of transport and new data collection methodologies [2]. The challenge nowadays is to manage and analyse this amount of data [3] in order to support policy makers, researchers and traffic engineers in their work towards smarter mobility. Within this context, the New Mobility Data & Solutions Toolkit (nuMIDAS), bridges this knowledge gap, by providing insights into what methodological tools, databases, and models are required, and how existing ones need to be adapted or augmented with new data. To this end, it starts from insights obtained through market research and stakeholders, as well as quantitative modelling. A wider applicability of the project's results across the whole European Union is guaranteed as all the research is validated within a selection of case studies in pilot cities, with varying characteristics, thereby giving more credibility to these results. Through an iterative approach, nuMIDAS creates a tangible and readily available toolkit that can be deployed elsewhere, including a set of transferability guidelines, thus thereby contributing to the further adoption and exploitation of the project's results. nuMIDAS, started at the beginning of 2021 under the Horizon 2020 programme and it is being developed by a European Consortium, composed of 9 partners from 6 countries: Belgium, Czech Republic, Greece, Italy, The Netherlands, and Spain. The project builds on a distributed selection of case studies in pilot cities to provide a geographic coverage of the EU. The three pilot cities are: Barcelona (Spain), Milan (Italy), and Leuven (Belgium). Thessaloniki (Greece) has been also added to the pilot cities with the aim of adding to the scope of the project a use case involving traffic management and the use of cooperative technologies.

The objective of this paper is to describe, in the first part, the methodology that led to the realisation of the two tools for the city of Milano, and in the second part, outline the characteristics, in terms of requirements and data inputs, and outputs of the Use Case 2.

After illustrating the use case design approach and how this was used for the realisation and definition of the nuMIDAS project use cases, the Use Case 2 tool, concerning the city of Milan regarding the shared mobility services, is explored in depth. Furthermore, before the conclusions, some strengths and limitations of the tool were highlighted.

2. Methodology

One of the main objectives of system design is to lay the ground for the development of a toolkit that is based on a comprehensive and user-friendly architecture and structure. Within the nuMIDAS project, system means the co-designed toolkit that enables data-driven support for decisions made by individual city decision-maker.

The first step towards this direction is the identification of system components in a simple, easy to read, and fully understandable manner. Many efforts and approaches have been made/suggested so far to conclude a good methodology for capturing the system functionalities and initial system's requirements. One very strong-formulated technique is the so-called use case design. Use cases constitute a well written description of how a person who is involved in the system could accomplish its goal by following a specific process. In other words, a use case is the interrelation between the user and the system focusing on the prerequisite steps that a system must follow so that the user achieves the final desired result [4]. Additionally, according to Booch et al. [5], a use case is a description of a sequence of actions, including variants, that a system performs to yield an observable result to an actor. To such an extent, it is worth mentioning the fundamental elements that each use case should contain [6]:

- Actors/users
- System
- Scenarios and their goals.

Users, who are involved with the system, are also knows as actors. Actors can be single persons, a group of people, another system or external inputs interacting with both the system and the whole process of a use case. Otherwise, whoever has an interest to system's behaviour and may react to the process can be an actor [7]. In most of the cases the difference between a user and actor is barely noticeable. The former is usually someone/something that utilises the system, whereas the latter is an entity which is represented by a specific user [6]. A prominent example constitutes the nomination of a person included in the human resources of a specific entity (e.g. a public or private body) as responsible for using a system. Use cases are usually written from the user/actor's perspective. The next fundamental element is the system itself. The system is the process that is required in order for the user to reach his/her final goal. As it is perceived, a goal or outcome is the desired result that an actor is trying to reach by interacting with the system. In some cases, the system may produce one outcome or in other cases multiple outcomes [8]. The ability of a system to produce multiple outcomes and adapt accordingly its functionalities is often achieved by including use case variations in the design process. These use case variations often termed as "scenarios" [9] consist of their own steps and conditions and are associated with specific goals that a user aims to reach. However, sometimes there is a need to extend the original or rigid goal(s) associated to a use case additional with soft goals that bring us to the concept of use case extensions or extension scenarios. Use case extensions or extension scenarios are often utilised as a means of transfusing flexibility in a system during the design process, i.e. render the system capable of addressing exceptions, limitations, or specific circumstances.

Additional, and contextually more complex, elements that are incorporated and present in use case design are the following:

- Events
- Stakeholders
- Preconditions
- Post conditions.

Events are whatever trigger the beginning of a use case. Each use case normally has a main scenario to follow but sometimes, as mentioned above, there are also alternative scenarios. Different external events may trigger specific scenarios of a use case. Stakeholders are intended as someone or something that cares about the progress of a tool system and is interested in its final outcomes. Stakeholders may, may not, or may to some extent interact with the tool [10]. Furthermore, preconditions are those conditions or steps that are essential before initiating the use case. On the other hand, postconditions can be divided into success conditions and failure conditions. The former refers to all those actions, which successfully terminate the scenario, while the latter reflects the actions that unsuccessfully bring the scenario to an end [9].

Overall, use case modelling is a very useful and concrete technique to depict and illustrate the entire process to be followed for the development of a tool. By designing in a rigorous and explicit manner the use cases of a tool, many benefits may arise. Firstly, once the use cases are explicitly and elaborately designed, the manner and order of the tasks and activities to be carried out by the tool becomes readily observable. Furthermore, the process of identifying and presenting user needs and requirements get easier and more readily understandable by any stakeholder. As it has been already mentioned, any person or other (external) system can contribute to the final outcome of the tool. In this respect, the documentation of such intervention(s) facilitates transparency and understandability of the outcomes of the tool on behalf of all stakeholders [4]. Moreover, use cases definitions clarify the initial structure and contents of a tool, thus preventing scope creep during the development of the tool. Scope creep describes a situation in which the development of a tool follows a repetitive and endless process without performance and progress that is attributed to a lack of strict definition and evaluation of the tool's boundaries and target outcomes [11]. On top of that, use case design facilitates the steps to be taken to develop a toll, thus enabling the definition of the development's timeline (including performance monitoring). In this respect, by having identified the target outcomes resulting from each scenario but also the development timeline the feasibility of the tool to be developed can be verified [12]. To conclude, another noteworthy benefit is that use cases not only provide information concerning the steps to be executed by the tool, but also, they describe all the critical points that might go wrong. Hence, having an upfront overview on potential pitfalls during tool development enables the definition of mitigation strategies and resources saving afterwards.

Within this theoretical framework, the first step for the design of the nuMIDAS set of methods and tools is the identification of the scope of the use cases to be addressed. This scoping exercise follows an agile approach consisted of many iterations. The first round of iterations includes the initial definition of the use cases scope taking as input the outcomes of:

- a close cooperation and discussion among the project's partners, including representatives of the project's pilot cities (Milan, Leuven, Barcelona, Thessaloniki), focused on the problems faced by these cities,
- a questionnaire sent to these cities partly oriented to gather input concerning the desired purpose and functionalities of the nuMIDAS toolkit, the shortcomings of any currently utilised methods or processes, as well as data availability in these cities,
- the state-of-the-art and business modelling analysis being the focus of Pribyl et al. [13],

• the outcomes of a survey targeting key stakeholders and experts (executed in the context of Pribyl et al. [13]), focusing on the identification of challenges and trends in the urban mobility ecosystem.

Subsequently, the results of this iteration were handed over to second round of iterations in which the contents of the derived use cases have been once again discussed by all project's partners. The main goals of this phase are ensuring that the problems reported by the pilot cities are addressed, increase the innovativeness of the nuMIDAS toolkit, and ensure that trends and challenges identified for the urban mobility ecosystem are properly covered. This iteration also includes a preliminary assessment of the technical feasibility of the derived use cases, as well as the enrichment of the use cases description with critical parameters to be addressed by the nuMIDAS tool that have been identified in the context of Shchuryk et al. [14].

Once this process was completed, six use cases with their corresponding pilot cities were identified:

- Use case 1: Pre-planning of shared mobility services
- Use case 2: Operative areas analysis shared mobility
- Use case 3: Air quality analysis and forecasting
- Use case 4: Planning for parking
- Use case 5: Inflows and outflows in metropolitan area
- Use case 6: Assessment of traffic management scenarios.

In the following lines Use Case 1 and Use Case 2 are described:

- Use case 1: Pre-planning of shared mobility services. The emergence of new mobility modes, such as shared electric scooters (e-scooters) and either docked or dockless bicycles, grouped under the umbrella of micromobility, provide opportunities for alleviating several issues of cities, including congestion and adverse environmental impacts of mobility [15]. Mobility services enabled by these modes provide an appealing alternative to conventional public and private transport services but also to private cars. They are operated by a wide range of service providers around the globe, thus forming a new type of international industry. The operation of shared mobility services is typically regulated and monitored by the public sector, including local governments and municipalities, through service tenders. In this respect, a crucial question that comes into play concerns the specification of these tenders to enable the provision of services beneficial for the end-users as well as viable in the long run. Consequently, the local departments tasked with issuing these tenders shall factor in both the needs and attitudes of citizens as well as other parameters regulating the operational efficiency and financial viability of these services. A crucial parameter that affects both the level of service and the operational efficiency is the fleet size of such services. Indeed, a lower than needed fleet size will conclude to a poor level of service and negative impact on the level demand for shared mobility services. On the other hand, a higher than needed fleet size will provide an increased level of service but will dramatically decrease the operational efficiency from the service operator's perspective, thus impacting negatively on the operators earning and hampering the financial viability of provided services. Therefore, the use case 1 of the nuMIDAS toolkit revolves around the development of a high-level decision support system tool supporting the identification of the optimal fleet size of shared mobility services taking as input socioeconomic, mobility, financial, and service provision-related parameters and constraints. Such a tool should ideally account for demand fluctuation caused by unexpected events, such as the COVID-19 pandemics, seasonal fluctuations, which caused either an increase or decrease in the level of demand for certain transport modes [16]. It is expected that this tool will enable a preliminary planning of shared mobility services to be deployed within a specific area and the issuing of tenders including rational terms and conditions. This use case has been conceptualised in cooperation with representatives from the city of Milan. Specifically, the city is interested in improving the process of issuing tenders for shared mobility services, given that they provide a fixed number for the required fleet, which creates complexity in the sense that the market can fluctuate, and demand can change over the time of operation. In addition, it is a concern of the city to ensure a sufficient level of service at an accessible price not only within the inner city of Milan but across the whole metropolitan area. This use case is also relevant for the city of Leuven, which is interested in improving the planning processes of shared mobility services. On top of that, policy instruments analysed in the context of Pribyl et al. [13], such as low emission zones, rely to a great extent on the availability of shared mobility services providing beneficial services to citizens within inner cities. Furthermore, one of the main challenges to be addressed by the rental and micromobility services analysed in the context of Pribyl and al. [13] is the optimization of the operable fleet to meet successfully existing demand. Moreover, as suggested by Shaheen and Cohen [17] and Nikitas [18] there is a need to define proper fleet management policies, in the sense of rebalancing fleet to achieve a proper density and service equity. In this respect, both the optimization of the operable fleet and the enforcement of fleet management will prove ineffective if the size of the fleet is a priori not adequate. Apart from operational concerns and as noted in Pribyl et. al [13], an excessive fleet size may lead to an excessive use of public space triggering the need for legislative regulation. The identification of the required fleet to be included in public tenders for car-sharing operators is also identified as a gap in Pribyl et al. [13]. Similarly, the obligation of the cities to set a minimum level of service or maximum fleet size constitutes a challenge of mobility management and their main responsibility while orchestrating the scenery of provided micromobility services. Finally, based on the results of the survey executed in the context of Pribyl et al. [13] targeting key stakeholders and experts of urban mobility and the identification of the most important challenges, it is derived that (environmental) sustainability constitutes a core challenge. The vision for sustainability can be achieved through the usage of policy instruments promoting the usage of transport modes relying on alternative fuels. Given that compatible technologies are heavily utilised by shared mobility operators, the provision of effective and viable relevant mobility services can use as an additional policy instrument.

- Use case 2: Operative areas analysis shared mobility. The vision of achieving sustainable mobility within European metropolitan areas has led to the wide recognition of the need to operate in these areas new environmentally friendly modes of transport and promote the usage of public transport services [19]. However, metropolitan areas in Europe and beyond are sprawled across large geographic areas, including both densely and less densely populated sub-areas. While the demand for public transport and shared mobility services in densely populated subareas is typically high, thus facilitating the cost-efficient deployment of a wide range of relevant services, this is not the case for less densely populated sub-areas. This fact often results in the existence within the same metropolitan area of overserved and underserved sub-areas in terms of offered mobility services, questioning the principles of equitable transport systems [20]. Thus, a critical concern of cities and transport planning authorities is to identify which mobility service operators will be active in which sub-area and to what extent in order to cover not only the city centre but also the peripheric areas of the city. The use case 2 of the nuMIDAS toolkit aims to support this need focusing on shared mobility services though the development of a decision support system tool that will distribute existing supply, in the form of operative fleet size into specific high or low demand sub-areas of a wider metropolitan area. Such a distribution will seek to maximise the level of service within each sub-area, minimise the economic losses of service operators, and ensure equity among sub-areas in terms of level of service and among operators in terms of treatment (i.e. services operators should be treated equally). This use case has been conceptualised in cooperation with representatives from the city of Milan. Specifically, these representatives have expressed the ascertainment of the city that there are more and less attractive areas in terms of the economic profit for operators but at the same time there is the need to define service areas that include peripherical zones of Milan. In this respect, the city needs a model for calculating the operative areas in which operators reach most of the Milan metropolitan region without incurring economic losses in low demand areas. Through this use case, an important challenge mentioned in the analysis of MaaS (Mobility as a Service) service in the context of Pribyl et al. [13] will be examined and addressed. This challenge is the management of competition between service operators by supporting the equal distribution to them of attractive service areas. Moreover, this use case can be viewed as an extension of the use case 1, in the sense that a proper spatial planning of mobility services provision will promote both the level of service provided to the end users and the financial viability of services. The latter is attributed to the facilitation of fleet management policies discussed in Pribyl et al. [13]. Finally, the implementation of this use case in metropolitan areas is expected to lead to an improvement of important new (social-related) KPIs that have been identified in the context of Pribyl et al. [13], including accessibility to all, equity in mobility offer, inclusiveness, and decrease of the modal share of private vehicles (cars).

Although they are not the subject of this paper, the other use cases identified by the project are being briefly described in the following lines:

- Use case 3: Air quality analysis and forecasting. The rapid rate of growth of vehicles rises the need of understanding the environmental impacts that caused by the massive usage of private vehicles within urban areas. In most cases, this is reflected by the road congestion and more specifically by the excessive vehicles' starts and stops induced mainly at signalised intersections. On the other hand, promoted concepts, including sustainability, liveability, and quality of life, indicate that there is a clear need to reduce vehicle emissions within urban centres, thus alleviating adverse environmental impacts of traffic [21]. To address this environmental issue with regards to air quality, the third tool to be integrated into the nuMIDAS toolkit is responsible for supporting the execution of relevant data analyses based on multi-source data. This is expected to support policy makers towards better planning and assessing enforced policy instruments, such as Low Emission Zones and Urban Vehicle Access Restrictions.

A critical consideration to be made is that the involved parameters are to certain extent interrelated. For instance, weather conditions may affect both traffic intensity and air quality, while air quality are affected by traffic intensity and weather conditions. This translates to the need for developing two models. The first one will provide an improved forecasting of traffic intensity based on traffic-related historical data, (planned) event-related data, and meteorological forecasts for the upcoming days. The second one will provide a forecast of air quality based on traffic-related data and meteorological forecasts. In this respect, traffic-related information to be provided as an input to the second model will be the output of the first model.

- Use case 4: Planning for parking. Due to the increase of the number of private vehicles within urban areas there is a shortage in the supply of parking facilities [22]. Such a situation is further exacerbated by vehicles circulating in search of a parking lot. In this respect and considering that parking is an important traffic generator, an effective measure for alleviating the above issues and reducing private vehicle attractiveness within metropolitan areas is the reduction of on-street parking space. The scope of the current tool of the nuMIDAS toolkit is to support the impact assessment of on-street parking restriction policies. In the current version, these impacts include the parking pressure relocated from the area in which a parking restriction policy has been enforced to adjacent areas and increases in parking searching time. The operational logic of this tool relies on the discretization of a road network using a grid comprised of cells of appropriate size and the use of parameters, such as the demand for parking and parking capacity (number of parking places) corresponding to each cell. By that means, the tool will enable the simulation of enforcing a parking restriction policy in one or more grid cells and the assessment of its impacts on the remaining cells.
- Use case 5: Inflows and outflows in metropolitan area. The estimation of the origins and destinations of vehicle trips is of particular use for large metropolitan areas given that they inform transport planning authorities on the extent to which prevailing

traffic conditions are a product of internal, inbound, outbound, or through-going vehicle trips. The scope of the fifth tool to be integrated into the nuMIDAS toolkit is the estimation of in- and out-flows of a specific zone of a metropolitan area (e.g., low emission zone), i.e., from its boundaries to the remaining districts. These estimations will be based on data generated by Automated Number Plate Recognition (ANPR) systems coupled with census data (vehicle registration). The main objective of the tool will be to improve mobility planning processes and acquire a better knowledge about users and mobility patterns. A valuable aid towards this direction would be the definition of an Origin-Destination (OD) Metropolitan matrix using as data input the detections of the available ANPR systems. By that means, a city will be able to better understand the effectiveness of policy instruments of Low Emission Zones (and any necessary adjustments) but also to plan public transport services, including, among others, park and ride facilities and services. The algorithmic framework of the current tool is presented to its full extent. However, for data availability completeness issues its application takes places upon sample data stemming from the pilot city of Thessaloniki. Its full application will be based on the data stemming from the pilot city of Barcelona, wherein ANPR systems are installed and operated.

- Use case 6: Assessment of traffic management scenarios. Last decades, the rising traffic congestion is a common situation in all large cities induced by the large number of vehicles circulating in the roads [23]. Hence, vehicle emissions are provoked in a high rate and therefore the ambient air quality is even more degraded. Apart from the adverse effect on the environment, there are also other traffic related impacts, such as the increase of travel delays and vehicular queueing. The most direct approach to reduce traffic congestion is the implementation of different traffic management scenarios enabled by intelligent transport systems and capable of improving the road conditions. The scope of the sixth tool to be integrated into the nuMIDAS toolkit involves the data-driven assessment of traffic management scenarios, including both conventional traffic management measures (e.g., traffic lights control or provision of information through Variable Message Signs) as well as novel and advanced technologies, such as C-ITS (cooperative intelligent transport systems) enabled dynamic traffic management (e.g., personalised provision of dynamic warnings, information, and guidance to drivers of connected vehicles). The information utilized by traffic managers may be divided into (a) incident-related, (b) weather-related, (c) speed-related, (d) field device-related, (e) work zone-related, and (f) event-related. Moreover, there are several approaches of varying sophistication for implementing traffic management [24]. The first and less complex approach is the static management of traffic according to which specific traffic management plans are drafted for each day type and time of day. Such an approach may provide satisfactory results only on the premise of limited variability of critical demand- and supply-side parameters. The second approach is the responsive management of traffic according to which specific strategies or measures are applied as a means of addressing observed traffic conditions. The third and most complex approach is the proactive management of traffic based on which the applied traffic management strategies or measures are called to respond to predicted demand- and supply-side changes or even delay and eliminate breakdowns. Both the last two approaches can be classified as dynamic traffic management approaches with their main difference being that in the former applied strategies or measures may have been tested in several circumstances, while in the latter the strategies and measures are by nature more experimental.

For each of these use cases, specific tools were co-designed in the Python programming language. In detail, the co-design process involved constant iteration between all project partners, as each version of the tools was discussed at length to identify the requirements to be implemented, coded to address the challenges of each pilot city and finally calibrated and validated.

3. Results

In this section, the Use Case 2 related to the city of Milan is described in more detail. In particular, the inputs necessary for the tool and the outputs are listed and described.

3.1 Use Case 2: Operative areas analysis shared mobility

UC2 deals with the allocation of existing shared mobility services' supply (i.e. operable fleets) to specific sub-areas of a metropolitan area. Its goal is to minimise economic losses of service providers while at the same time guaranteeing a satisfactory level of service to the users. The request arises from the observation that in Milan some areas are more profitable than others, even if there is the necessity to delimit service areas that include, not only the city centre, but also its peripheral zones. For this purpose, the tool calculates the operational areas in which operators can implement their services in a large part of the Milan metropolitan area, without losing much of their profit in low-demand areas.

The tool receives as input the value of the fleet size that should optimally be operated in each sub-area from the tool associated with the use case 1. Subsequently, the tool is capable of approximating the profitability of service operators during a day for a given allocation of their capacity into specific sub-areas. The suggested value of the operable fleet per service operator and transport mode seeks to optimise the level of service and the profitability of provided services in each area in a manner similar with the tools associated with use case 1. Taking into consideration that the land uses in European metropolitan are organized in such a manner so that a city centre exists in each city (and typically city centres constitute attractive areas), service operators may have to overlap within this area.

Being able to assess the operative area where the sharing mobility modes operate geographically in the City of Milan will give the public administration more accurate information to structure more comprehensive tenders. This tool will permit to find a good balance between increasing the geographic coverage of the sharing mobility service and the economic viability for operators. In terms of inputs, the following data have to be entered:

- Selection of the type of mode to be analysed (bike, moped, kick-scooter, or car-sharing): it is the mode of transport utilised in the simulations.
- Operating costs per vehicle per minute (in Euros): are the expenses which are related to the maintenance of the car (parking costs, insurance, car maintenance costs).
- Expected revenues per minute of rent (in Euros): these are the earnings that the operator of the service obtains and derives from the payment by the user of the rental rates.
- Average trip duration (in minutes): it is the average of the vehicle usage time of a certain mode of transport.
- Weighting factors assigned to service operator's and society's perspectives: the weights are the coefficients that measure the relative importance end-users and operators. The sum of the two weights always equals 1.

After entering the input data, the user has the option to include the entire existing operational area in the calculation of new operational area alternatives, or to remove some of the areas already served or to add others.

Operationally, the algorithm, performs a clustering by trips per areas and creates all possible combinations between the areas to be evaluated and the areas that are currently served. For each cell, it applies a simplified model of the use case 1 algorithm in order to identify which fleet is optimal and which costs and profits for the service operator are technically and economically feasible. At the end of the computation, the tool returns as output a csv file containing:

- the first column shows the ids of possible alternatives

- the second column shows the costs incurred by the service operator to the relevant operational area configuration
- the third column is the total accessibility calculated according to Hansen's Accessibility Model
- the fourth column represents the percentage of the population, compared to the total population, which has access to the sharing service
- the fifth column reports the service operator's profits at the relative configuration of the operational area
- the sixth column lists the number of areas constituting a defined operational area.

To show how the tool calculates possible alternatives, a test simulation was conducted, using the following input parameters:

- Type Mode: Bike sharing
- Operating costs p/vehicle p/minute (in euro's): 0,1
- Expected revenue per minute of rent (in euro's): 0,5
- Average trip duration (in minutes): 12
- Weighting factor society: 0,5
- Weighting factor service operator: 0,5

Moreover, six additional zones have been added to the zones already currently served for calculation purposes.
At the end of the simulation, the nuMIDAS dashboard returned 10 different alternatives. Each alternative, has associated, some previously described KPIs. Specifically, the cost incurred by the service operator, the profits earned by the service operator, accessibility and the percentage of the population, out of the total population of the municipality, that is covered by the service were chosen.
As shown in figure 1, in particular, the first alternative is alternative 0, i.e. no areas were added to the areas currently served. In this configuration, the percentage of the population covered is 92%.

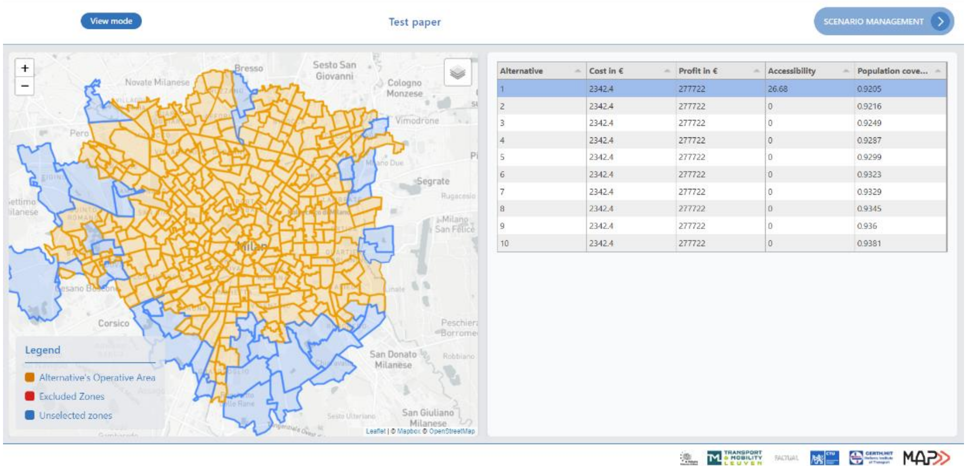

Fig.1 Alternative 1 map

Whereas, figure 2 shows the alternative in which all areas that can be added, and in which there is a balance between service coverage and profit for the operator, have been added.

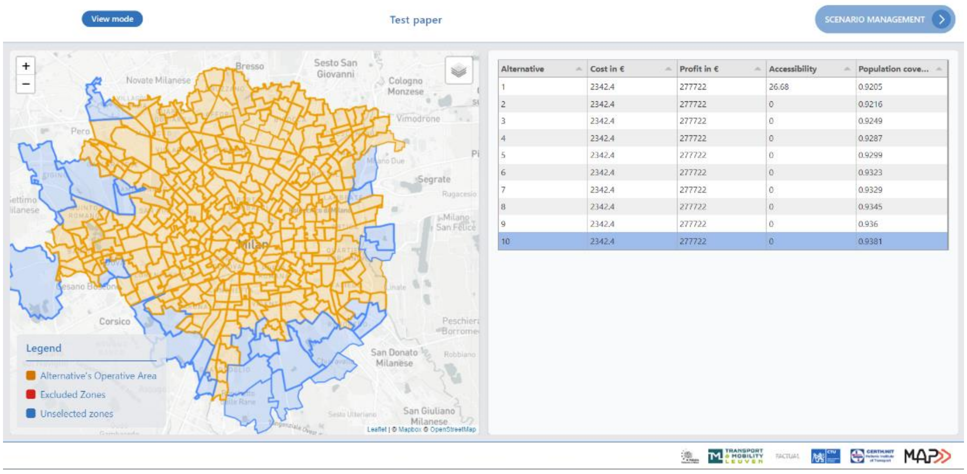

Fig.2 Alternative 10 map

In the last alternative, there is an increase in the population covered, which specifically reaches a value of 93.5%.

The feature of having several alternatives for each scenario created allows the decision maker not to have a single 'best solution' but a set of solutions that can be compared with each other or evaluated separately. In this way, the co-designed tool supports the user to make a decision or decisions that are adaptable and suitable to the social and economic context of the city.

4. Discussion

The tool models and reproduces the processes that are at the basis of the definition of the operating area for mobility sharing services, even though some parameters within the algorithm still need further calibration. However, a first limitation can be found in the results concerning the service operator's profit as it was often found to be overestimated during the simulations for the calibration and validation of the model. This problem is apparently caused by the use of a low value for operating costs which are not publicly available and were therefore estimated by consulting various experts in the field. In fact, even if the operating cost is a value that is not publicly available and the costs for the operation of the cars can only be estimated, a high value of profits (e.g. higher than EUR 4/5,000 per day) seems unlikely. A further upgrade that can be made to the tool in the future, is to look not only at one operator and one transport mode, but to analyse the sharing mobility system as a whole. In particular, future developments may concern taking into consideration several operators offering the same service in the same area, or perhaps taking into account that on the same area two modes of transport, such as free-floating bikes and scooters may compete with each other. Finally, with a view to future development, the tool could also be used without including the areas already currently served and start from a blank space in order to suggest new areas of operation, where there is a balance between operator profits and increased accessibility of services by users, which in some cases could be even smaller than the current ones.

5. Conclusions

In general, "Operative areas analysis shared mobility" tools described in UC2 in this paper, is intended as a decision support tool and therefore it doesn't provide the user with the "best solution", instead allows the policy makers in exploring different hypothetical scenarios, evaluate their effects and compare different alternatives, to get to a better-informed decision making. In fact, they are certainly important for public decision-makers on the topic of shared mobility as they allow decision-makers to know in advance the effects of decisions that might be made on the shared mobility system. Moreover, this algorithm was co-designed with the aim of being used over time by decision makers who in this way can explore different scenarios and different solutions of the sharing mobility set-up. Furthermore, thanks to the continuous iteration between developers and representatives of the city of Milan, the tool was tailored on the case study even though, having used a transferability by design approach, its methodology can be easily adapted to other realities sharing the same problem in the Italian city. In conclusion, all the tools of the nuMIDAS project were not only conceived as products to be used, but from the outset, they aimed to build a methodology that could contribute to the dissemination of a more data-driven perspective in mobility and transport planning.

Funding: This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007153.

Institutional Review Board Statement: Not applicable

Informed Consent Statement: Not applicable

Data Availability Statement: Not applicable

Acknowledgments: This paper was the result of the excellent joint efforts and contributions of all the project partners involved. We wish to especially mention the following colleagues: Bart Ons and, Kristof Carlier (Transport&Mobility Leuven, TML), Rick Overvoorde, Anton Wijbenga, Tessel van Ballegooijen, Dennis Hofman, Levi Broeksma, Martijn Harmenzon, Luc van der Lecq, and Jaap Vreeswijk (MAPtm), Evangelos Mitsakis and Maria Stavara (The Centre for Research & Technology –Hellenic Institute of Transport, CERTH-HIT), Carola Vega, Josep Laborda, and Eglantina Dani(Factual Consulting), Ondřej Přibyl, André Maia Pereira, Tomas Horak, and Jan Přikryl (Czech Technical University in Prague, CTU), Pablo Recolons, Ramon Pruneda, and Xavier Conill Espinàs (Àrea Metropolitana de Barcelona, AMB Informació), Valentino Sevino, Alessandro Giovannini, Paolo Campus, and Adriano Loporcaro (Agenzia Mobilità Ambiente Territorio, AMAT), and Eli Nomes, Tim Asperges, and Fatma Gözet (City of Leuven).

Conflicts of Interest: The authors declare no conflict of interest.

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