

The New Mobility Data and Solutions Toolkit (nuMIDAS)

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Abstract

The mobility ecosystem is rapidly evolving, with the rise of new stakeholders and services, accompanied by new ways for the generation, collection, and storing of data. In the nuMIDAS (New Mobility Data and Solutions Toolkit) project, we provide insights into what methodological tools, databases, and models are required, and how existing ones need to be adapted with new data. We start from insights obtained through (market) research and stakeholders, as well as quantitative modelling. A wider applicability of the project's results across the whole EU 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. Finally, through an iterative approach, nuMIDAS is creating 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.

Keywords:

Intelligent traffic and mobility management, Data management

The nuMIDAS project in a nutshell

The mobility ecosystem is rapidly evolving, whereby we see the rise of new stakeholders and services. Examples of these are the presence of connected and automated vehicles, a large group of organisations that rally to establish various forms of shared mobility, with the pinnacle being all of these incorporated into a large MaaS ecosystem. As these new forms of mobility offerings start to appear within cities, so do new ways in which data are being generated, collected, and stored. Analysing this (Big) data with suitable (artificial intelligence) techniques becomes more paramount, as it leads to insights in the performance of certain mobility solutions, and is able to highlight (mobility) needs of citizens in a broader context, in addition to a rise in new risks and various socio-economic impacts.

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Successfully integrating all these disruptive technologies and solutions with the designs of policy makers remains a challenge at current. let alone being able to analyse, monitor, and assess mobility solutions and their potential socio-economic impacts.

nuMIDAS, the New Mobility Data and Solutions Toolkit, 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 EU 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. Finally, 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, the New Mobility Data and Solutions Toolkit, started at the beginning of 2021 under the Horizon 2020 programme and its 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 four pilot cities to provide a geographic coverage of the EU: Barcelona (Spain), Milan (Italy), Leuven (Belgium), and Thessaloniki (Greece), as shown in Figure 1.



Figure 1 – Locations of the pilot cities.

From ideas and conceptual designs to toolkit deployment in pilot cities

General methodological approach

In order to achieve the project's outcomes, we take the following steps:

- Perform an assessment of the current trends
- Define advanced methods and tools
- Execute case studies in pilot cities
- Create a consolidated toolkit for stakeholders

Some of these steps run in parallel, with feedback mechanisms involved in order to capture and process the latest developments and insights during the creation of the nuMIDAS toolkit, as shown in Figure 2.

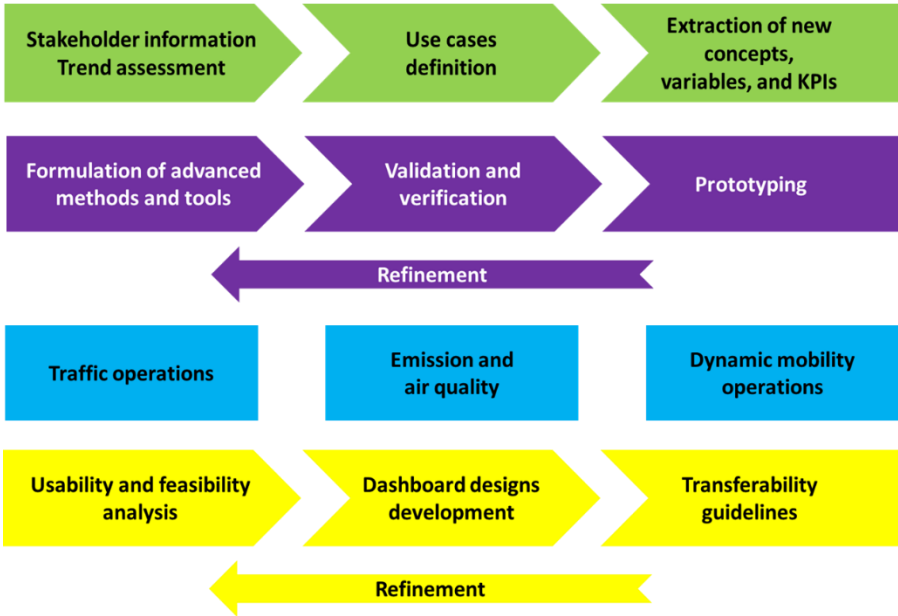


Figure 2 – General overview of the methodological steps followed in the nuMIDAS project.

A service-oriented architecture

In order to make sense, and to have a common and agreed upon language of terminology (see also Figure 3), the nuMIDAS project adopted a service-oriented architecture.

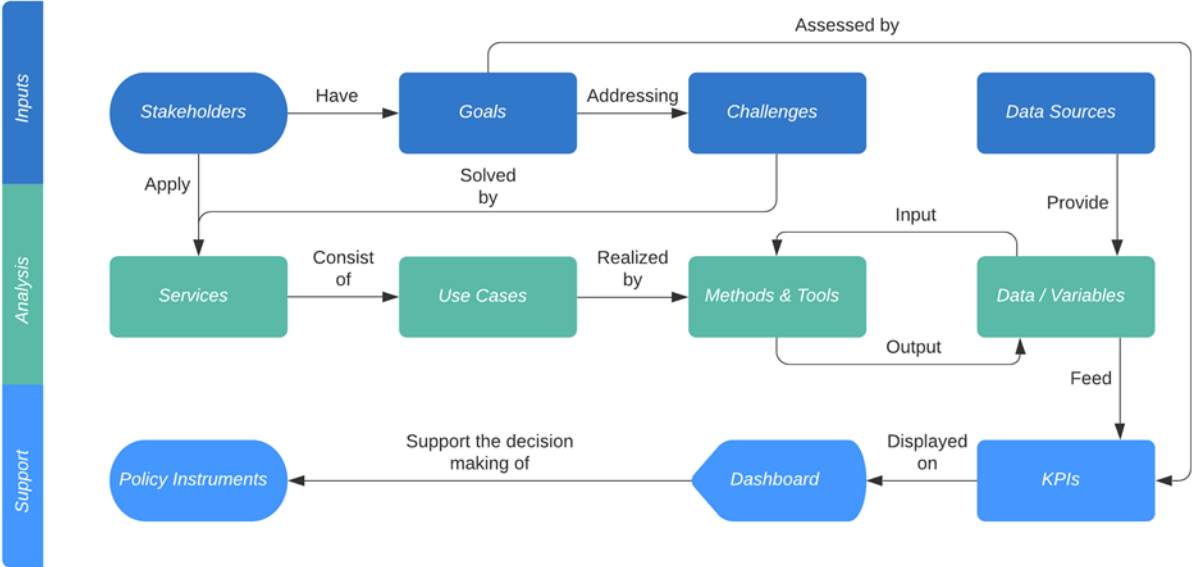


Figure 3 – The nuMIDAS model as a service-oriented architecture.

To this end we identified the services in scope. For each of them, a detailed overview of the state of the art was provided. After the individual analysis, a big picture was prepared to show links among the services and policy instruments. This big picture allows us to ensure unity in the produced output.

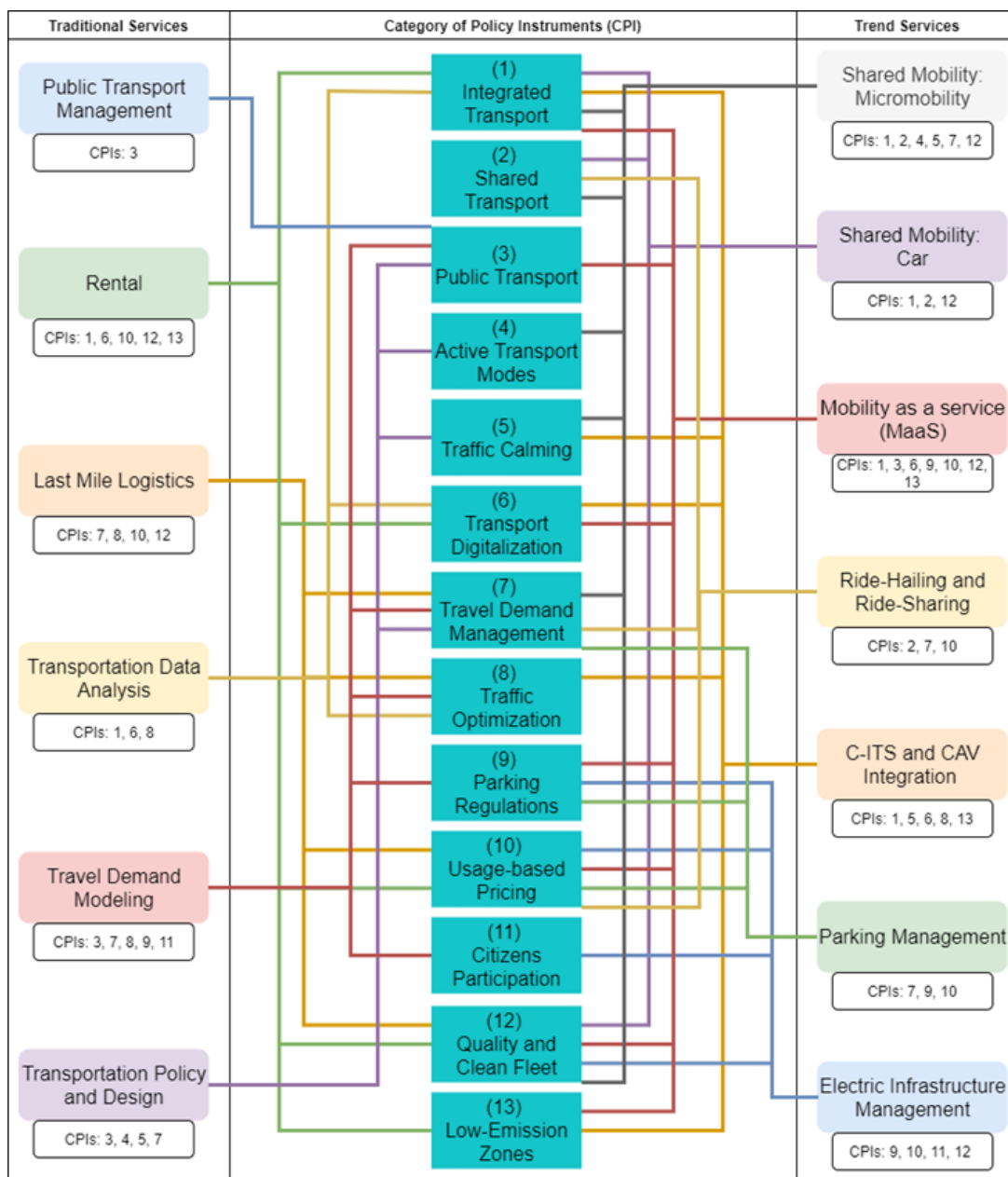


Figure 4 – The relations between services and categories of involved policy instruments.

Selection of use cases

To successfully support transportation planners, researchers, and policy makers, emphasis has been given on the harmonisation of the development of the toolkit. With this objective, a series of parameters has been defined: extensibility, interoperability, minimisation of development and operational costs, reliability, and usefulness and user-friendliness of the toolkit. nuMIDAS provided high-level descriptions of the use cases, along with descriptions of problems which need to be addressed in the specific city(ies) and the technical approach to be adopted. In addition, we also provided UML mock-ups giving the visual representation of each use case approach, and capturing the entire process of a tool in combination with the interrelations with the involved actors.

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In order to make the scope of each use case more understandable and tangible, they set the boundaries of the tool, the steps to be followed each time, and the requirements needed to move forward. An overview of what steps were followed to identify the use cases are shown in Figure 5 and Figure 6.

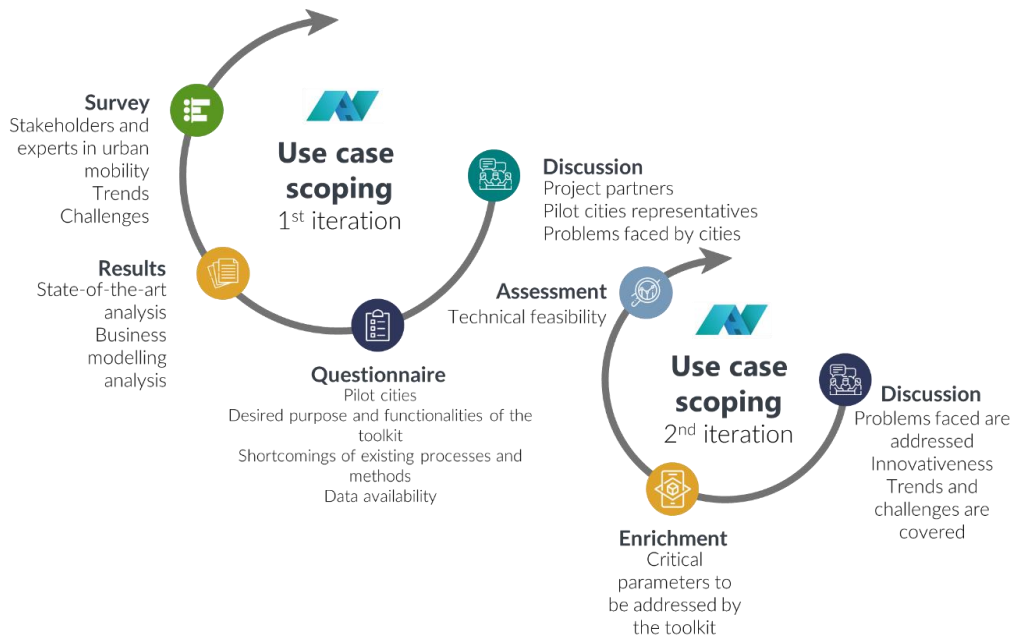


Figure 5 – Overview of the processes followed for scoping the use cases in nuMIDAS.

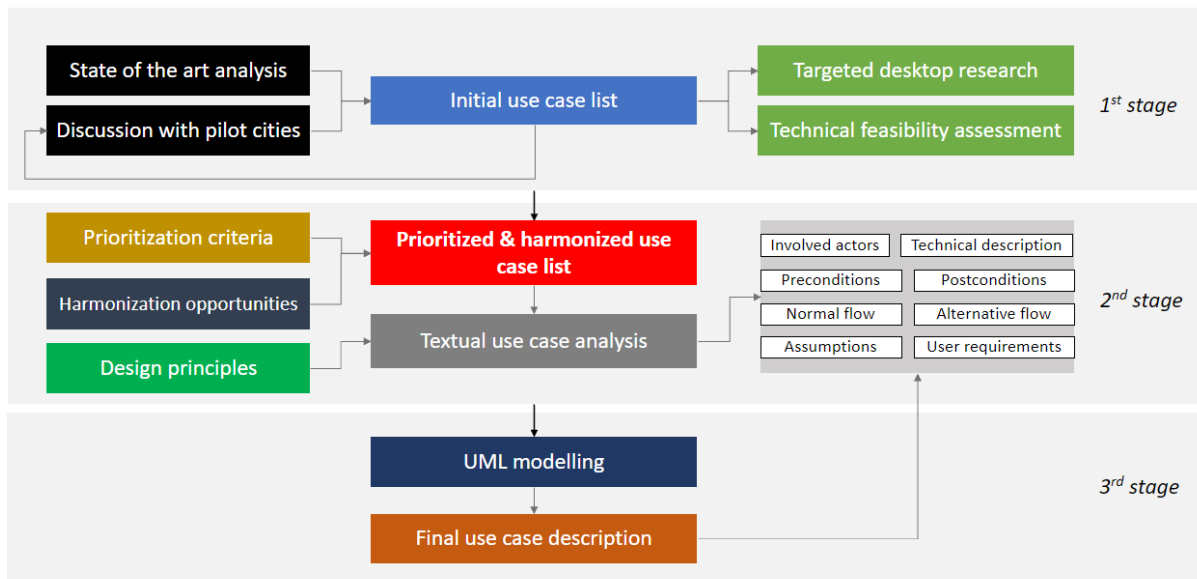


Figure 6 – Overview of the methodology behind the final selection of use cases.

Thanks to the requirements that emerged from the discussion and the interaction with the project pilot cities and relevant stakeholders, we identified the following 6 use cases (UC) to address the problems and provide the technical support to solve them by creating specific methods and tools:

- **Use case 1: Pre-planning of shared mobility services (Milan and Leuven)**
This use case focuses on the optimal fleet size of shared mobility services (e.g. shared bikes, e-scooters) considering different parameters and constraints such as socioeconomic parameters, mobility, financial, and service provision-related. The urgent need is the designing of a tool which will be capable of providing solution to an optimization problem to minimise the generalised cost of trips as well as the cost of the system (including operating costs).
- **Use case 2: Operative areas analysis (Milan)**
This use case targets at the allocation of existing shared mobility services' supply (i.e. operable fleet) to specific sub-areas of a metropolitan area with the aim of minimising economic losses of service providers and ensuring an acceptable level of service for citizens, in line with the principles of equitable transport systems.
- **Use case 3: Air quality and vehicle emissions analysis based on multi-source data (Barcelona and Leuven)**
This use case supports the linkage and correlation of multi-source data including traffic-related, emissions-related, and weather-related data. The ultimate purpose of this linkage/correlation is to assess the impact of traffic on air-quality, forecast air quality in a short- to medium-term basis (e.g. 10 days), and/or simulate scenarios for the development and enforcement of air quality-related policies and policy instruments.
- **Use case 4: Planning for parking (Leuven)**
This use case focuses on the assessment of traffic-related impacts of reducing on-street parking space within inner cities, thus supporting the formulation and enforcement of relevant policies and policy instruments, including excess searching time of affected drivers and the pressure relocated to areas adjacent to the affected one.
- **Use case 5: Inflows and outflows in a metropolitan area (Barcelona)**
This use case revolves around the estimation of inflows and outflows between the districts of a metropolitan area based on data generated by point-to-point detection systems (i.e. Automated Number Plate Recognition systems) as well as of census data (i.e. vehicle registration). The ultimate purpose is to support the refinement and proper enforcement of environmental policies and policy instruments (e.g. low emission zones).
- **Use case 6: Assessment of traffic management scenarios (Thessaloniki and Leuven)**
This use case involves the assessment of traffic management scenarios. The certain tool supports the assessment of C-ITS enabled traffic management scenarios based on simulation-based tools and data analytics, making use of multi-source data including data from connected vehicles fused with data from conventional counting systems.

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These use cases are currently being implemented in the toolkit, thus providing researchers, planners, and policy makers with visualisations of the results derived from the methods and tools used in the case studies.

Creating the toolkit's back-end and front-end software

Integrating our the disruptive solutions and technologies from our use cases into coherent planning, decision making, and policy making for mobility is a huge challenge at current. The nuMIDAS project creates a tangible and readily available toolkit (see also the architectural view in Figure 7) to support local governments and bridge this gap by providing a comprehensive approach regarding what datasets, methodologies, tools, and models are required and which existing ones can be adapted. Moreover, nuMIDAS makes policy decisions measurable and quantifiable, and impact assessments more tangible and directly usable. By applying research and implementing the tools in pilot cities with varying problems and characteristics, a wider applicability across Europe is guaranteed.

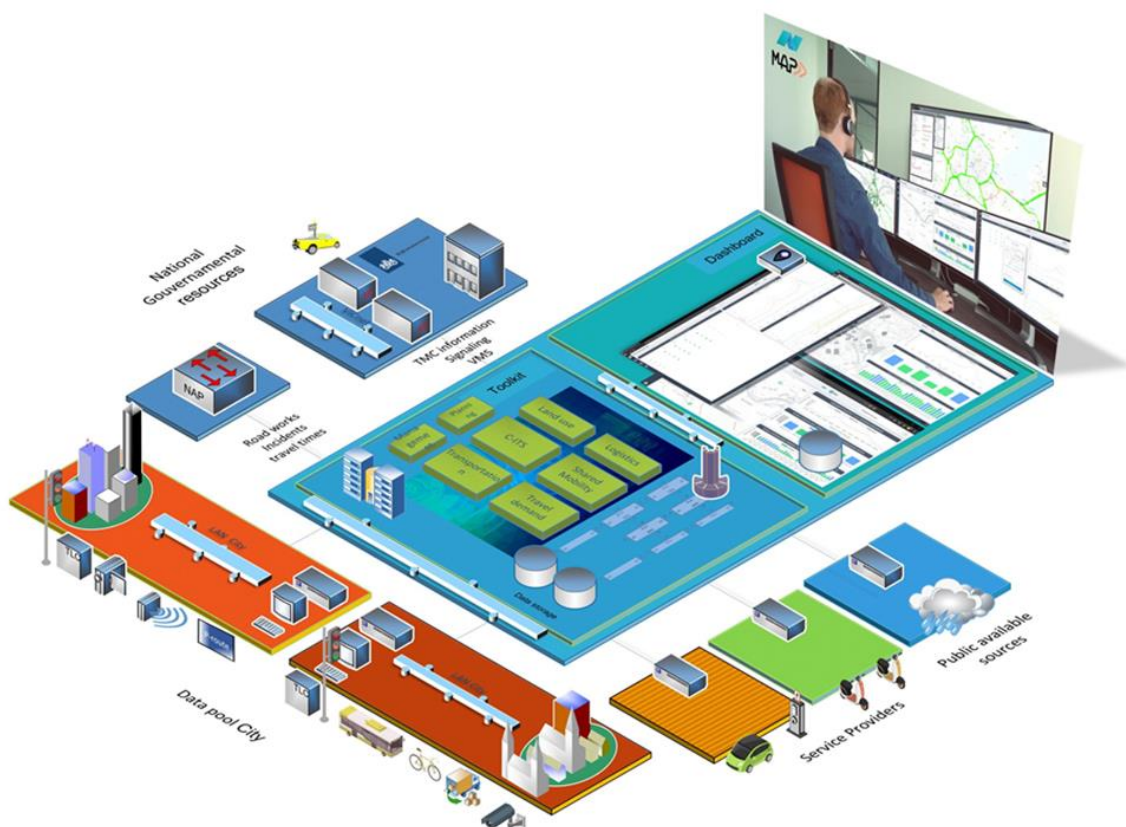


Figure 7 – Schematic view of the architecture of the nuMIDAS toolkit.

nuMIDAS's prototype development (i.e. its 'toolkit') approach is validated through an iterative approach within the six case studies in the different European pilot cities. We deploy the toolkit in each of those cities. Advanced methods and tools are required to analyse, assess, and monitor these new mobility solutions and policies including new data management techniques. The toolkit (in the form of a dashboard) incorporates these methods and tools providing researchers, planners, and policy makers a visualisation of the results through a GUI.

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For each of the use cases, we devise new algorithms that take the current state of the art into account and add new elements to it. Our algorithms are currently being developed, with three of the six use cases ready by March 2022. The algorithms are coded in Python and first tested under lab conditions. Then they are ported to a back-end engine (forming part of the toolkit) that will run an instance of Amazon Web Services (AWS) with appropriate GIS-databases and input/output file handling capabilities. To perform smooth operations, the entire endeavour will operate using private and public APIs, with the front-end system containing access control regulations and the visual part of the different use cases (e.g. graphs for geographical interpretations, monitoring of key performance indicators, etc.), as well as scenario management where suitable.

Example implementation of a use case

As an example, in the city of Milan, the policy maker required a tool for the preplanning of shared mobility services. The nuMIDAS team designed and is currently developing a tool that processes available data to produce the output required by Milan city mobility planners. The aim is to produce a tool replicable and scalable in different cities/regions in Europe. In the case of station-based car-sharing, as an example, the dashboard will suggest the proper location of new car-sharing stations and a well-balanced car fleet. This outcome will be produced by back-end algorithms that will elaborate data provided by the municipality. New car-sharing services, or extensions of the existing ones, can then be planned based on the outcomes of the nuMIDAS tool. The dashboard allows tuning parameters of the algorithms to compare different scenarios, depending on the weight given to conflicting objectives. Examples of the latter are the increase of shared mobility options to citizens in low-demand areas, and the economic sustainability of car-sharing operators. The policy maker will use the dashboard to link data sources and input parameters, and to visualise the results of the computation in a user-friendly environment. This specific example will be tested in the case of Milan, but will then be extended to be used by any European city willing to make use of a tool that supports car-sharing planning.

Upscaling and transferability to other cities

In order to maximise the exploitation of project results, and in particular a widespread use of our new mobility toolkit, we will draw up transferability guidelines. These will describe how new cities can implement new instances of the tools within the nuMIDAS architecture framework, and use them for new mobility solutions analysis, assessing, and monitoring.

From an operational point of view, due to the city-specific and location specific parameters and constraints (air quality, origin-destination matrix, etc.), the guidelines will transfer not the models themselves, but rather provide a useful methodology to adapt the model to each city. At this time of writing, the transfer methodology is still in draft, but, given that the conference will be held in September 2022, the toolkit and its transferability guidelines will already be almost fully developed.

Developing suitable business models

The state-of-the-art analysis provided early on in our project the basis for the work on business models for particular services. As the mobility field is rapidly changing due to, among others, digitalisation, as well as the uprise of small and large electric vehicles, business models and stakeholder roles change. Furthermore, more and more services combine many disciplines, which often means that services require multiple types of stakeholders to become effective. For this reason, a stakeholder analysis was performed in the context of nuMIDAS, in combination with a business model analysis.

The analysis was performed using a Service Dominant Business Model Radar (SDBM/R). The SDBM/R gives insight into which stakeholders can be found within the business model, as well as the way these stakeholders add value to this service. In addition to the SDBM/R, the analysis contains descriptions of the change in business models and stakeholder roles within the business models over time.

All SDBM/Rs were created per service, based on the achievement of shared goals and value co-creation by a group of actors (businesses, firms, and costumers) which interact to achieve that shared goal. This activity required to identify the values-in-use as the focal points of the services, and further the value propositions (part of the central values contributed by the particular actors), coproduction activities (i.e. those that actors perform to achieve the co-creation of the values), and costs and benefits for particular actors. The radars were complemented with the description of the corresponding business model scenarios, descriptions of actors and their roles and activities, and the discussions of the transitions of business models influenced by new methods and tools. An example of such a SDBM/R is shown in Figure 8 for the micromobility service.

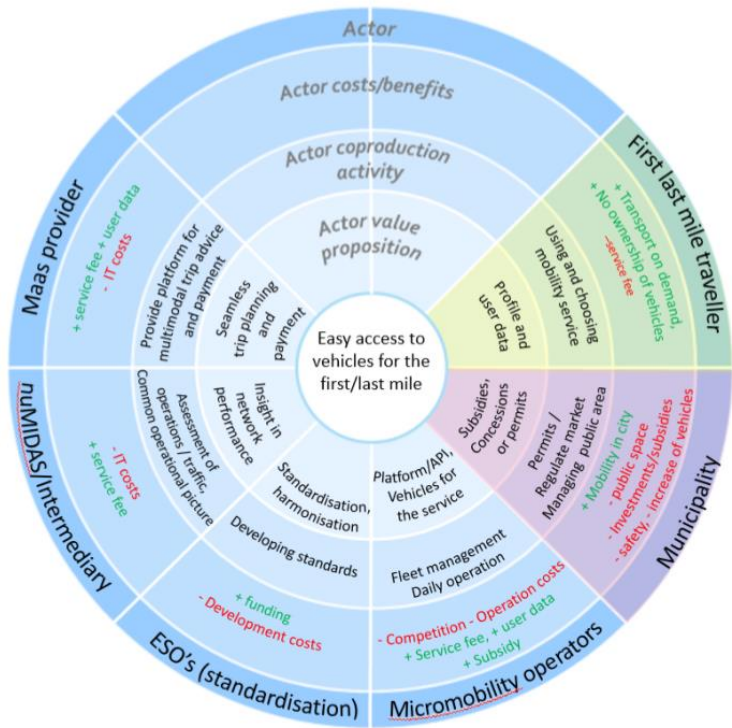


Figure 8 – Example of a business model radar (SDBM/R) for the micromobility service.

The summary resulted in a short list of the most common stakeholders within the SDBM/Rs. These are: municipalities, travellers, (mobility) service providers, intermediaries, and MaaS providers. The first three stakeholders within this list are most important and most common. These three stakeholders respectively provide policies, demand, and supply for transportation. The last two of these stakeholder types, intermediaries and MaaS providers, are not yet so common in the actual urban mobility field. These are categorised as future partners and are expected to become more prevalent. As transport systems become more and more integrated, while mobility service providers are competing, intermediaries stay independent and are able to handle data of competing partners with care to provide services which would otherwise not have been possible due to said competition. When the apps of MaaS providers finally really take-off, many services are expected to change, as mobility will be even more accessible from within our pockets. Based on all this information, we will position our nuMIDAS toolkit appropriately in light of further commercial exploitation after the project's end.

Acknowledgements

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

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 co-authors: Bart Ons and Kristof Carlier (TML), Rick Overvoorde, Anton Wijbenga, Tessel van Ballegooijen, Dennis Hofman, Levi Broeksma, Martijn Harmenzon, Luc van der Lecq, and Jaap Vreeswijk (MAPtm), Evangelos Mitsakis, Dimitris Tzanis, and Maria Stavara (The Centre for Research & Technology – Hellenic Institute of Transport, CERTH-HIT), Carola Vega, Josep Laborda, and Eglantina Dani (Factual Consulting), Magdalena Hyksova, Andre Maia Pereira, Tomas Horak, and Jan Prikryl (Czech Technical University in Prague, CTU), Valerio Mazzeschi, Valerio Paruscio, Alessandro Lue, Gabriella Atzeni, Fabio Vellata, and Roberta Falsina (Poliedra Polytechnic Milano), Pablo Recolons, Ramon Pruneda, and Xavier Conill Espinàs (Àrea Metropolitana de Barcelona, AMB Informació), Cristina Covelli, 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).

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