nuMIDAS: The New Mobility Data and Solutions Toolkit

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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 provided insights into what methodological tools, databases, and models are required, and how existing ones need to be adapted with new data. We started 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 was guaranteed as all the research was 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, nu-MIDAS created 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.

1 General overview

1.1 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. 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 socioeconomic impacts.

nuMIDAS, the New Mobility Data and Solutions Toolkit, bridged 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 started 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 was guaranteed as all the research was 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 created 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, ran during 2021 and 2022 under the Horizon 2020 programme and was developed by a European Consortium, composed of 9 partners from 6 countries: Belgium, Czech Republic, Greece, Italy, The Netherlands, and Spain. The project built on a distributed selection of case studies in four pilot cities to provide a



public deliverables can be readily downloaded from our website (https://numidas.eu/).

1.2 Selection of use cases

geographic coverage of the EU: Barcelona (Spain), Milan (Italy), Leuven (Belgium), and Thessaloniki (Greece). All

To successfully support transportation planners, researchers, and policy makers, emphasis was put on the harmonisation of the development of the toolkit. With this objective, a series of parameters was 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. 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. Various use cases were implemented in the toolkit, some fully, others partially, thus providing researchers, planners, and policy makers with visualisations of the results derived from the methods and tools used in the case studies.



Fig. 1. Overview of the processes followed for scoping the use cases in nuMIDAS.

The toolkit now supports answering the following questions:

- Milan:
 - How many shared (micro)mobility services need to be provided, and where?
- Barcelona:
 - How large are the vehicle emissions (CO2, NOx, and PM)?
 - How much vehicles drive from A to B?
- Leuven:
 - What is the impact of removing on-street parking spaces?
- Thessaloniki:
 - What is the impact of traffic management measures (traffic lights and speed limits)?

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

Advanced methods and tools are required to analyse, assess, and monitor new mobility solutions and policies including new data management techniques. The toolkit (in the form of a dashboard) incorporated these methods and tools providing researchers, planners, and policy makers a visualisation of the results through a GUI. For each of the use cases, we devised new algorithms that took the current state of the art into account and add new elements to it. The algorithms were initially coded in Python and first tested under stand-alone lab conditions. Then they were ported to a back-end engine (forming part of the toolkit) that runs an instance of Amazon Web Services (AWS) with appropriate GIS-databases and input/output file handling capabilities. To perform smooth operations, the entire endeavour operates 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.

2.1 Example implementation of a use case: shared mobility planning

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 developed a tool that processes available data to produce the output required by Milan city mobility planners. The aim was 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 suggests the proper location of new car-sharing stations and a well-balanced car fleet. This outcome is produced by back-end algorithms that 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. A policy maker can 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 was tested in the case of Milan, but can be extended to be used by any European city willing to make use of a tool that supports car-sharing planning.

2.2 Example implementation of a use case: planning for parking

The main objective was to assess the potential impact of on-street parking restriction policies in the city of Leuven. The city is especially concerned with possible spill-over effects of hyperlocal policy changes, such as substantively reducing the available parking spaces in one street or neighbourhood. Through the simulation of enforcing a parking restriction policy in one or more roads of the network, both the policy maker as well as the transport planner are able to evaluate the effects, on the basis of the KPIs provided by the tool. Specifically, the evaluation of an on-street parking restriction policy includes the calculation of parking pressure, the calculation of searching time, and the examination of the extent of the effect.

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Fig. 2. Example of the shared mobility planning use case (*left*) and planning for parking use case (*right*) in the nuMIDAS toolkit's online dashboard.

2.3 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 drew up transferability guidelines. These 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 transferred not the models themselves, but rather provided a useful methodology to adapt the model to each city.

2.4 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.

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. As such, our nuMIDAS toolkit is excellently positioned in light of further commercial exploitation.

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