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HARMONY

Holistic Approach for Providing Spatial & Transport Planning Tools and Evidence to Metropolitan and Regional Authorities to Lead a Sustainable Transition to a New Mobility Era

D9.2- Secondary data from the HARMONY areas

Submission date: 20/05/2020

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SUMMARY SHEET

PROJECT

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Responsible Co-Author(s):	Bok, M. de (TUD), Bothos, E. (ICCS), Fermi, F. (TRT), Magoutas, B. (ICCS), Raman, S. (OCC), Salas Jones, A. (UoW), Tsouros, I. (UAEGEAN), Tzivelou, N. (OASA), Yfantis, L. (UCL)
Peer Review:	Bothos, E. (ICCS)
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EXECUTIVE SUMMARY

Aligned with the main goals of the project, HARMONY WP9 envisages and works towards efficiently organized demonstration activities. In this framework, task 9.1 specifically focuses on setting up the HARMONY case studies and managing cross-metropolitan activities. It covers all preparatory steps, which are necessary to set-up and coordinate the demonstrations, as well as the stakeholders engagement activities, the primary and secondary data collection and the evaluation of the case studies. The current deliverable aims at identifying the secondary data requirements for the HARMONY models, defining their availability as well as potential limitations, which is an essential part of the process in order to ensure consistent data developments and standards.

Deliverable 9.2 firstly provides the secondary data template, developed as a guideline for the different areas on the types of data which need to be considered. Following, the four different case study areas, i.e. Rotterdam, Oxfordshire, Turin and Athens, and their urban development plans are shortly described in separate sections, focusing on their secondary data requirements, availability and limitations. Alternative data sources have been suggested when secondary data are not available. Next to these, a summary of the data management plan for the secondary data is presented, consisting of sections on data security, storage of sensitive data, adherence to the General Data Protection Regulation and data access and usage. The deliverable is completed by the sections on conclusions and references. Lastly, an annex is provided showing the secondary data template, including Land Use Model Data Requirements, Transport Demand Model Data Requirements, Transport Supply Model Data Requirements, Calibration Data Requirements and New Mobility Service Data Requirements.

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1. Introduction

1.1 Aim of the project

Nowadays, new mobility services and technologies are presented as possible solutions to reduce greenhouse gas emissions and energy consumption in metropolitan areas. However, authorities face several challenges when it comes to harmoniously integrating these developments into spatial and transport plans to improve citizens' wellbeing and achieving environmental targets. Given rapid technological advances and the emergence of new mobility services, metropolitan authorities are often in need of expertise, knowledge and tools for multiscale spatial and transport planning.

In the view of this background, HARMONY's vision is to enable metropolitan area authorities to lead a sustainable transition towards a low-carbon new mobility era. This will be guided by its harmonised spatial and multimodal transport planning tools, which comprehensively model the behavioural and operational dynamics of the changing transport sector as well as metropolitan areas' spatial organisation.

HARMONY has set ambitious targets for the co-creation of metropolitan scenarios, informing updated spatial and transport planning tools. Therefore, a strict and stable planned coordination is mandatory to ensure the quality of the results and findings of each area and also to allow comparisons across the six different geographic areas. The consortium's intention is to ensure the best experience of the implementation of the HARMONY concept in each area and its exchange, not only across the HARMONY metropolitan areas, but also across other EU and international areas.

1.2 Purpose of the document

Within HARMONY, WP9 is responsible to ensure that demonstration activities are efficiently organized, contributing to the main goals of the project.

In this framework, task 9.1 specifically focuses on setting up the six HARMONY case study areas (Rotterdam, Oxfordshire, Turin, Athens, Trikala and Katowice) and managing the cross-metropolitan activities. It covers all preparatory steps, which are necessary to set-up and coordinate the demonstrations, as well as the stakeholders engagement activities, the primary and secondary data collection and the evaluation of the case studies. Alongside modelling use cases, physical pilots with demonstrations will take place in Rotterdam, Oxfordshire and Trikala, whereas Turin, Athens and Katowice (GZM) co-creation labs will focus on stakeholder engagement activities necessary to fulfil their identified scope of activities.

In this document, an overview of the secondary data requirements for the HARMONY models and their availability and limitations have been given for the four different HARMONY areas that these secondary data are collected for.

The data management plan for the secondary data is a further essential element for this document, consisting of sections on data security, storage of sensitive data, adherence to the General Data Protection Regulation and data access and usage.

1.3 Structure of the document

Deliverable 9.2 includes the following parts. First, the HARMONY secondary data template is provided as a guideline for the different areas on the types of data to be considered at this stage. Secondly, the four different cities, i.e. Rotterdam, Oxfordshire, Turin and Athens, used as case studies are presented, focusing on their secondary data requirements, availability and limitations. Following, the data management plan for the secondary data is presented. The deliverable is complete by the section on conclusions and references. Lastly, an annex is provided showing the secondary data template.

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2. The HARMONY secondary data template

The HARMONY Model Suite (MS) will incorporate and integrate a spatial and a transportation modelling framework that will capture the decision making and interaction of both passengers and freight. The most critical task for developing the HARMONY MS is to find all necessary input data and parameters to create a realistic scenario. Due to potential data availability challenges, there is a need for a data collection and model development plan to ensure consistent data developments and standards. Such a plan needs to include considerations for secondary data, i.e. existing data sources, usually available on a national and local level, such as population and household data (socio-demographic and economic characteristics), land use data and network geometry and transit operation related data, which can be used for sourcing information needed for developing the model system.

In order to obtain the information of the available data in the selected metropolitan areas, it was, thus, necessary to create a secondary data template that specified the types of data considered at this stage for the HARMONY MS. HARMONY builds upon the state-of-the-art to extract data-related needs identified in similar research efforts. This has been based on an elaborative state-of-the-art review presented in D1.1. To this end, the review identifies the generic data as well as specific modelling requirements that enable integrated spatial and transport planning models. The availability of an undoubtedly large size and wide variety of secondary data required from these types of models is a requirement towards optimizing the quantity and quality of primary data collection. Therefore, secondary data availability surveys have been defined in the form of data templates. This work has been performed on the basis of models required for the various modelling levels incorporated in the HARMONY MS (strategic tactical and operational), by the corresponding members of the Scientific and Technical team. Where necessary, the interconnections and shared data needs have been identified and the templates have been restructured to best reflect the way that stakeholders usually handle data. To satisfy needs for up-to-date, usable and available data, aspects such as data formats, year of collection, data source, license and availability within the context of the project have been defined. The survey is generally based on guided open-ended questions that provide flexibility to the participant to list diverse datasets and, at the same time, illustrate the relevant data needs. The formulated template was distributed among the project partners that represent the pilot cities of HARMONY. Figure 2-1 illustrates the data specifications requested in the HARMONY secondary data template. Screenshots of the full template can be found in the annex.

***2. Data Requirements Specification** - Please, provide information regarding the availability of the requested data types and further descriptions*						
Data Type	*Can data be used in the project? (Yes/No)*	*When data will be available to the consortium (indicate project month e.g. M4; M1 is May 2019)?*	*Data Format and source? (e.g., omx, text file, ASCII, csv, shapefile...)*	*Data Year (e.g 2019)*	*Description (e.g. Level of Disaggregation - Temporal/Spatial resolution/scale)*	*Additional Comments (e.g. links to data sources, data source description)*

Figure 2-1. Data requirements specification - Secondary data template

The HARMONY MS envisages to develop sociodemographic, land use, transport demand, multimodal network and energy and emission models that will include the latest trends in mobility services development for both freight and passenger transport. These models are distributed amongst three levels: strategic (long-term), tactical (mid-term) and operational (short-term). To satisfy the individual data requirements at each level, the HARMONY secondary data template was divided in four main categories: land use, transport supply, transport demand and new mobility services. These categories were further divided into relevant areas of interest needed for the development of the models.

The first category, i.e. land use data, refers to statistics and information regarding the population, types of land use and urban developments in the area. These data serve as an input for the development of the models at strategic level; those are regional economic, demographic forecasting, land-use, spatial freight interaction and long-term mobility choice models. For a better and more detailed delimitation of the data needed in this category, land use data have been sub-divided in economic, land use, demographics, housing, topography, administrative boundaries, building and planning and policy data. Table 2-1 presents the most relevant data types included in the land use category of the HARMONY secondary data template.

Table 2-1. Land use data - Secondary data template

Category	Data types	Description
Economic	Employment	Disaggregated by zone, occupation, wage, floorspace
	Retail activities	Disaggregated by zone, occupation, wage, floorspace
	Freight flows	By industry/employment class
Land use	Land use data	Type of land use
Demographics	Population	Current resident population
	Population projections	Estimated future resident population
	Occupational class	Skilled occupational group
	Ethnicity	Ethnic group distribution
	Income	Mean income or income percentiles
Housing	Housing tenure	Housing tenure percentages
	House prices	Average price paid
Topography	General topography	Land and coastline geography
	Point of interest data	Location of point of interest
	Digital elevation model	Surface and elevation model
Administrative boundaries	Municipal boundaries	Municipality/Metropolitan boundaries
	Local authority boundaries	County/District boundaries
Building	Building footprints	Building footprints outlines
	Building floorspace	Commercial floorspace and residential units
	Building function	Functionality of the building
	Public housing states	Location of large public housing states
Planning and policy	Future urban developments	New town locations and opportunity area
	Planning zoning	Zoning restrictions on urban development
	Development restrictions	Environmental restrictions
	Future transport developments	Major transport planned developments

Transport supply data represents everything related to the existing physical infrastructure assets. These include geometric specifications of the road network, traffic control and public transport services. These data are required for the development of the freight, passenger and noise and emission models, at tactical and operational level. For an added level of detail, this category was further divided into network, traffic control, public transport, parking, freight related and energy emissions and noise data. Table 2-2 presents the most relevant data types included in the transport supply category of the HARMONY secondary data template.

Table 2-2. Transport supply data - Secondary data template

Category	Data types	Description
Network	Georeferences of centroid and connectors	Shapefile with information of number OD pairs and location of origin and destination centroids
	Open street map data	Open street map data with detailed lane information of study area

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	Aerial photographs	Aerial images of the network
	Road network information	Road network characteristics: speed limit, lane widths, curvature, bike lanes
	Transhipment terminals	Location of multimodal transhipment terminals
	Urban distribution centres	Location of urban distribution centres
	Airport location	Location of airports
Traffic control	Sign data	Location of traffic signs
	Fixed signal control data	Traffic lights position, phases and groups
	Semi actuated signal control data	Adaptive signal data such as movement counts and details of each phase
	Ramp meter control data	The metering rate associated with a ramp meter
	Variable message signs	Location of variable message signs and variable speed signs
Public transport	Routing	Public transport line routing
	Stops location	Location of stops
	Timetable	Timetable covering the simulation period
	Vehicle fleet	Fleet size, type of vehicle, capacity
	Signal priority	Available signal priority scheme
Parking	Parking areas	On-street parking areas
	Lane closure information	Lane closure for parking during specific times of the day
Freight related	City constraints	Regulation imposed by local governments
	Terminal locations	Transfer locations (intermodal facilities)
	Customer locations	Customer demand
Energy and emissions	Vehicle engine	Vehicle engine type data
	Noise emission	Noise emission data
	Building height	Information on existing buildings height
	Road surface	Type of road surface
	Vehicle types	Classification of vehicles

Transport demand data refer to the mobility needs of the different agents in the model, usually coded as a set of OD matrix for each mode and vehicle type. Similar to transport supply, these data are needed both at tactical and operational level, as input for the passenger, freight and multimodal network models. For the purpose of the secondary data template, transport demand data were further divided into passenger, freight and pedestrian data. Table 2-3 presents the most relevant data types included in the transport demand category of the HARMONY secondary data template.

Table 2-3. Transport demand data - Secondary data template

Category	Data types	Description
Passenger	Household demand	Travel demand surveys
	SP experiments	Mode, route or vehicle purchase choice
	Static OD matrix	Static OD matrix by vehicle type

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	Dynamic OD matrix	Dynamic OD matrix by vehicle type
	Public transport data	Passenger flows on public transport
Freight	Freight demand	Freight demand surveys
	OD matrix	Freight OD matrix by vehicle type
Pedestrian data	Pedestrian counts	Estimated pedestrian counts at crossings
	Bicycle counts	Bicycle counts or occupancy share

Calibration data include traffic counts collected by loop detectors or other sensors in the transportation network. These data are needed to calibrate the short-term traffic simulation model at operational level. The capability of the transport simulation model to correctly depict existing traffic conditions depends heavily on the calibration and validation of the model. Table 2-4 presents the most relevant data types included in the calibration category of the HARMONY secondary data template.

Table 2-4. Calibration data - Secondary data template

Category	Data types	Description
Calibration data	Loop detector data	Location and measurements of loop detectors
	Travel times	Travel times for routes
	Automatic vehicle identification data	Location and semantics of data from automatic vehicle identification data (e.g. cameras)
	Automatic vehicle location data	Location and semantics of data from automatic vehicle location data (e.g. floating cars)
	Taxi travel times	Zone to zone taxi travel times

One of the main contributions of the HARMONY MS is the incorporation of new mobility services in the multimodal network models at operational level. To this end, information about the availability of data regarding the fleet characteristics of new freight and passenger mobility services was also added in the secondary data collection template. This refers to the vehicle fleet characteristics such as fleet size, capacity and fuel consumption for each mobility service. Some of the innovative freight and passenger mobility services captured using the template were: ride hailing (e.g. Uber, Lyft), carsharing (e.g. DriveNow), bike sharing (e.g. Santander Bikes), crowd shipping and cargo bikes. Table 2-5 presents the data types requested for each mobility service in the HARMONY secondary data template.

Table 2-5. New mobility services data - Secondary data template

Category	Data types	Description
New mobility services	Fleet size	Number of vehicles in the fleet
	Fleet composition	Vehicle types
	Vehicle capacities	Passenger/freight capacity
	Fuel consumption	Fuel consumption information, if applicable
	Station capacities	Dock/parking location and capacities

3. Rotterdam secondary data

3.1 Overview

3.1.1 Description of the city

Rotterdam is located in the province of South Holland in the Netherlands, at the mouth of the Nieuwe Maas channel leading into the Rhine-Meuse-Scheldt delta at the North Sea. It is a port city, the second

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largest after Amsterdam, with a history of about 900 years. Rotterdam is the largest port in Europe, holding as a major logistic and economic centre which provides direct and indirect employment for around 385,000 people. The extensive distribution system including rail, roads, and waterways have earned Rotterdam the nicknames "Gateway to Europe" and "Gateway to the World".

Rotterdam forms the centre of the Rijnmond conurbation, bordering the conurbation surrounding The Hague to the north-west. The municipality of Rotterdam occupies an area of about 325 km2 (208 km2 of which is land), and is home to 640,000 inhabitants, about 25% of the population of the Rotterdam–The Hague metropolitan area. The metropolitan area consists of almost 66 municipalities and is inhabited by almost 4 million people.

In terms of transport infrastructures, Rotterdam offers connections by international, national, regional and local public transport systems, as well as by the Dutch motorway network. At urban level, public transport services include an extensive metro network of about 78 km, operated by 5 lines, a tram network of about 93 km, offering 13 lines, as well as 55 city bus lines with a total length of about 430 km. Finally, there is a Waterbus network consisting of seven lines.

3.1.2 Description of the urban development plans (regional, spatial and transport plans/SUMPs') until 2050

With reference to urban planning, the general framework (**Omgevingsvisie**) for regulating land use, municipal scale, complemented by provincial and national framework for higher order aspects is currently being drafted. At metropolitan level, the **Roadmap Next Economy** strategy and action programme has been approved in 2016 and identifies five transition paths which are required to shape the new economy of the metropolitan region Rotterdam-The Hague. In the field of freight transport and city logistics, a policy document has been officially established, describing the roadmap to a **Zero Emission City Logistics** zoned (ZECL zone) around the city centre by 2025 (Stappenplan ZES Roadmap to ZE City Logistics). The **cycling plan** (Fietskoers) has been approved in 2018, describing strategies and policies up to 2025. The **public transport plan** (OV Visie) has been approved also in 2018. In 2017, the **SUMP** at city level was approved (**Stedelijk VerkeersPlan Rotterdam**). It is aligned with regional and national policies, while more detailed action programmes for specific aspects are being developed (cycling, pedestrians, public transport).

In the SUMP, which is a high-level document based on a long-term view, targets have been described on an abstract level only. The translation into parameters which can actually be measured and monitored (and eventually target levels to be achieved or maintained) is currently taking place. The implementation programme (UitvoeringsProgramma Mobiliteitsplan Rotterdam, UPMR) is developed using input from the EU-funded SUMI project. As yet, the indicators don't have the status of performance indicators.

The long-term Mobility Strategy for the accessibility of the city and the region reported in the current SUMP builds on the following policy decisions:

- Fewer car kilometres within the Ring: priority for bicycles and public transport.
- An interconnected regional and urban network: roads and public transport in balance.
- Regional and urban river crossings: create new ones and transform existing ones.
- An appealing and vibrant city and centre: City centre boosted.
- Boosting new modes of transport: water transport and Last Mile.
- Eliminating transport poverty: social and community participation boosted.
- A healthy living environment: boosting spatial quality and zero emissions.
- Smart mobility: technological innovation and IT.
- Areas outside of the Ring: sustainable connections with the inside areas.

3.2 Rotterdam modelling use cases

3.2.1 City goals

In accordance with the Paris Climate Agreement, the city of Rotterdam (GROT) sets a clear objective to reduce all the greenhouse gas emissions by 49% in 2030 and by 95% by 2050. This goal shapes the

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long- and short-term mobility plans of the Rotterdam City Council, which are discussed above, and is the basis behind the development of a roadmap for Zero Emissions City Logistics (ZECL). Specifically, the ZECL is developed around the “Trias Mobilica”, which includes the following three pillars: Cut back, Change and Clean up. Firstly, Rotterdam will make efforts to eliminate all unnecessary freight kilometres by developing consolidation centres to bundle freight outside the city centre. The freight bundling will be followed by a modal shift to zero emissions vehicles such as electric/ autonomous vans and cargo bikes. The third pillar refers to “cleaning up” the existing vehicles and use technologies to turn them into zero emissions vehicles. In 2014, in cooperation with several logistics providers and the Netherlands Organisation for Applied Scientific Research (TNO), Rotterdam signed the Green Deal 010 for Zero Emissions City Logistics (GD010ZECL) setting the ambitious goal to make all logistics in the city centre emission-free by 2020. GROT is currently challenged to design a concrete framework in combination with the adoption of effective policies to ensure the development of a zero emissions zone for city logistics where transport movements will be kept into low levels and will be carried out by zero emissions vehicles (City of Rotterdam, 2019).

In accordance with the ZECL roadmap, GROT identified the use cases presented in the subsection below and aims to model in the HARMONY model suite.

3.2.2 Description of the modelling use cases, models and secondary data needs.

GROT model will test the following use cases:

Table 3-6: Description of the modelling use cases (Rotterdam)

Use case 1: Zero-emission zone:	
Description:	The introduction of a zero-emission zone will impose access restrictions for certain polluting vehicle types in parts of the study area, possibly in Rotterdam city centre. The purpose is to increase the efficiency of urban distribution, due to the trends identified in D1.1 (urbanization, growing population density, scarcity of public space). A zero-emission scenario involves the formulation of transitions for each logistic segment. These scenarios include transitions: usage of alternative vehicle types in direct transports, or the use of urban consolidation centres that facilitate the deliveries to/from location within the zero-emission zone. In this use case the following logistics concepts will be examined: 1) different types, smaller in size zero emissions vans, 2) change of location or creating new urban consolidation centres, 3) identification of new routes that would connect consolidation centres with business in the city centre.
Modelling needs:	Models on the preferences of the agents on the new technologies and the location of consolidation centres. 1. Mode choice models for the different zero – emission vehicles. These models will be used to recreate the logistics decisions of the agents in the tactical freight simulator. 2. Simulation of different location of consolidations centres scenarios in the tactical freight simulator and identification of the most efficient solutions. 3. Inclusion of the consolidation centres, new vehicle types in the route assignment model of the operational simulator.
Secondary data:	1. Data on the specification of the types of vans, costs and technologies. 2. Disaggregate mode choice data. 3. Data on the location of possible consolidation centres.
Use case 2: Deployment of AV’s for urban deliveries	

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Description:	In this use case we explore the impacts of the introduction of autonomous logistic services for urban deliveries. The design of these services will include the vehicle characteristics and the location of drop-off/pick-up points to load or unload the vehicle. The pilot and the simulation should focus on requirements which are specific for AV delivery and identify to what extend will each logistic segment adopt these autonomous services. Alternative scenarios of AV applications within the city will be explored. In this case study we will check the following two logistics concepts: 1) the deployment of autonomous freight vehicles; and 2) the development of drop-off/pick-up point addressing the needs of these autonomous vehicles.
Modelling needs:	Models on the preferences of the logistics agents on the deployment of autonomous vehicles. 1. Mode choice models for AVS per logistic segment. The mode choice models will be used to identify the factors that influence the deployment of the vehicles and test the effectiveness of different subsidy schemes. Then the models will be applied to recreate the logistics decisions of the agents in the tactical freight simulator. 2. Development of a simulation scenario to test the optimal location of pick-up and drop-off points. 3. Inclusion of AVs and drop-off and pick-up locations in the route assignment model of the operational simulator.
Secondary data:	1. Data on operational specification of AVs, costs and requirements. These data will also be used to identify possible locations of the pick-up and drop/off points. 2. Disaggregate mode choice data. 3. Primary data collected during the pilot testing of the AV in Rotterdam on the operational characteristics of the vehicles and the preferences of users.
Use case 3: The usage of Cargo bikes in urban deliveries/collection	
Description:	In this use case we explore the impacts of alternative scenarios for the use of cargo bikes. The design of these scenarios includes the location of urban consolidation points where packages are transhipped to cargo-bikes, the expected demand for this system, and algorithms to translate these into the shipment demand patterns. We will also examine the development of cargo bikes and their dimension and the location of consolidation points for the transhipment of cargo/from the bikes.
Modelling needs:	Models on the preferences of the logistics agents on the deployment of cargo bikes. 1. Mode choice models for cargo bikes. This model will feed the simulation model in order to more accurately recreate the logistics decisions of the agents in the tactical freight simulator. 2. Development of a simulation scenario to test the optimal location of consolidation centres for cargo bikes. 3. Inclusion of cargo bikes and consolidation centres in the route assignment model of the operational simulator.
Secondary data:	Disaggregate mode choice data. These data should include the possibility to use cargo bikes for urban deliveries.

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Use case 4: Logistic sector future trends and developments	
Description:	The logistic sector is faced with external trends, the impact of which will be analysed in some of the use cases. Trends can be analysed in one or more use-cases. In these use cases we aim to explore one or more of the following:1) explore alternative growth scenario's for parcel delivery, or; 2) analyse the impact of different vehicle characteristics (less emissions) or; 3) driver behaviour (more efficient driving) or; 4) decrease in driver availability.
Modelling needs:	Develop simulation scenarios in the tactical simulator to check the logistics efficiency for parcel delivery, different horizontal collaboration scenarios, efficient collaboration, efficient driving, eco-friendly vehicles and fuels and also the external trends for the demand of e-commerce and various economic growth scenarios.
Secondary data:	Data on future trends, efficient driving, eco-friendly vehicles and fuels and the development of external trends for the demand of e-commerce and various economic-growth scenarios.

3.3 Available secondary data in Rotterdam

In the HARMONY project, GROT has at its disposal two types of secondary data. Secondary data that can be taken from transport models' output and data that have been made available by external sources, such as the Dutch National Statistics Bureau (CBS). It should be also noted here that all the use cases in Rotterdam deal with freight transport. Consequently, we do not focus on passenger data.

i. **Data from models' output:**
   a. **NRM West model**. This model is developed for the provinces of South-Holland, North-Holland and Utrecht. NRMW models freight and passenger transport on a tactical level and assigns car and truck traffic to the networks. It can give data on the passenger and freight transport demand. For calibration this model uses data from the Netherlands household survey and National Dutch Goods Survey. The model gives inter regional (NUTS3) freight vehicles OD matrixes.
   The model is owned by Rijkswaterstaat (Ministry of Infrastructure and Water Management). There is permission to use data from these models in HARMONY, but data may not be sent to third parties without permission.
   b. **MRDH model**. This model is developed for the metropolitan areas of Rotterdam and the Hague. It models passenger and freight transport on a tactical level and then assigns traffic to the network. The data used to calibrate the model are taken from the Dutch travel household survey and the National Dutch Goods Survey are taken from the regional transport model NRM. The model calculates freight vehicles OD matrixes on a regional level.
   The model is owned by the city of Rotterdam (GROT). There is permission to use data from these models in HARMONY, but data may not be sent to third parties without permission.
   c. **MASS-GT model**. MASS-GT models tactical freight and logistics movements for the province of South-Holland. Data used in these models come from the National Dutch Goods Survey (see ii.a.), the microdata of the CBS (see ii. b.) and the distribution centre data from Rijkswaterstaat (see iv.).

ii. **Freight transport demand data**. CBS provides data on freight transport demand through:
   a. **The National Dutch Goods Survey:** This survey contains data on the national and international movement of goods by road, rail, inland waterways, air and sea. This database contains information on mode of transport, commodity type and origin and destination. These data are owned by CBS and are privacy sensitive. Access is only provided under strict conditions and in a secured environment.
   b. **The XML microdata:** This dataset consists of a large number of truck diaries across the Netherlands. Transportation companies are obliged to participate in the survey and provide

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information through the use of an XML interface to deliver inputs on their trips from their transport management system. The data contain trip patterns from hundred firm form different sectors and for several weeks. These data are owned by CBS and privacy sensitive. Access is only provided under strict conditions and in a secured environment.

iii. **Land use data:** A synthetic firm population has been created by TU Delft using data from the Ministry of Infrastructure and Water Management.

iv. **Logistic network data:** These data belong to the Ministry of Infrastructure and Water Management and can provide information on the location of multimodal transhipment terminals and distribution centres.

v. **Freight Related Data:** Data on the regulations imposed by local governments (e.g. forbidding trucks on specific times, vehicle weight restrictions, etc.). Truck access is usually provided in the transportation networks of the models described in (i).

3.4 Missing secondary data in Rotterdam

3.4.1 Description of the missing needed secondary data

The tactical freight simulator already contains a first representation of the logistical decisions of the various actors (de Bok et al., 2018). However, there are still data missing that would ensure the accurate modelling of logistics agents' preferences and the evaluation of the abovementioned logistics cases.

In general, what is missing for the development of the tactical freight simulator is data on the preferences, or willingness-to-pay, of different stakeholders in the urban freight distributions, such as carriers, LSPs or retailers. Therefore, GROT aims at collecting the following data:

1. Choice data of different stakeholders (shippers, carriers, shopkeepers) in the use of urban consolidation centres and new last-mile solutions such as autonomous vehicles or cargo bikes.
2. Choice data on the use of new services or technologies, such as autonomous logistic services, cargo bikes.
3. Choice data on the response of stakeholders to specific subsidy schemes, such as for zero emissions vehicles, LSPs and carriers.
4. Preference of companies for the configuration of different zero emissions zones from carriers, LSPs and retailers.

3.4.2 Options for alternatives

GROT is a pro-active public administration that holds close relation to the logistic stakeholders in the study area. GROT will try and mobilize the following channels and networks for the required data collection:

1. Survey results and surveyed community of the EVOFENEDEX survey, launched in March 2020.
2. The Logistiek010 community, some 1200 member organisations are linked to the Logistiek010 platform. A website (www.logistiek010.nl), a digital newsletter and two meetings a year with > 100 participants.
3. The community of (potential) signatories of the Covenant for the introduction of a ZE City Logistics zone (ZECL zone), each having vowed to carry out a number of actions which contribute to the successful introduction of the zone in 2025.

To collect data on the behaviour, preferences and interactions between the stakeholders, GROT and TUD are looking into the development of two different approaches: 1) questionnaire-based stated preference surveys and 2) the development of a simulation game.

1. Stated Preference Surveys

For the collection of disaggregate data, GROT will investigate the development of questionnaire surveys including both stated (SP) and revealed (RP) preference experiments. The surveys will be divided into two parts. The first part will include revealed preference data on the characteristics of the company. In the second part, SP data will be collected which will then be used for the estimation of discrete choice

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models (mode choice, consolidation centre location choice, etc.) (Ben Akiva & Lerman, 1985). In these experiments, each respondent is asked to make a choice between different alternatives, for example, to choose which mode to use in a specific scenario, given certain level of attributes such as cost, time, emissions etc. For each stakeholder group, different experiments will be developed because their decisions are based on different attributes.

2. Simulation Gaming

The second approach investigated by GROT, will be simulation gaming. Simulation games are representation of real-world complex systems that consider the complex relationships created between stakeholders (Lukosch et al., 2018, Lukosch et al., 2016). Games allow researchers get deep insights on the structures of existing systems, enable players deploy new collaboration mechanism and experiment with new business models. They serve as behavioural data collection method that enables the observation of the interactions created between the players. They have already been proven as valid research tools for complex transport systems (Kourounioti et al., 2018; Kurapati et al., 2017).

GROT will investigate the development of a multiplayer simulation game, where all engaged stakeholder groups (carriers, LSPs, city of Rotterdam, retailers and shippers) will be represented. The game will be designed in such a way that permits the interaction between the players. Via the game play, stakeholders will be able to experiment with different transition to zero emission zones scenarios, have more degrees of freedom to interact and agree on the optimal zero emissions zone configuration and express their preferences on the deployment of zero emissions vehicles (electric/ autonomous vans, cargo bikes etc.) and the location of the consolidation centres. GROT, as one of the players, will be able to experiment with the effect of various subsidy schemes and policy measures. Game play results will provide input on the behaviour and preferences of stakeholders, as well as their interactions.

4. Oxfordshire secondary data

4.1 Overview

4.1.1 Description of the city

Oxfordshire is a county in South East England, covering an area of more than 2500 sq. km. It includes parts of three areas of outstanding natural beauty. Oxfordshire is home to around 666,000 people, an increase of over 10% in the past decade. The county is divided into five district council areas, with a quarter of the county's residents living in Oxford city. As well as the city of Oxford, other centres of population are Banbury, Bicester, Kidlington and Chipping Norton to the north of Oxford; Carterton and Witney to the west; Thame and Chinnor to the east; and Abingdon-on-Thames, Wantage, Didcot, Wallingford and Henley-on-Thames to the south. It is home to nearly 30,000 businesses, providing over 380,000 jobs.

It sits on the busy road and rail transport corridor between the south coast ports, the Midlands and the north and enjoys easy links to London and West Midlands. However, it suffers a lack of connectivity to and from the east, in particular to the high-value growth areas around Milton Keynes and Cambridge.

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The county is the second more rural area at the UK’s South East, with a combination of urban (both historic and modern), peri-urban, highways and rural locations.

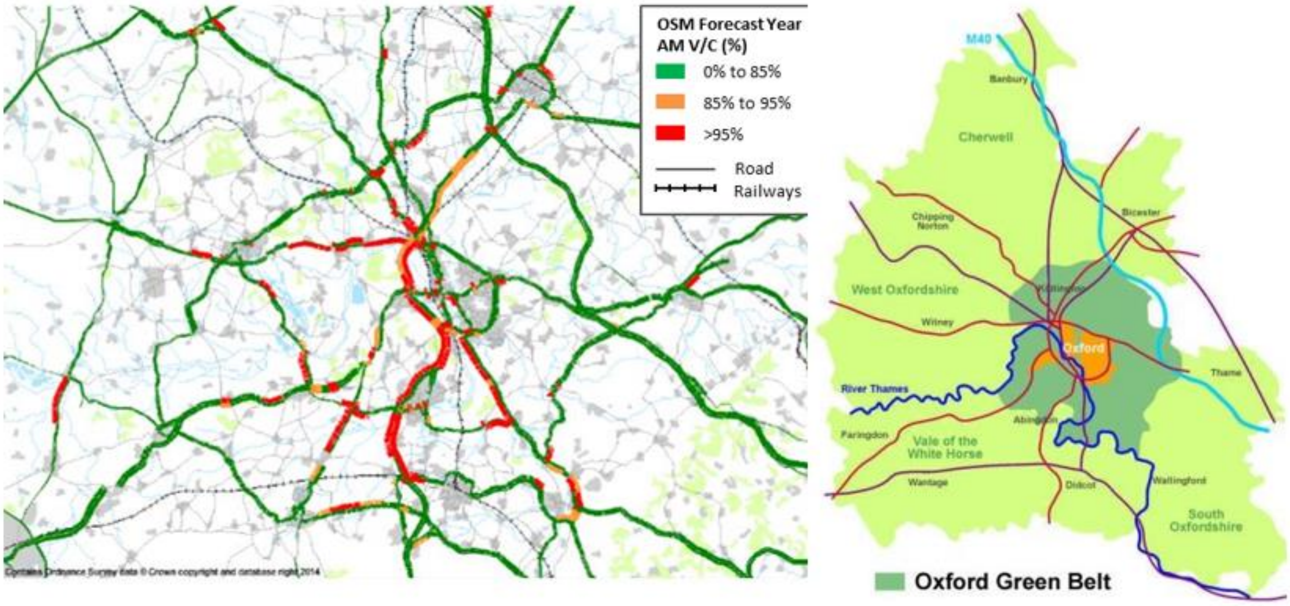

Figure 4-2: Highway network in Oxfordshire in the morning peak in 2031 with no intervention (left) and the Green Belt area (right)

Oxfordshire contains a Green Belt area (see figure 4-1), that fully envelops the city of Oxford and extends for some miles to afford a protection to surrounding towns and villages from inappropriate development and urban growth. Its border in the east extends to the Buckinghamshire county boundary, while part of its southern border is shared with the North Wessex Downs AONB. It was first drawn up in the 1950s, and all the county's districts contain some portion of the belt.

Oxford’s unique character as a leading university city and a historic centre sets it apart from the rest of the county and attracts much more travel than most towns or cities of comparable size. Tourism, business and academia are vital to the economy and 35% of the county’s jobs are in the city. Due to the high number of jobs and the shortage and cost of housing in the city, more people commute to Oxford from outside the city than are working residents.

Car ownership and usage is high outside Oxford with 87% of households owing a car, compared to only 67% in Oxford. There is a good network of bus/rail services linking the county’s main towns with Oxford. Despite variable quality of bicycling networks within Oxford, around 25% of the residents cycle to work; though the split is much less in other parts of the county. OCC is committed to increase the active travel and public transport use at the county.

Planning authorities have assessed a need for 100,000 new homes to support 85,000 new jobs to 2031, a scenario that will provide a major challenge to Oxfordshire’s transport system which has resulted in the Oxfordshire Growth deal, to be delivered by 2030. Interlinked with transport is the challenges of public health, with the county’s overall prosperity masking health inequalities in areas of deprivation, and a rising obesity rate, especially amongst the young. The potential impact of housing and jobs growth on the county’s transport networks, considering committed transport infrastructure, has been forecast using a strategic transport model. The model shows many junctions over capacity in 2031 (see figure 4-1) and severe delays on many routes, especially the A34, A40, A338 and A4074.

With these challenges, the primary focus of planning in Oxfordshire has been made with three over-arching spatial and transport planning goals (as mentioned in the Local Transport Plan):

1. to support jobs and housing, sustainable growth and economic vitality;
2. to reduce overall emissions, enhance air quality and support transition to a neutral carbon economy;

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3. to protect and enhance quality of life (including public health, safety and well-being) inclusively.

These are consistent with the three overarching goals highlighted at the OCC corporate plan: “Thriving People, Thriving Communities, Thriving Economy”.

4.1.2 Description of the urban development plans (regional, spatial and transport plans/SUMPs’) until 2050

The **Local Transport Plan** (LTP)[1] consists of a set of planning documents that, when collated together, can be termed as the **Sustainable Urban Mobility Plans (SUMP)** for Oxfordshire. This consists of various sections:

- Policy & Overall Strategy
- Strategies for specific Transport Areas
- Strategies for specific Transport Corridors (includes various district-level plans)
- Science Transit Strategy, with focus on new mobility services. This was the first UK transport policy to name Connected and Autonomous Vehicles (CAV) in the UK.

Other planning documents connected to land use, energy, infrastructure, connectivity, etc. are listed below[2]:

The **Digital Infrastructure Strategy** (in draft, planned submission in 2020) is a strategy document to lay out the county’s programme to change emphasis on Digital Infrastructure, underpinned by a Digital Infrastructure Partnership comprising the County, city, and district councils.

The **Oxon Energy Strategy (2019)** is a strategy document that details the annual delivery plan that sets out the projects necessary to meet our carbon targets and cost objectives.

The **Oxfordshire Plan 2050** (in draft, planned submission in 2021) is a document setting the framework for future decision making on big issues like development, infrastructure and place-making. The Plan for 2050 will be aspirational and use the opportunity of growth as a positive to improve the quality of life for everyone.

The **Oxfordshire Infrastructure Strategy (OXIS, 2017)** has been prepared on behalf of the Oxfordshire Growth Board to provide a view of emerging development and infrastructure requirements to support growth from 2016 to 2031 and beyond.

The **Partnering for Prosperity - NIC Report (2017)** is a planning document for the Cambridge-Milton Keynes-Oxford arc, to establish long-term national and local infrastructure investments, along with upgrading of public transport, integrating transport hubs and providing safe cycling infrastructure.

With respect to the **SUMP**, Oxfordshire is in the process of refreshing its Local Transport Plan, to create the Local Transport and Connectivity Plan, to better reflect the growth agenda across the county. This is currently in the consultation phase. Though the 2019 European Guidelines haven’t been comprehensively followed, a lot of the underlying principles are the foundation of the LTP as well. There is renewed focus on sustainable mobility, involvement with citizens and stakeholders, defining a long-term vision and arranging for future monitoring and evaluation.

The key elements in planning in Oxfordshire across all relevant domains is the focused compartmentalisation of different areas and goals, with a smooth interchange of ideas and information across plans. Additionally, the planning frameworks are always linked or supplemented to national-level strategies to enable seamless growth.

1 http://www.oxfordshire.gov.uk/connectingoxfordshire
2 https://embed.kumu.io/c983aa9d528fe0cb3485208d81c38a38#smart-visions

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With reference to the planning process, the current iteration of the Local Transport Plan (LTP4) focuses on challenges from 2016 to 2031. Oxfordshire just started consultations for its next Local Transport Plan (LTP5) and the expected delivery date of the SUMP being in the latter half of 2020.

Since Oxfordshire occupies a key role in England's Economic Heartland Hub, there is a coordinated effort to align strategic and planning goals. This alliance plays a key role in increasing economic output of the region, with collaborative work in adopting a 'one voice' approach, especially in the area of strategic transport investment.

In terms of monitoring and evaluation, there is a multi-phase planning process with gradations based on increasing levels of data collection and resolution. These parameters influence the level of monitoring and evaluation done as part of planning. For example, in the case of cycle scheme assessment and prioritisation, many studies were performed on the target corridors to develop further proposals for rapid transit, pedestrian and cycle improvements. Apart from using manual data to monitor and evaluate measures, there is a new interest in using automated modelling solutions to provide quicker and more robust results. The use of agent-based models could help identify pre and post-facto scenarios, providing easier understanding of the effects of different strategies.

The following barriers can be identified in the planning process. Given the different areas (geographic and domain) that the LTP covers, some of the planning methodologies that can be used are restricted based on the local / national frameworks. Similarly, in the areas of new technologies that do not have real-world data and minimal literature, identifying ways of providing the complete information to the concerned stakeholders can be challenging. On the other side, since the overarching goals of the LTP (and other planning policies) coincide with sustainable mobility, the ability for neighbourhoods to formulate local plans that tackle critical problems and align with the County's goals is strengthened and constitute one of the drivers of the planning process.

The Local Transport Plan, through its different strategy documents, details the measures for different modes and areas. The different planning documents also provide an underlying foundation to support various KPIs that can be extracted from all the planning processes and measures. The measures that are on the focal points are listed in the following table.

Table 4-7: Action lines and measures of the SUMP of the Oxfordshire county

ACTION LINE	ACTION
1. Public Transport	• Enhanced bus network connectivity, integration and access • Reliability of public transport • Development of rapid transit routes and services • Traffic management • Smart payment • Connecting Oxfordshire and outer region • Rural area connectivity • Creation of Bus Network Hierarchy • Phases of implementation • Quality Bus Partnership
2. Rail	Very limited role on investments, but can influence decisions taken by organisations responsible (Department of Transport, Network Rail, Train Operating Companies, etc.)
	Potential measures, like East-West Rail, Cowley line, Electrification, Improvement of stations
3. Active & Healthy Travel	Potential measures: • Door to Door": multi-modal travel for longer trips • electric bike sharing creation of cycle route categories to increase cycling network • cycle training to all primary school students

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ACTION LINE	ACTION
	Soft measures: • Data aggregation for greater insight • journey planning tools
4. Managing Transport Demand	Parking-based measures
5. Key Performance Indicators	Planning methodologies provide key metrics for future strategic model assessments. Examples: • Quality of Life measure • Labour Market Profile, O/D and demographic representation • Housing Affordability ratios • Health and Wellbeing • Walkability • Air Quality/ Noise pollution • Accuracy: confidence integral on model predictions • Digital Connectivity • Emission reduction • Journey times • Maximize use of sustainable transport investment • Reduction in sole-occupancy car journeys • Increase in public transport use and healthy modes of travel • Modal split • Road Safety • Vulnerable Road Users Audit • Reduction of accidents and incidents

4.2 Oxfordshire modelling use cases

4.2.1 City goals

HARMONY's overarching goal is to develop a state-of-the-art integrated spatial and transport planning tool that will be able, among others, to assist regional authorities and urban-sub-urban planning organizations with updating their regional and urban mobility plans for the new mobility era (e.g. SUMPs). The facilitation of such a task relies on the development of a configurable tool, i.e., the HARMONY MS, which offers the possibility to perform various spatial and transport planning scenario analyses, as well as generate reliable insights and performance indicators. For the metropolitan area/county of Oxfordshire, the scope of the HARMONY MS, or more specifically, the use-case(s) for which the model system will be developed and tested, has been conceptualized using a co-creation approach. The modelling use-case(s) selection has been implemented in a way to cater for both the metropolitan area's plans and requirements, as well as the project's need for verification of the HARMONY MS's applicability.

As already mentioned in 4.1.1, the SUMP for the metropolitan area of Oxfordshire, i.e., the Local Transport Plan 4 (LTP4), focuses on challenges from 2016 to 2031, while consultations are currently in place for updating it (LTP5) within 2020. LTP4 does currently include two broad underlying objectives, among which are:

- **O1**: to support jobs and housing, sustainable growth and economic vitality.
- **O2**: to reduce overall emissions, enhance air quality and support transition to a neutral carbon economy.

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Towards realizing the above objectives, LTP4 indicates a set of actions (table above), including a renewed focus on sustainable mobility via new, on-demand, multimodal and energy-efficient mobility services and concepts. At the same time, Oxfordshire county constitutes a major transport innovation hub where several demonstrations of automated vehicles (AVs) and connected and automated vehicles (CAVs) have been implemented and are, also, being planned for 2021. This new technology and potentially disruptive mobility service has been already introduced to an extent in the metropolitan area's transport policy via the Science Transit Strategy.

In line with the county's objectives, requirements and future action plans, HARMONY envisages and is working towards the realization and evaluation of three modelling use cases which will produce valuable outputs and performance indicators with regards to land-use, transport demand, congestion and air quality (energy and emissions). More specifically the use-cases under investigation are:

1. New housing developments within different county locations

Addresses **O1** and aims at identifying the new land-uses which will arise, the new transport demand patterns and the potential impact on road and public transport network.

2. Zero emission zone for Oxford city centre

Addresses mainly **O2** aims at identifying the impact of urban centre access restrictions for specific types of vehicles on travel demand, congestion and emissions.

3. Widespread deployment of Autonomous Vehicles and MaaS for multimodal regional transport

Addresses **O2** along with the county's intention to introduce new forms of automated mobility services in conjunction with public transport. Main goal is to identify how electric and autonomous vehicle fleets offering new types of mobility services in isolation or as MaaS systems might impact travel demand, multimodality, network performance, travel experience, energy and emissions.

In principle, the Oxfordshire use-cases will include the use of the HARMONY MS as a whole (where possible due to data availability) and the application of the Strategic Level (Economic, Demographic and Land-use models), Tactical level (Activity-based Demand Model) and the Operational level (Multimodal network supply and demand interaction model).

4.2.2 Description of the modelling use cases, models and secondary data needs

Table 4-8: Description of the modelling use cases (Oxfordshire)

Use case 1: New Housing Development	
Description:	The introduction of a new housing development within the Oxfordshire region will be pursued as it has been found to have a high potential for implementation in the Oxfordshire region and it would allow the examination of changes in terms of land-use and transport. The impact of such a use-case will spread upon all modelling levels. Changes in land use and residential locations will change the household population for the whole region. Consequently, the demand for transport needs to be updated (tactical level), something that will then trigger the update of the demand-supply interactions (operational level).
Generic Modelling Approach:	Land use transportation interaction (LUTI) model already used in various versions for Greater London and the outer-metropolitan area. This is being specifically built for the Harmony project and is coupled to a land development model where land development is based on accessibility potential.
Secondary Data:	The model requires floorspace for dwellings, dwelling types, plot area for plots of development, as well as land use layers such as topography and physical features as well as land use.

Impact indicators:	The indicators will be based on average trip lengths from home to work associated with the new development, density, accessibility to the rest of the system, and access to utilities, retailing, schools and health centres.
Use case 2: Zero emission zone	
Description:	In HARMONY, we further consider a scenario where we impose access restrictions for different types of polluting vehicles in parts of the study area under investigation, which will probably be the Oxford city centre. The main objective of this particular use-case is to estimate the impact of this particular intervention on air quality, via capturing new energy and emission levels for the study area, We further aim for estimating the potential impact of the traffic restrictions to passenger transport demand and supply, including vehicle ownership per household and the vehicle's type. Since accessibility to the urban centre is also expected to be affected, new land uses will be probably be investigated via a LUTI model (see D1.1). There is currently discussion with the Oxfordshire pilot partners to specify the details of the use-case including, types of vehicles to be banned, zero-emission zone boundaries, etc.
Generic Modelling Approach:	The evaluation of a zero-emission zone with regards to its impact on energy, emissions, transport demand and supply and land uses requires the development and integration of the models below: 1. an activity-based demand model (Tactical Level), i.e. SimAGENT (Goulias et al., 2011) responsible for generating activity schedules and mode choices for each agent in the simulation model. 2. a network supply model (demand-supply interaction; Operational Level), i.e., Aimsun NEXT[3], responsible for emulating agents' (travellers, vehicles) movements in a multimodal network. 3. an energy and emission model (most probably FASTSim), which will quantify the lifecycle energy and emissions impact from passenger vehicle movements as they result from the traffic flow simulator. 4. And a LUTI model (Strategic Level), which will allow us to understand how modified accessibility might impact land-uses around the network area under investigation.
Secondary Data:	A calibrated and validated integrated baseline model system, composed of all the above components, will be used as the basis for the modelling of the above intervention. For the baseline model, a range of secondary data requirements are needed for each component, which are described more clearly in sub-section 4.3. Integral data information to the use-case are i) the fleet size, ii) type of vehicles and vehicle technology characteristics per household and road service provider operating in the area, iii) car ownerships per household, mode choices and boundaries of zero-emission zone.
Impact indicators:	Generally, this use case application intends to (a) provide different recommendations, enabled by the integration of the above components, and, (b) verify the applicability of the HARMONY MS. We are aiming to generate several impact indicators of interest to OXS, including:

[3] https://www.aimsun.com/aimsun-next/

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	• Lifecycle energy use and CO_2 emissions • New modal splits due to the traffic restriction zone such as number of trips by mode and time of day • Traffic loads, travel times and average speeds for the network • New accessibilities per mode and land uses
Use case 3: Widespread deployment of Autonomous Vehicles and MaaS for multimodal regional transport	
Description:	This use case focuses on investigating the impact of new, on-demand, shared and autonomous vehicle-based mobility services on network performance, travel experience and, generally, within-region transport demand. The use case is twofold, including i) AV service deployments operating as taxis, shared taxis/vans or part of a carsharing fleet and ii) AV services integrated with traditional public transport (first-/last-mile) and other modes via online multimodal and personalized traveller recommendation systems (MaaS). Both station-based and free-floating models will be considered for increasing the connectivity and accessibility of regional areas (e.g. Didcot and Bicester) with the city of Oxford. At the same time, this uses intends to model and capture the impact of i) a range of events that might occur such as road closure, congestion, weather conditions etc. on demand patterns through dynamic choice models and ii) the impact of agents' satisfaction and updated perceptions of network travel times on the day-to-day travel behaviour.
Generic Modelling approach:	The investigation of AV-based service fleets using the HARMONY MS will be realized via the integration of four main components: 1. an activity-based demand model (Tactical Level), i.e., SimAGENT (Goulias et al., 2011) responsible for generating activity schedules and mode choices for each agent in the simulation model, 2. a network supply model (demand-supply interaction; Operational Level), i.e., Aimsun NEXT[4], responsible for emulating agents' (travellers, vehicles) movements in a multimodal network, 3. a multimodal Passenger Service Controller system (as described in D1.1; Operational Level), responsible for managing and optimizing new on-demand mobility services and multimodal journey recommendations. 4. a LUTI model (Strategic Level), which will allows us to understand how modified accessibility might impact land-uses around the network area under investigation
Secondary Data:	A calibrated and validated integrated baseline model system, composed of components 1, 2 and 4 as described above, will be used as the basis for the modelling of the above intervention. For the baseline model, a range of secondary data requirements are needed for each component, which are described more clearly in sub-section 4.3. It needs to be noted here, that since these new mobility services and concepts are not operational in the area, primary collected data (see 4.3.b) will be used to estimate the demand for AV and MaaS services. Different fleet sizes, types of vehicles and station locations will be tested.

[4] https://www.aimsun.com/aimsun-next/

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Impact indicators:	Generally, this use case application intends to (a) provide different recommendations, enabled by the integration of the above components, and, (b) verify the applicability of the HARMONY MS. We are aiming to generate several impact indicators of interest to OXS, including: • New zone-to-zone accessibility indicators per mode • New land uses • New modal splits in the presence of new mobility services • Number of intermodal trips • Traffic loads, travel times and average speeds for the network • Level-of-service for the new mobility services, including costs, trip travel and waiting times, vehicle occupancies, etc.

4.3 Available secondary data in Oxfordshire

Oxfordshire County Council (OCC) has various sources of secondary data – transport models, external on-site devices, other local/regional/national statistic sources. The procurement of these data is a varied exercise as the engagement mechanism with each source is different.

i. **Data from Existing Models**:

1. **SATURN**. The existing strategic regional transport model that has been coded in its format gives output such as traffic flows on the network. The demand data (Origin-Destination matrices originated from INRIX data) is an input to SATURN. OCC holds the highway model (in SATURN) and the demand matrices (which can be extrapolated in .csv format) can be used.
2. **NEVFMA project**. This model covers areas bounded by the M40 and A34 and looks at total vehicles and fixed-route buses. It is updated by on-ground detectors.
3. **OMNICAV project**. This model covers a 32km Loop covering South West Oxfordshire from Botley Road to Culham Science Centre, and looks at Light and Heavy Vehicles, Pedestrians and Cyclists.

ii. **Data from External Devices**:

1. Loop Detector Data from SCOOT (signal control) loop locations.
2. Vivacity Lab Camera/Sensors provide data on vehicle counts at crossings per direction, along with tracks of flow of vehicles. These data are split based on mode – pedestrian, cycle, bus, car, etc.
3. Air Quality sensors provide information on AQ levels across various locations in Oxfordshire.

iii. **Data from Statistics and Other Sources**:

1. Ordnance Survey provides data on Land Use and Buildings specifications.
2. GTFS (General Transit Feed Specification) data provides information on public transport supply.
3. Geo-spatial information will be provided by the GIS team in OCC; this includes traffic zoning system of the county, OSM data, transport network, etc.
4. Census statistics provides information on demographics, zoning regulations, etc.

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5. Mobile phone data from multiple sources; INRIX for a long duration, while Google data for a two-month window in 2016.
6. Strava application data provides live information on cyclist trips, which can be used to synthesize O-D waypoints for pedestrians and cyclists, in conjunction with data provided by other devices/sensors.

Access to Data: The Oxfordshire County Council holds data from various models, devices and sources (as described above). Due to data-sharing agreements with some of the data providers, not all datasets will be transferrable to the HARMONY server. However, access to all the datasets can be guaranteed through a multi-layered approach. This categorisation of data can help identifying the protocols and procedures needed for each type of data:

1. Data owned by Oxfordshire and can be transferred to HARMONY server. For example: loop detectors, GTFS, census.

2. Data owned by Oxfordshire and need a Data Sharing Agreement with the GIS team at Council and then can be accessed using the OS license. For example: most GIS data.

3. Data licensed by Oxfordshire and can be shared with HARMONY partners through Data Sharing Agreement and only with companies acting on behalf and for the Council. For example: SATURN, Strava, INRIX, other models.

4. Data available to Oxfordshire and can be shared through existing APIs. For example: Vivacity Lab sensors.

NOTE: Based on the needs of different partners, Oxfordshire can collate, organise and store some of the data in an Amazon Cloud instance and provide access with different permissions based on the needs of the project. This approach is a suggestion to make the access of data more streamlined.

4.4 Missing secondary data in Oxfordshire

4.4.1 Description of the missing needed secondary data

The Passenger Tactical Simulator is based on a hierarchical series of interconnected behavioural/discrete choice models that estimate and capture the daily activity schedules (travel plans) for each agent. Both revealed and stated preference data are required on new and traditional transport modes, as well as new mobility services. The collection of the following missing data will ensure the accurate derivation of the individual daily schedules and travel behaviour patterns:

1. Choice data on habitual daily travel plans in the form of travel diaries (activity type and duration, departure time, mode choice).

2. Choice data on within-day event-driven choice re-evaluation to account for a range of events that might occur such as road closure, congestion, weather conditions etc.,3. Choice data on agents' satisfaction and updated perceptions of network travel times (day-to-day learning).

4. Stated preference data about car-ownership, mode choice, and route choice (indicatively).

In addition, questionnaires will be designed to explore the response of different stakeholders from the AVs and drones demonstration regarding: i) their views on new mobility services (e.g. AVs and MaaS) and ii) potential barriers in the adoption of new technologies (AVs, drones).

4.4.2 Options for alternatives

The collection of the required data in Oxfordshire will be conducted using a smartphone-based travel survey tool (the MOBYapp) that provides different interfaces -all linked in one user account- to collect:

1. Revealed preference data

Questionnaires will be designed and hosted on the MOBYapp tool to collect socio-demographic data about the individuals and their households, car and mobility plans ownership, travel expenditure data, and attitudes and perceptions towards new and traditional mobility services.

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2. Activity diary data

The activities and trip activities of the individuals will be collected through the MOBYapp smartphone application. This will provide information about the starting/ending time of individual's activities and trip activities, the mode or combination of modes used to travel to each activity, travel costs, as well as a number of extra trip-related questions (i.e. satisfaction with the mode used, number of people travelled with you etc.). In addition, the available open data and APIs of the cities will be connected to the backend of the MOBYapp system to improve tracking and enhance the collected data with choice alternatives.

3. Stated preference experiments

The design of stated preference experiments will focus on capturing strategic (e.g. car ownership) and tactical level decisions for the estimation of the passenger activity and travel demand model. In addition, online stated adaptation experiments will complement the activity diary data collected by MOBYapp, in which respondents will be given a hypothetical disruptive scenario on their daily activity schedule. They will then be asked to respond on how information provision such as congestion or road closure would affect their travel plans (Parvaneh et al., 2014; these data will allow incorporating parameters into the models that can capture the factors and their dynamic nature affecting travel change within and throughout the day and week).

5. Turin secondary data

5.1 Overview

5.1.1 Description of the city

Turin is an important business and cultural centre in northern Italy. It is the main centre of Piedmont Region: the population of Turin municipal area is 886,837, while the OECD estimated that the population of Turin metropolitan area (Città Metropolitana) accounts for 2,277,857 inhabitants on a surface of 6,830 km^2 and with a population density of 335.5 inh. / km^2. The Metropolitan area includes 312 municipalities and is quite heterogeneous from a geographical point of view, including both plains, hills and mountains areas. The plain part, in particular, is included in the Po Plain (Pianura Padana) and it is one of the areas in Europe with higher exposure to air pollution.

The Turin pilot within the HARMONY project will focus on the Urban Functional Area (FUA) of Turin, including the Turin municipality together with the municipalities of the first and second belt (87 in total).

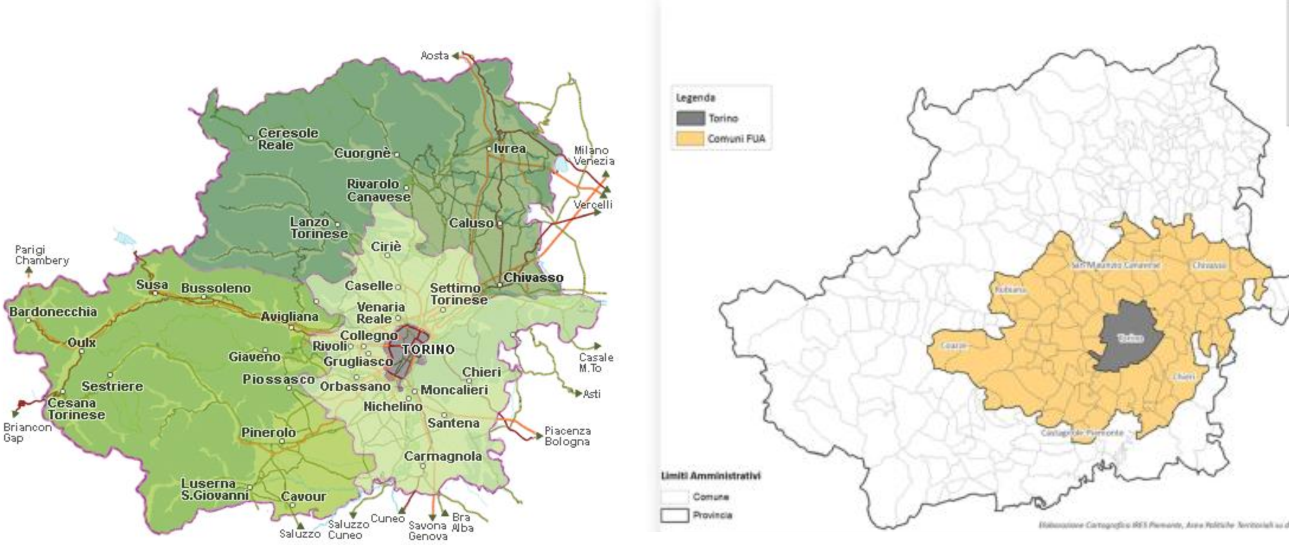

Figure 5-1. The Turin metropolitan area (on the left) and the Turin Urban Functional Area (in orange and grey on the right)

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In terms of urban mobility, the passenger modal split shows a predominance of car (about 56%), followed by public transport (about 16%); walking and cycling account respectively for about 21% and 5%, while motorcycling covers the residual 1%. About 80% of the trips are related to a medium-short distance band, up to 10 km (with 29% below 2 km). The motorisation rate is largely higher than the EU average, with about 661 cars per 1000 inhabitants and 96 motorcycles per 1000 inhabitants.

With reference to sustainable transport modes, the Turin municipality urban area accounts for some 0.52 m^2/inhabitants of pedestrian areas and about 200 km of cycling network. Furthermore, a limited traffic area of about 2.30 km^2 is established in the city centre, with limited access from 7:30 am to 10:30 am.

As for the metropolitan area transport services, the main public transport service is the metropolitan railway service, including 8 lines and 93 stops. This service is managed by Trenitalia (national operator for railway transport) and GTT (public transport utility of the City of Turin). A network served by buses integrates the railway to complete the transport system. All the bus operators cooperate within a consortium named EXTRATO.

The transport system of the City of Turin is based on the following services: public transport (1 metro line, 8 tramway lines, 90 bus lines), car sharing (3 operators, about 750 vehicles), taxi, bike sharing (2 operators, about 2000 bikes), scooter sharing (electric, about 100 scooters).

5.1.2 Description of the urban development plans (regional, spatial and transport plans/SUMPs') until 2050

The City of Turin has adopted the SUMP (Sustainable Urban Mobility Plan) in 2010. The plan was developed according to a strategic vision pursuing the coordination of all the mobility system components, producing scenarios and updating them periodically. The SUMP has a ten-year time horizon and is updated at least every five years.

According to the Italian National Law of 2017, the body in charge of drafting the SUMP is now the Metropolitan City and not the Municipality. The drafting work of the new SUMP of the Turin metropolitan area began in mid-2019 and should be concluded within 24 months. The City of Turin's SUMP will be incorporated and updated into the new SUMP of the Turin metropolitan area (including, as already mentioned, about 312 municipalities).

This paragraph focuses on the SUMP approved by the City of Turin in 2010, which refers only to the urban area of the municipality. The main goal of the plan has been to change the urban modal split, in order to attain 50% of the trips carried out with sustainable transport modes. The main targets[5] are listed below:

1. guarantee and improve accessibility to the area
2. guarantee and improve the people's accessibility
3. improving the air quality and the urban environment
4. increase the public transport effectiveness
5. guarantee road and transport system efficiency and safety
6. governing mobility through innovative technologies and info mobility
7. define the governance system of the Plan

The plan has been drawn up through the involvement of several local mobility players, in order to develop coordination mechanisms among concerned authorities and departments: City of Turin Mobility Division, 5T (in-house company of the city of Turin), Metropolitan City, Agenzia della Mobilità Piemontese (regional mobility agency), Polytechnic of Turin. Several stakeholders have been involved to guarantee a participatory approach, i.e. local bodies, transport management companies and non-

[5] http://geoportale.comune.torino.it/web/sites/default/files/mediafiles/pums_all1_linee_indirizzo_3.pdf

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profit associations engaged in environmental issues. A monitoring and evaluation plan have been defined, including a list of key performance indicators.

The data collection has been performed by the Infrastructure and mobility department of the City of Turin, while the use of modelling and other quantitative tools has not been applied. With this respect, collection of data from mobility companies has been the main barrier in the planning process.

The Turin SUMP has adopted seven action lines. For each line, the plan has defined several key measures, as listed in the following table.

Table 5-9: Action lines and measures of the SUMP of the Turin municipality (2010)

ACTION LINE	MEASURES
1. Improve the accessibility to the urban area	1.1. Enhance the public transport infrastructure
	1.2. Facilitate inter-modality
	1.3. Face the open issues of the road infrastructure
	1.4. Encourage pedestrian and cycle mobility
	1.5. Encourage pedestrian access in the historic city centre
	1.6. Meet new mobility demand
	1.7. Guarantee mobility even to people-in-need
2. Guarantee and improve the people's accessibility	2.1. Guarantee the accessibility to public transport vehicles
	2.2. Facilitate the accessibility to public spaces
	2.3. Guarantee the accessibility to disabled people
3.a. Improve the air quality	3.a.1. Reduce trips using private motor-vehicles
	3.a.2 Supporting the penetration of green vehicles
	3.a.3. Promote alternative sustainable mobility solutions
	3.a.4. Promote pedestrian/cycle mobility
	3.a.5 Optimising urban freight logistic
	3.a.6. Reduce the environmental pollution due to the traffic
3.b. Improve quality of urban environment	3.b.1. Public space redevelopment
	3.b.2. High standard of public space maintenance
	3.b.3. Parking policies
	3.b.4. Reducing noise pollution
4. Enhance the use of public transport	4.1. Improving the effectiveness of public transport
	4.2. Increasing the efficiency of public transport
	4.3. Improving the security of public transport
5. Guarantee efficiency and safety of road network	5.1. Reorganizing the local viability of neighbourhoods
	5.2. Reorganizing road signals
	5.3. Improving road safety
6. Innovative technologies for mobility	6.1. Enlarging the telematics road traffic management network
	6.2. Enlarging the telematics management of public transport
	6.3. Improving mobility for vulnerable users
7. Government plan	7.1. Stakeholders participation
	7.2. Communication
	7.3. Monitoring

5.2 Turin modelling use cases

5.2.1 City goals

The Turin municipality pursues the goal of rebalancing the demand for transport between collective and individual, in order to reduce congestion and improve the accessibility to the various urban functions. The SUMP in 2010 has been designed embracing this vision, which is likely to be continued in the new SUMP of the metropolitan area currently under definition.

Pursuing this strategy, implies an incisive mobility policy, pushing the collective transport use through large infrastructure implementation (such as the underground and the metropolitan railway service) and

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through new ITS technologies development, while, on one hand, improving the economy in the use of these services and, on the other hand, developing new sharing services.

5.2.2 Description of the modelling use cases, models and secondary data needs.

Taking into account the overall vision described above, the Turin pilot goals within the HARMONY project are focused on a modelling study on the territorial impact generated by the new public transport infrastructure and the new MaaS mobility paradigm on the Turin Urban Functional Area, with particular reference to its integration with the Metropolitan Railway System (SFM).

With reference to the MaaS mobility paradigm, the last years Torino has been supporting and promoting the diffusion of this new approach to mobility through several actions. In fact, between 2018 and 2019 the City of Torino has built a living lab to test the 3rd level MaaS paradigm thanks to several EU projects, namely SOLEZ (Interreg Central Europe), SUMP-UP (H2020) and IMOVE (H2020). The IMOVE App, developed within the later project, allowed to test the integration of Public Transport, Taxi, Bike sharing, e-scooter and Electric Motor scooter. The App provides info-mobility services and enables ticket purchasing and validation in pay-per-use mode. A new MaaS project will start in June 2020, with the aim of building a new Living Lab to test MaaS level 4; it will provide citizens with mobility vouchers related to a MaaS platform, which can be used to purchase bundle and Pay per use offers. The project is supported by the Municipal Government and the national Ministry of Environment. Furthermore, the project BIPforMaas has been launched in 2019 (lasting until 2021) aiming at enabling the MaaS paradigm in an open eco-system for the urban and metropolitan area of Torino and for the whole Piemonte region.

In this context, the focus of the modelling use-cases in Turin on MaaS paradigm is straightforward. Since the area of study accounts for more than 80 municipalities (see **Error! Reference source not found.**), the MaaS paradigm will be applied taking into account the following services and planned infrastructures:

- the shared mobility services (cars, bikes, e-scooter and Electric Motor scooter)
- the urban and suburban public transport network, including:
  - Extension of the Metro Line n. 1 to south towards Moncalieri – Nichelino;
  - Extension of the Metro Line n. 1 o West towards Rivoli-Cascine Vica;
  - The new Metro Line n. 2, from Rebaudengo Fossata / Pescarito to Orbassano (North to South-West of Turin).
- the Metropolitan Railway System (SFM), including:
  - The new SFM3 line, which will connect the Porta Susa railway station with the Caselle International Airport Sandro PertiniThe SFM5 line, which will connect the Torino Stura railway station to the City of Orbassano. Three new railway stations will be built in this line: Orbassano Ospedale S.Luigi, Grugliasco – Le GRU and Torino-San Paolo.

Furthermore, since the **SUMP** of the Metropolitan City of Turin is currently under development, the HARMONY MS will be used to simulate some of the specific **strategies and scenarios** of the new plan. In this sense, the engagement of stakeholders is still ongoing: therefore, the topics mentioned above should be considered as preliminary and subject to integrations by the outcome of the co-creation lab.

The use cases will be simulated with the HARMONY MS: in the Turin pilot the application of the strategic and the tactical level for passenger demand is planned, complemented with an update and integration of the network model.

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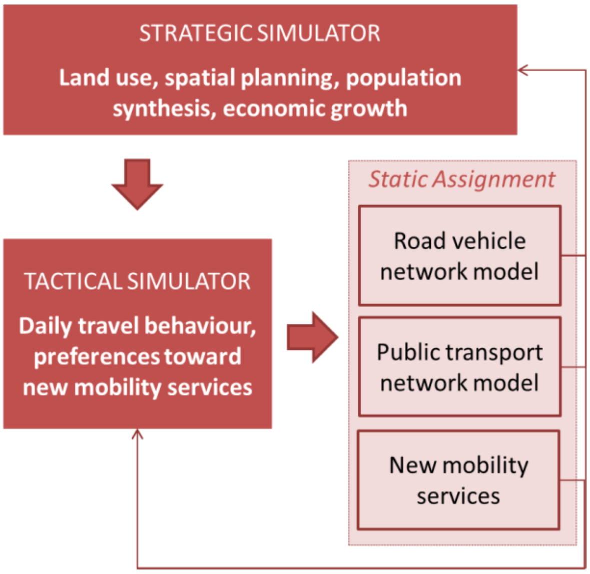

Figure 5-2. The conceptual simulation framework of the Turin use cases

The existing network models will be therefore integrated and complemented in order to be linked to the strategic and tactical levels of HARMONY MS. In other words, the application of the HARMONY MS will allow to estimate updated OD matrices by vehicle type which will be assigned to the network models (road and public transport). The static assignment using the road and public transport network models will allow the estimation of complementary performance indicators to evaluate the impacts of the use cases.

Two separate VISUM network models are available, including:

- Road Private vehicles (including also exogenous trucks flows);
- Public Transport (buses, tram, metro and rail).

The road network includes 6 road categories (from motorway to urban roads). The road traffic assignment is planned in AM peak hour, but matrices are available for the whole day for working / not working days; public transport is assigned in AM peak hour of a working day.

The secondary data needed for simulating the use cases are reported in the following table.

Table 5-10: Secondary data needed for the Turin use cases

Data typology	Data
Economic data	Employment
	Retail Activities
	National Gross Domestic Product
	Tourism arrivals
	Public Investments in transport sector
	Car ownership
Land Use Data	Land use
Demographic data	Population
	Population Projections
	Occupational Class
	Ethnicity
	Income
	Urban density
	Firm data by industry
	Household variables

Data typology	Data
Housing data	Housing Tenure
	House Prices
	House Rents
	Retails activities Rents
Topography and boundaries	General topography
	Point of interest data
	Digital elevation model
	Municipal Boundaries
	Local Authority Boundaries
Building Data	Building Footprints
	Building Floorspace / Heights / Storeys
	Building Function
	State / Public Housing Estates
Planning Policy Data	Locations for major future urban development
	Planning zoning urban restrictions
	Environmental or other development restrictions
	Major future transport infrastructure development
	Land Development / utilities network
Network data	GIS shapefile of TAZ system and georeferences of centroids and connectors
	GIS shapefile of study area
	Open Street Map data
	Aerial photography and/or CAD for refinements (Google Streetview can be a replacement for this requirement)
	Bike lane network
	Walking network
	Intersection (node) coordinates
	Section: Road category, speed limit
	Number of lanes
	Length of turn bays
	Link free-flow speed
	Location of multimodal transhipment terminals
	Location of distribution centres
	Airport location data
Public transport data	GTFS files availability
	Line routing (ideally GIS based)
	Stops location (ideally GIS based)
	Stops assigned to each line
	Timetable covering the simulation period/day
	Type of vehicles used to operate each line
Passenger demand data	Household travel demand surveys
	SP experiments (mode, route or vehicle purchase choice)
	GPS or other geolocation data survey
	Trip or activity or time-use diaries
	Static OD matrix
	Static OD matrix per vehicle type
	Skim matrices
	Dynamic OD matrix
	Dynamic OD matrix per vehicle type
	Public transport Data on passenger flows

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Data typology	Data
	Pedestrian counts at crossings per direction (estimated or observed)
	Bicycle counts or occupancy at exclusive bicycle lanes (in case of sharing lanes with other modes provide occupancy share)
Energy, emission, noise data	Vehicle Engine Type data
	Noise emission data
	Building height
	Type of road surface
	Classification of vehicles
Traffic Control Data / calibration	Sign data (e.g., location of sign data, stop, yield, exit signing and/or lane turning assignment)
	Fixed Signal Control data
	Signalized Intersections (for each signal groups, signal phases, control plans, coordinates)
	(Semi) Actuated Signal Control data
	Loop detector data
	Ramp Meter Control Data
	Location of variable message signs and set of possible pre-fixed messages
	Location of variable speed signs, operational rules and algorithms used
	Loop detector location data
Station-based or free-floating Carsharing	Fleet sizes
	Fleet composition/Vehicle Types/Number for each type
	Vehicle Capacities
	Station capacity/dock-parking numbers
	Fuel Consumption
	Static or dynamic daily station/zone stock level data
	Trips /ODs
	Rentals/Bookings
Station-based or free-floating Bike sharing	Fleet sizes
	Fleet composition/Vehicle Types/Number for each type
	Station capacity/dock-parking numbers
	Static or dynamic daily station/zone stock level data
	Trips /ODs
	Rentals/Bookings
Station-based or free-floating scooters	Fleet sizes
	Fleet composition/Vehicle Types/Number for each type
	Station capacity/dock-parking numbers
	Fuel Consumption
	Static or dynamic daily station/zone stock level data
	Trips /ODs
	Rentals/Bookings

5.3 Available secondary data in Turin

In Turin, a good amount of the secondary data needed for simulating the use cases is available. Some of them are available from online public databases, other are available for the HARMONY pilot study with restricted access, i.e. can be used by the Municipality and TRT for the purposes of the HARMONY project, but it's not possible to publish them or provide them to third parties.

The following table provides an overview of the available data, the source and the type of access.

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Table 5-11: Secondary data available for the Turin use cases

Data typology	Data	Source	Access
Economic data	Employment	National Census (ISTAT)	Online public data
	Retail Activities	National Census and Municipality Retail Office	Online public data
	National Gross Domestic Product	National statistic (ISTAT)	Online public data
	Tourism arrivals	Regional database	Online public data
	Public Investments in transport sector	Municipality, metropolitan city government	Restricted access
	Car ownership	ACI data	Online public data
Land Use Data	Land use	Regional database	Online public data
Demographic data	Population	Census Regione Piemonte	Online public data
	Population Projections	National / regional statistic (ISTAT)	Online public data
	Occupational Class	National Census (ISTAT)	Online public data
	Ethnicity	National Census (ISTAT)	Online public data
	Income	National Census (ISTAT)	Online public data
	Urban density	National Census (ISTAT)	Online public data
	Household variables	National Census (ISTAT)	Online public data
Housing data	Housing Tenure	Regional database	Online public data
	House Prices	Regional database	Online public data
	House Rents	Regional database	Online public data
	Retails activities Rents	Regional database	Online public data
Topography and boundaries	General topography	Regional database	Online public data
	Point of interest data	Regional database	Online public data
	Digital elevation model	Ministry of Environment	Online public data on-demand
	Municipal Boundaries	National / regional statistic (ISTAT)	Online public data
	Local Authority Boundaries	National / regional statistic (ISTAT)	Online public data
Building Data	Building Footprints	ARPA Piemonte region (Environmental Agency)	Online public data
	Building Floorspace / Heights / Storeys	Regional database	Online public data
	Building Function	Regional database	Online public data
	State / Public Housing Estates	Regional database	Online public data
Planning Policy Data	Locations for major future urban development	Municipality, metropolitan city government	On-demand, might be restricted
	Planning zoning urban restrictions	Municipality, metropolitan city government	On-demand, might be restricted
	Environmental or other development restrictions	Municipality, metropolitan city government	On-demand, might be restricted
	Major future transport infrastructure development	Regional database	Online public data
	Land Development / utilities network	Only river available (regional database)	Online public data
Network data	GIS shapefile of TAZ system and georeferences of centroids and connectors		Restricted access
	GIS shapefile of study area	National statistics (ISTAT)	Online public data
	Open Street Map data	Open street map	Online public data

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Data typology	Data	Source	Access
	Aerial photography and/or CAD for refinements (Google Streetview can be a replacement for this requirement)	2018 Municipality of Turin, 2016 Piedmont Region	Online public data
	Bike lane network	Metropolitan city database	Online public data
	Walking network	5T (regional)	Restricted access
	Intersection (node) coordinates	5T (regional)	Restricted access
	Section: Road category, speed limit	Open street map	Online public data
	Number of lanes	5T (regional)	Restricted access
	Link free-flow speed	5T (regional)	Restricted access
	Location of multimodal transhipment terminals	5T (regional)	Restricted access
	Airport location data	-	Restricted access
Public transport data	GTFS files availability	GTT	Restricted access
	Line routing (ideally GIS based)	GTT / Google Maps	Restricted access / open
	Stops location (ideally GIS based)	GTT / Google Maps	Restricted access / open
	Stops assigned to each line	GTT / Google Maps	Restricted access / open
	Timetable covering the simulation period/day	GTT / Google Maps	Restricted access / open
	Type of vehicles used to operate each line	GTT	Restricted access
Passenger demand data	Household travel demand surveys	IMQ2013 (source Metropolitan City)	Online public data
	Trip or activity or time-use diaries	Trip diaries: IMQ2013 (source Metropolitan City)	Online public data
	Static OD matrix	National Italian Census, 5T	Online public data / restricted access
	Static OD matrix per vehicle type	5T	Restricted access
	Skim matrices	5T	Restricted access
	Pedestrian counts at crossings per direction (estimated or observed)	Only for main historical and commercial streets	Restricted access
	Bicycle counts or occupancy at exclusive bicycle lanes	Max. 5 counts for entire municipality area	Restricted access
Energy, emission, noise data	Vehicle Engine Type data	ACI	Online public data
	Noise emission data	ARPA Piemonte region (Environmental Agency)	Online public data
	Classification of vehicles	ACI	Online public data
Traffic Control Data / calibration	Sign data (e.g., location of sign data, stop, yield, exit signing and/or lane turning assignment)	5T	Restricted access
	Fixed Signal Control data	5T	Restricted access
	Signalized Intersections (for each signal groups, signal phases, control plans, coordinates)	5T	Restricted access
	(Semi) Actuated Signal Control data	5T	Restricted access
	Loop detector data	5T	Restricted access
	Location of variable message signs and set of possible pre-fixed messages	5T	Restricted access
	Location of variable speed signs, operational rules and algorithms used	5T	Restricted access
	Loop detector location data	5T	Restricted access
Station-based or free-floating Carsharing	Fleet sizes	Turin municipality	Restricted access
	Fleet composition/Vehicle Types/Number for each type	Turin municipality	Restricted access
	Vehicle Capacities	Turin municipality	Restricted access

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Data typology	Data	Source	Access
	Station capacity/dock-parking numbers	Turin municipality	Restricted access
	Fuel Consumption	Turin municipality	Restricted access
Station-based or free-floating Bike sharing	Fleet sizes	Turin municipality	Restricted access
	Fleet composition/Vehicle Types/Number for each type	Turin municipality	Restricted access
	Station capacity/dock-parking numbers	Turin municipality	Restricted access
	Static or dynamic daily station/zone stock level data	Turin municipality	Restricted access
	Trips /ODs	Turin municipality	Restricted access
	Rentals/Bookings	Turin municipality	Restricted access
Station-based or free-floating scooters	Fleet sizes	Turin municipality	Restricted access
	Fleet composition/Vehicle Types/Number for each type	Turin municipality	Restricted access
	Station capacity/dock-parking numbers	Turin municipality	Restricted access
	Fuel Consumption	Turin municipality	Restricted access
	Static or dynamic daily station/zone stock level data	Turin municipality	Restricted access
	Trips /ODs	Turin municipality	Restricted access
	Rentals/Bookings	Turin municipality	Restricted access

5.4 Missing secondary data in Turin

5.4.1 Description of the missing needed secondary data

The following table provides an overview of the missing data related to the Turin pilot.

Table 5-12: Missing Secondary data for the Turin use cases

Data typology	Data
Demographic data	Firm data by industry
Network data	Length of turn bays
	Location of distribution centres
Passenger demand data	SP experiments (mode, route or vehicle purchase choice)
	GPS or other geolocation data survey
	Dynamic OD matrix
	Dynamic OD matrix per vehicle type
	Public transport Data on passenger flows
Energy, emission, noise data	Building height
	Type of road surface
Traffic Control Data / calibration	Ramp Meter Control Data
Station-based or free-floating Carsharing	Static or dynamic daily station/zone stock level data
	Trips /ODs
	Rentals/Bookings

5.4.2 Options for alternatives

The missing information will be discussed with the partners responsible for the models requiring their use, and alternative proxy data (or with higher level of aggregation) will be considered where possible.

Furthermore, with reference to passenger demand data, it will be investigated the possibility to use the planned collection of primary data to fill some of the gaps reported in Table 5-4.

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6. Athens secondary data

6.1 Athens

6.1.1 Description of the city

Attika is an administrative region of Greece that encompasses the entire metropolitan area of Athens. Located on the eastern edge of Central Greece, Attika covers about 3,808 km^2. Athens metropolitan area consists of more than 60 municipalities and is inhabited by almost 4 million people, with the Municipality of Athens being the most dense and compact. It is a metropolitan area with a dynamic services sector and one of the major exporting gates of Greece. Growth during the decade 2000-2009 in the region can be partly attributed to significant infrastructure investments made for the 2004 Olympic Games. During that period, infrastructure projects to upgrade the transportation service level have been implemented, such as the development of the metro network, tram network and suburban railway, the development of Attiki Odos (the major peri-urban highway), the construction of the new Athens international airport.

The Athens Public Transport system is the largest public transport system in Greece. It consists of a metro, a tram, an extensive bus and trolleybus network and suburban railway which provide easy access to all major points of interest. The Athens metro is the backbone of the Athens Transport System. It has three lines and provides direct connection of the City Centre to the city's entry points like the Airport of Athens, the Port of Piraeus and the Athens Railway Station. The Athens metro extends from north to south and east to west, connecting the urban suburbs. Athens' motorized transport (cars and powered two-wheeler) modal split stands at 53%, public transport at 37%, and quite paradoxically little walking (8%) and almost no cycling (~2%). Every day more than a million passengers travel and 2.5 million boardings are made using public transport.

6.1.2 Description of the urban development plans (regional, spatial and transport plans/SUMPs') until 2050

Athens faces vital urban challenges concerning traffic congestion, traffic safety, pollution and citizen's health. In 2012 the 'Strategic Plan for transportation and Sustainable Mobility in Athens' was firstly introduced as part of the Strategic plan of Athens, but it has not been implemented, and in 2013 a bike sharing system in the Municipality of Athens was strongly debated.

In 2018, actions towards the development of SUMPS have been initiated in half of the municipalities of the Attika region, regarding the management of public transport, the development of an extended cycling network, the systematic upgrade of public spaces and the establishment of an integrated pedestrian network, with the most important being the alteration in planning mentality and development of priorities.

A new Athens Master Plan (AMP) known as the **Regulatory Plan of Athens-Attica 2021** (L.4277/2014) recently updated the first one, enacted in 1985. The main strategic objectives applied are: the promotion of the image of Athens as a Mediterranean capital with emphasis on civilization, policies for social cohesion, reconstruction of the production structure, restriction of unauthorized building, strengthening and redistribution of development resources, establishment of green belts and ecological corridors, urban regeneration with recycling of land and housing stock, vivification of centrality, strengthening of sustainable mobility, valorisation of the sea front, and improvement of the system of spatial planning and governance (ORSA /YPEKA, 2011).

"Athens 2030," the city's Resilience Strategy (PRA). Released in July 2016, the PRA sets the resilience baseline for Athens, introducing 5 discovery areas that the city had to explore more in order to discover opportunities that would help it built its resilience. The discovery areas are: 1) Maximize the dynamic of the Athenian neighbourhood, 2) Data driven and inclusive city, 3) Nature in the city: Best possible use of urban resources, 4) Crisis within crisis, 5) Enhance social cohesion. One of the main goals of the plan is to promote sustainable mobility and co-create public spaces, initiating various schemes. Therefore, currently the municipality of Athens has started developing a strategic plan for urban mobility. Funding for the **Athens Sustainable Urban Mobility Plan** is provided by the "National

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Green fund." In addition, the Urban Cycling plan is designed consistently with the **Regional Cycling plan**, which is currently being implemented across several municipalities in the Attica Region. The Region of Attica has allocated a budget of 10 million Euros for the construction of the north axis of a cycling lane which is currently in progress. Furthermore, currently, Athens municipality implements a pilot project in a selected part of the Commercial Triangle of Athens. This program aims at the overall revitalization of the area by upgrading infrastructure, pedestrianizing an area of 110 acres, redesigning cleaning and municipal police services and renewing urban equipment.

Athens Strategic Transport Plan (2011-2023). In 2006, OASA launched a 3-year development program, drawing up a medium-term Strategic Transport Plan for the Attica region, focused on three horizons (2011, 2016 and 2023). The Strategic Transport Plan consisted of a number of planned infrastructure projects, mainly concerning fixed rail projects (e.g. extensions of Metro Lines), and a series of new proposed measures, such as infrastructure proposals (e.g. new tram lines, Bus Rapid Transit (BRT) lines, P&R stations, etc.), fleet procurement, traffic management schemes, operational measures for public transport, and smart technology innovation projects. Nevertheless, the deep economic recession experienced in Greece during the last decade affected infrastructure investments, resulting in postponing or cancelling the planned infrastructure projects. On the other hand, operational measures have been implemented as well as the two smart technology innovation projects. Within 2020 **an update of the Athens Strategic Transport Plan is being scheduled to start**.

The Hellinikon - Urban Development Project (the largest urban regeneration project in Europe) in the south coastal area of Athens with a total area of 6,200,000 sq. m. encompasses the creation of a world class Metropolitan Park as well as the enhancement of the Coastal Front, both fully accessible to the public. The project development, which was stalled for 4.5 years due to objections by residents and environmental groups as well as Greece's Archaeological Service, has recently moved to the top of the Greek government's agenda and all the necessary steps have been taken to allow for the project to move to the implementation stage.

In order to give some insights on what is under discussion in one of the SUMPs, the following paragraph focuses on the forthcoming SUMP of the Municipality of Hellinikon-Argyroupoli.

The Hellinikon-Argyroupoli municipality covers an area of 15.7 km2 and its population is approximately 51,000 inhabitants. It holds a special role on the Athens coastal line area, due to the implementation of the Hellinikon - Urban Development Project planned in the former Hellinikon airport area (5.3 km^2). This Project is expected to have a positive effect not only on the Hellinikon-Argyroupoli municipality but on the entire region of Attica. In addition, the municipality's spatial location combined with the fact that it is crossed by significant arterial road axes makes it a major attraction pole for supra-local activities in the south of Athens.

The proposed measures of the SUMP of the municipality of Hellinikon- Argyroupoli are related to the transport areas presented below. The soft scenario includes the following measures:

Table 6-13: Description of the proposed SUMP measures

Traffic Management	Implementation of traffic calming interventions on the collectors and local roads network
	Introduction of new traffic lights signalling programs, enforcement of speed limits (50km/h)
Parking Management	Prevention of illegal parking by widening sidewalks and - where possible – bicycle lanes
	Planning measures to prevent / eliminate illegal parking - especially on sidewalks

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	Implementation of a Parking Control System, using "smart systems" to serve primarily the residents and then visitors in commercial zones (i.e. maximum permitted parking time of 3 hours)
	Construction and operation of additional off-street parking spaces
Redevelopment of road intersections	Road infrastructures projects (e.g. Undergrounding of Vouliagmeni Ave.)
	Construction of roundabouts and improvement of intersections facing safety issues
Public Transport	Redesign of Metro Line 2 regarding its extension to Varkiza
	Construction of reserved bus lane on Vouliagmeni Ave. for both directions.
	Operation of new Municipal Bus Lines and enhancement of the bus lines efficiency
	Expansion and implementation of bus telematics system at all bus stops of the Municipality
Green Route Network	Installation of electric vehicle charging points in accessible public spaces
	Pedestrianisation of roads, renovation of sidewalks and improving design parameters
	Construction of pedestrian bridges in Vouliagmeni Ave., for safe pedestrian crossing
	Development of an integrated Green Routes Network, connecting school complexes, sports facilities, the Hellinikon Development, neighbourhoods, etc.
	Implementation of bicycle parking systems and storage facilities and of bicycle sharing system
Green spaces	Restoration and utilization of green spaces Construction of new city squares
Freight Transport	Sustainable freight transport management. Establishment of urban freight distribution centres.

The Radical Scenario includes all the soft scenario measures up to the 15-year horizon. Furthermore, interventions are proposed in order to effectively reduce the use of private vehicles within the municipality and to promote sustainable transport solutions. The Radical Scenario requires a change of transport planning mentality and encourages a shift towards more sustainable modes (public transport, cycling, walking). The main prerequisite for the SUMP is the construction of the relevant infrastructure and the implementation of radical changes in the road network design and in urban planning in general. The additional proposed measures of the radical scenario are:

- Implementation of extended pedestrianisation scheme. Establishment of pedestrian areas around Metro stations.
- One-way streets and traffic calming measures in arterial roads.
- Reduce of speed limits to 30 km / h.
- Conversion of the entire road network of the Municipality into a Green Road Network.
- New Express Bus Line for connection to the northern suburbs.

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6.2 Athens modelling use cases

6.2.1 City goals

During the last years the vision and main goals of the Athens municipality revolves around 3 axes: a) the organization of a collective process and effort to beautify Athens, focusing mainly around a programme for the refurbishment of Athens building facades, upgrading of a set of thematic routes (including options for micro mobility and active transport) in the centre of the city, which has positive impact on both visitors and residents; b) introduction of Athens Municipal parking system and c) improving accessibility, especially for special segments of the population such as elderly, immigrants, people with restricted mobility, citizens living in areas with restricted access to public transportation. Especially for the latter, a series of on-demand bus routes are considered.

Additionally, given that a SUMP is currently being designed and implemented for Athens city, there is an ongoing investigation of further integration of urban planning, environmental and citizen accessibility/support programs in order to further comply with EU-wide sustainable transportation and environmental goals (e.g. an alternative fuel program to be implemented soon, the aforementioned SUMP, cleaner environment acts and programmes, garbage collection and management, promotion of pedestrianizations, micro mobility and active transport policy bundles.)

6.2.2 Description of the modelling use cases, models and secondary data needs.

Table 6-14: Description of the modelling use cases, modelling and data needs (Athens)

Use case 1: Micro transit services with flexible routes to cover the trips between Athens and the greater area	
Description:	The first use case investigates the implementation of micro transit services with flexible routes to cover trips between Athens city and the greater area. Given that specific parts of the greater metropolitan region are currently facing significant connectivity and accessibility issues, the implementation of such a flexible, micro-transit route program could lead to significant raise in local population accessibility, addressing issues of social cohesion and inclusion and lowering dependence on private transport and other private services.
Modelling needs:	Utilization of the strategic model of OASA to investigate optimal routing of such services, as well as, identification and assessment of indicators that prove the validity of such a solution such as: 1. Passenger/kms diverted to public transport for the study areas 2. Fleet needs for the implementation 3. Scheduling and flexibility 4. Other
Secondary data:	Disaggregate mode choice data. These data should include the possibility to use flexible, micro-transit services especially in comparison with current means of transport. The data should include latent demand, for example trips that are not conducted due to restricted access to reliable PT.
Use case 2: Uninterrupted cycling and walking routes	
Description:	The use-case is based on a) the current, renewed touristic attraction of the city centre, big portion of which is inaccessible to visitors and inhabitants using active transport means. This use-case is in line with the

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	municipality goal of implementing scenic routes passing through historical sites and other attractions. The use-case will explore and attempt to identify such uninterrupted cycling and walking routes in the city centres and in corridors connecting the city centre to nearby attractions (such as the Niarchos foundation, the coastal complex in the South of Athens and other)
Modelling needs:	The model of OASA will be utilized in order to identify any traffic bottlenecks, threats of interrupted movement of motorized transport and to identify a working solution for the allocation of such routes aiming to a) maximize interconnectivity and multimodality; b) avoiding bottlenecks and large restrictions in the movement of essential vehicle traffic and c) providing integrated, uninterrupted solutions to maximize the total network of new routes.
Secondary data:	Micro mobility transit data; cyclist data, traffic flows [Optional, may already be delivered by existing secondary data]
Use case 3: On-demand bus routes provided to specific areas	
Description:	Similar to use-case 1, use-case 3 will focus on investigating the potential social and economic advantages to implementing specific on-demand bus routes to areas around the city centre and to suburbs. Due to flexible demand (both because of strong seasonality and of constantly raising grade of temporal and spatial fragmentation of activities), on-demand bus services are considered to be a fit solution. The bus routes will be identified based on current gaps in the transit network and raising needs of specific areas to have access to more flexible schedules.
Modelling needs:	The model of OASA will be utilized to identify zones with rising demand needs and geographic areas/zones which are currently identified to have a significant negative equilibrium between supply and demand for public transport services. Given the wide area of the OASA model, we will be able to identify overlap with regional buses (KTEL) and to provide solutions to better organize multimodality and interconnectivity.
Secondary data:	Data are covered from the existing secondary data. Optionally, we could benefit from SP experiments including on-demand bus services, aimed at respondents of specific areas.
Use case 4: Implementation of future, innovative mobility services, such as MaaS, offered by OASA.	
Description:	MaaS and other novel mobility services are central in HARMONY. Recent experience from the implementation of a common, electronic card/ticket in the case of Athens has provided evidence that users of the PT system are keen on and easily adjust to such changes.
Modelling needs:	Given that the OASA model will be applied only for the strategic level a significant portion of the modelling work would focus on future vehicle ownership and subscription to MaaS services sub models, with the model identifying effects of such shifts (based on scenarios) would have on the future traffic flows and overall network performance.

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Secondary data:	Additionally, we would require SP experiments focusing on future vehicle purchase and the willingness to purchase a MaaS plan given various scenarios.

6.3 Available secondary data in Athens

With respect to the major data categories identified by the project, the available data from the Athens metropolitan area may be further distinguished as follows:

1. **Land use**: transport interaction model data: population data, land use data,
2. **Transport supply modelling data**: network data, traffic control data, public transport data, and
3. **Transport demand modelling data**: passenger demand data, freight demand data.

In particular, the data referring to the first category (population data and land use data) are derived from the 2011 census. Population data generally refer to Greece's permanent residents, but, they also account for Greece's legal residents due to the significant migration flows observed in the last years. Categorization of the population is based on aggregated personal and socio-economic characteristics, such as sex, age group, marital status, number of children, citizenship, educational level, profession, branch of business activity, status of professional activity (active, unemployed, student, pensioner etc), work hours per week etc, with the classification taking place on various administration levels (municipality, prefecture, regional unit). The land use data, on the other hand, specify the classification of the country's buildings and is made in accordance with multiple distinct parameters regarding the building itself (in structural / construction terms), its position in relation to the surrounding buildings and the wider residential area and the scope it serves and whom this scope applies to. The specific criteria include the number of the building block the building is located in and its respective serial number within the block, the housing address, the location of the building in relation to the rest of the residential area as well as the existence of any tangent buildings, the building's number of storeys, type of upper storey ceiling (roof, plane), year of construction, main construction material, square footage of the ground floor and connection to the sewerage system, the building's public or private ownership and whether it houses public administration services, the type of land use that the building may be classified under (distinguished into exclusive and / or mixed use serving accommodation (house), religious (church), health (hospital), educational (school) purposes etc)), and, finally, the number of existing residencies within the building.

In terms of the transport supply modelling data, these can be distinguished into the categories of: (a) network data, (b) traffic control data, and (c) public transport data. Network data comprise the following:

- GIS shapefile of the TAZ system with georeferences of the centroids and the connectors,
- GIS shapefile of the study area,
- aerial photography for the necessary refinements,
- intersection (node) coordinates,
- road categorization and speed limits,
- number of lanes per directional link,
- free flow travel speeds on the links,
- roadway lane widths, and
- airport location data.

All data date back to 2014, except for the aerial photography data that will be used for the refinements. This will depict the current state (year 2020) and will be derived from the VISUM aerial photography applet. In addition, the GIS shapefile of the TAZ system comprises 1284 internal zones and 12 external ones, while the GIS shapefile of the study area provides an illustration of the core road network with the use of directed links (the links are also accompanied by all the necessary data (e.g. speed limits, capacity per lane etc.). It also incorporates the existing turn prohibitions at the intersections as well as the traffic lights at some junctions (no traffic signalling program will be embedded though).

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Furthermore, the traffic control data are analysed into:

- the fixed signal control data, and
- the signalized intersection data.

Both categories describe the traffic lights' positions, phases and groups, but no signalling program will become available (data year: 2014).

Finally, the public transport data include the following:

- GTFS files,
- line routing,
- location of the stops,
- stops assigned to each line,
- timetables covering the simulation period per day, and
- type of vehicles used to operate each line (along with the necessary details regarding the fleet size and composition (e.g. bus length, number of doors, number of doors used for boarding, number of seats, passenger capacity etc.).

All the aforementioned data will be updated to reflect the current state (year 2020).

Finally, the transport demand modelling data comprise two categories: (a) the passenger demand data, and (b) the freight demand data. With respect to the passenger demand data, five data sub-categories may be distinguished:

- data from household travel demand surveys,
- data from stated preference experiments,
- static OD matrices,
- static OD matrices per vehicle type, and
- skim matrices.

The available household travel demand data are derived from a 2006 survey and include details ranging from the socioeconomic state of the respondents, to data regarding their trips, mode choice, trip purpose etc. The stated preference data are also from the 2006 survey and focus on the respondents' choice of mode on the basis of time / cost criteria. With respect to the static OD matrix, this comprises both 24h and peak period matrices for both private and public transport vehicles, with the aggregated data also analysed per trip purpose. Available are also static OD matrices per vehicle type, distinguishing between the aforementioned vehicle categories. It is noted that all OD data are relatively new (year 2014). Finally, the skim matrices provided, make use of various types of impedance (time, distance, generalized cost) and date back to 2009.

As for the second category of transport demand modelling data, the respective freight OD matrix also comes from the 2006 survey.

In this respect, the following matrix summarizes the available secondary data for the Athens metropolitan area per data type and subtype. It additionally provides a description of the individual categories along with the data reference year and the respective data format.

Table 6-15: Available secondary data for the Athens metropolitan area

Data type	Data subtype	Description	Data year	Data format	Access Policy
Land use - transport interaction model data	**Land use data**	• Land use classification of buildings	• 2011	• XLSX	Obtained from the Greek Statistics agency. Policy outlines “use within the institution which obtained the
	Demo-graphics	• Population data	• 2011	• XLSX	

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					data"; unclear and will be specified at future point.
Transport supply modeling data	**Network data**	• GIS shapefile of the TAZ system with georeferences of the centroids and the connectors • GIS shapefile of the study area • aerial photography for the necessary refinements • intersection (node) coordinates • road categorization and speed limits • number of lanes per directional link • link free flow travel speeds • lane widths • airport location data	• 2014 • 2014 • 2020 • 2014 • 2014 • 2014 • 2014 • 2014 • 2014	• Shapefile, MS-ACCESS • Shapefile • JPG • Shapefile, CSV • Shapefile, MS-ACCESS • Shapefile, MS-ACCESS • Shapefile, MS-ACCESS • Shapefile, MS-ACCESS • Shapefile, MS-ACCESS	Data owned by OASA. Available to the project partners for the purposes of HARMONY MS.
	Traffic control data	• the fixed signal control data • the signalized intersection data	• 2014 • 2014	• Shapefile, MS-ACCESS • Shapefile, MS-ACCESS	
	Public transport data	• GTFS files • line routing • location of the stops • stops assigned to each line • timetables covering the simulation period per day • type of vehicles used to operate each line	• 2020 • 2020 • 2020 • 2020 • 2020 • 2020	• Shapefile, MS-ACCESS • Shapefile, MS-ACCESS • Shapefile, MS-ACCESS • Shapefile, MS-ACCESS • Shapefile, MS-ACCESS	

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Transport demand modeling data	**Passenger demand data**	• data from household travel demand surveys • data from stated preference experiments • static OD matrices • static OD matrices per vehicle type • skim matrices	• 2006 • 2006 • 2014 • 2014 • 2009	• Text file, CSV • Text file, CSV • MS-ACCESS • MS-ACCESS • MS-ACCESS	Data owned by OASA. Available to the project partners for the purposes of HARMONY MS.
	Freight demand data	• Freight OD matrix	• 2006	• MS-ACCESS	
Telematic data from AthenaCARD and other sources	Telematic data	• Demand data and usage of Athena CARD	• 2017 - 2020	• CSV	Not accessible at the moment, policy may change in the coming months and data may become available to HARMONY partners via APIs

6.4 Missing secondary data in Athens

6.4.1 Description of the missing needed secondary data

Unfortunately, due to data collection absence or inefficiencies, the Athens metropolitan area is currently missing some of the secondary data types that are specified by the HARMONY project and that could possibly prove valuable for the analyses conducted. As examples, the following could offer as important, although optional, data sources:

1. SP experiments of on-demand bus services aimed at respondents of specific geographical zones (to be determined);
2. SP experiments of flexible bus routes aimed at respondents of specific geographical zones (to be determined);
3. SP experiments of future vehicle purchase in comparison with future subscription to MaaS or other sharing/PT services bundling (Open to discussion, not in the current data collection plan).

6.4.2 Options for alternatives

For respective missing data we propose the following options:

1. Existing secondary data or SPs already defined in the OASA database or data from mobile phones (still under consideration);
2. Existing secondary data or SPs already defined in the OASA database or data from mobile phones (still under consideration);
3. Telematic data from OASA Athena Card.

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7. Data management plan

In this section, the aspects of the data management which are related to secondary data collection and use in terms of storage, adherence to data protection rules and the approach for data exchange, archiving and preservation are summarised. Note that the HARMONY approach for data management is handled within task T10.2 "Data Management Plan and Open Science" and is reported in deliverable D10.3. Aspects related to data management continuously evolve within the project as new data become available. These aspects are continuously added in D10.3 which is a "living document" with three planed versions. The first version of that document is already submitted in M10 of the project.

7.1 Data Security

The HARMONY platform will provide all required measures for secure data access with the usage of the latest encryption tools and protocols as well as data access control practices to prevent data misuse or manipulation. The data security mechanisms are defined and implemented as part of WP3. It is envisaged that the starting candidates will be TLSv3 protocol for secure data connections and OAuth for access control.

7.2 Storage of sensitive data

Data privacy and user data protection issues will strictly follow the "user decides" principle. End-users (and only them) will always have the possibility to decide which personal or private data to be used and all user referenced data will always be grouped and combined via anonymization tools to avoid the possibility of breaking it down to one user. All personal data stored within the HARMONY project will be archived for the lifetime of the project only, and will be coded, stored and kept privately in a secure location. No information will be shared with any, external to the HARMONY consortium, party without the prior expressed permission of the user. Sensitive information will be stored in an encrypted form and all data will be protected by password access.

7.3 Adherence to the General Data Protection Regulation

The General Data Protection Regulation (GDPR) (Regulation (EU) 2016/679) concerns issues related to the protection of natural persons with regard to the processing of personal data and on the free movement of such data and repealing Directive 95/46/EC (General Data Protection Regulation). The regulation has been proposed and established by which the European Parliament, the Council of the European Union and the European Commission. It intends to strengthen and unify data protection for all individuals within the European Union (EU) and addresses issue related to the export of personal data outside the EU.

The GDPR aims primarily to give control to citizens and residents over their personal data and to simplify the regulatory environment for international business by unifying the regulation within the EU. GDPR has been adopted on 27 April 2016, while it became enforceable from 25 May 2018, allowing a two-year transition period for member states. It is important to note that GDPR does not require national governments to pass any enabling legislation and is thus directly binding and applicable. The HARMONY consortium is taking measures so that any user and personal data gathered from the project ,as well as related process, adhere to GDPR.

7.4 Data access and usage

The consortium, within its competences and available infrastructure, will assure secure storage, delivery and access of personal information, as well as managing the rights of the users. In this way, there is complete guarantee that the accessed, delivered, stored and transmitted content will be managed by the right persons, with well-defined rights, at the right time. State-of-the-art firewalls, network security, encryption and authentication will be used to protect collected data (specific details will be developed in the course of the technical implementation of the HARMONY model suite). Firewalls prevent the connection to open network ports, and exchange of data will be through consortium known ports, protected via IP filtering and password. Where possible (depending on the facilities of each partner), the data will be stored in a locked server, and all identification data will be stored separately. A metadata

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framework will be used to identify the data types, owners and allowable use. Data security will be implemented across all the research sites, and will cover procedures for storage, encryption and transmission of personal data in addition to any national data protection legislation.

The collected data will be stored in a secure server, only visible to the research site network. Anonymous and identifiable data will be stored separately, and only the project authorized person(s) will have access to the stored data. Anonymity will be guaranteed by separating identifiable data from anonymous data. Anonymous data will be available to researchers. If any identifiable data are required for research purposes, access and distribution to it will be granted only after explicit permission and after agreement of the data holders (participants providing the data). Authentication will be required to access stored data on the research site.

Authorized researchers will have access to the recorded anonymous data after authentication with a centralized server and on a need-to-know basis. Researchers will have access rights to add data to the identity database. No editing or reading rights will be granted to them to prevent alteration/disclosure of private data, if a specific permission is not granted by the data holder.

Researchers handling and processing personal and sensitive data within the project will be asked to sign a statement that they are familiar with and abide by the contractual obligations of the consortium. If not included in this obligation, they will sign a statement that commits them to make sure project data are not provided to persons outside the project consortium.

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8. Conclusion

Deliverable 9.2 outlined a major step in the process of data collection, for efficiently organized demonstration activities leading to successful model implementations, aligned with the goals of the HARMONY project. All the co-creation labs and demonstration activities are currently in the process of setting up, which involves the collection of both primary and secondary data.

Each of the cities has, therefore, been asked to provide all the relevant information regarding the modelling use cases and their corresponding secondary data needs. In addition to that, the different areas have indicated potential missing secondary data, as well as options for alternatives.

What is widely noticed is the possibility to use data coming from (existing) model outputs and, also, from statistical bureaus, resulting in a satisfactory level of data availability per area. However, similarities are also observed with respect to the missing secondary data. This is mostly emerging from the lack of choice data on: different stakeholders' s view on new mobility solutions and their response to specific subsidy schemes, on the use of new services or technologies, on daily travel diaries and their diversity due to event-driven re-evaluations, on travel satisfaction, on the use and preference of on-demand bus services and on future vehicle purchase in comparison with future subscription to MaaS or other sharing/ PT services bundling.

The most prevalent examples presented by the areas as options for alternatives are related to additional stated or revealed preference surveys, simulation gaming, data tracking from mobile phones and/ or smartphone applications for activity diaries and use of older existing databases.

Regarding the data access policies, there are three different cases, with restricted datasets, on-demand datasets or online public ones. In order to use data coming from existing models, permission to use data in HARMONY project exists, however, extra permission might be needed so that the data can be sent to third parties. For personal data, owned by statistical bureaus and are privacy sensitive, access is only provided in a secured environment and under strict conditions.

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References

Ben-Akiva, M., and Lerman, S. (1985). Discrete Choice Analysis: Theory and Application to Travel Demand, The MIT Press, Boston, 1985.

City of Rotterdam, 2019. Roadmap ZECL, Moving towards Zero Emission City Logistics (ZECL) in Rotterdam in 2025, Rotterdam, 2019.

de Bok, M., and Tavasszy, L. (2018). An empirical agent-based simulation system for urban goods transport (MASS-GT). Procedia Computer Science, 130 (8).

Kourounioti, I., Kurapati, S., Lukosch, H., Tavasszy, L, and Verbraeck, A. (2018). Simulation Games to Study Transportation Issues and Solutions: Studies on Synchromodality. Transportation Research Record, 2672 (44), 72-81.

Kurapati, S., Kourounioti, I., Lukosch, H., Bekebrede, Tavasszy, L. and Verbraeck, A. (2017). The role of Situation Awareness in Synchromodal Corridor Management: A simulation gaming perspective, Transportation research procedia 27, 197-204

Lukosch, H., Bekebrede , Kurapati, S. and Lukosch, S. (2018). A Scientific Foundation of Simulation Games for the Analysis and Design of Complex Systems. Simulation & Gaming, 49(3), 279-314.

Lukosch, H., Groen, D., Kurapati, S., Klemke, R. and Verbraeck, A. (2017). Relating planner task performance for container terminal operations to multi-tasking skills and personality type. Transportation Research Part F: Traffic Psychology and Behaviour, 51, 47-64.

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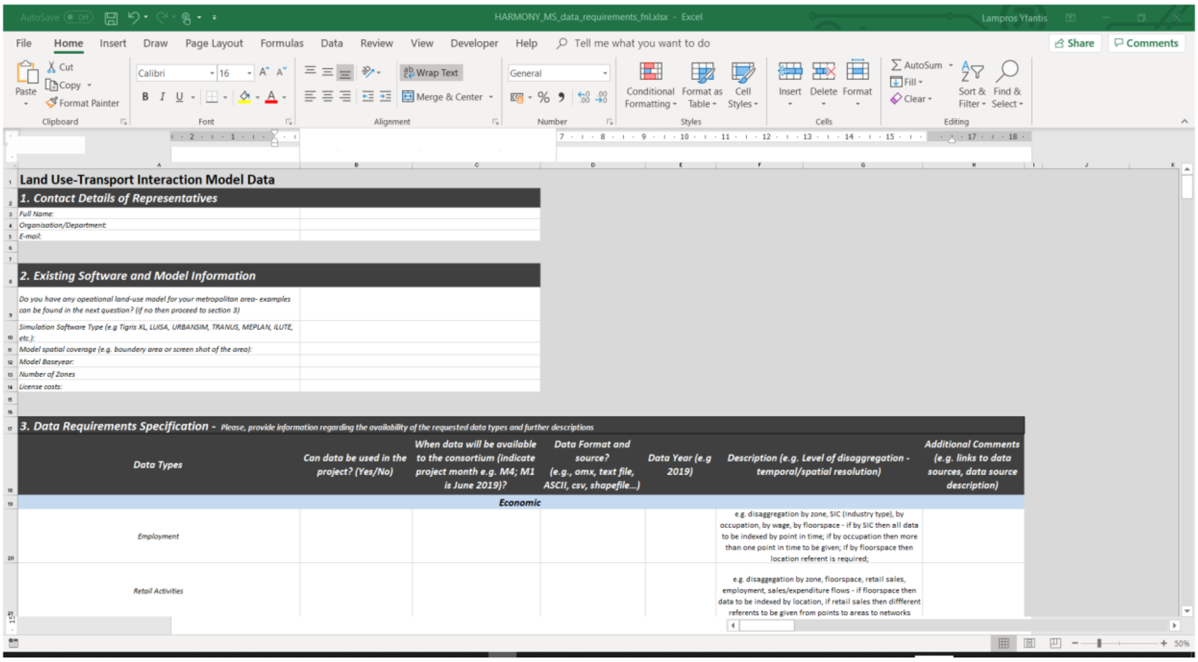
Annex: Secondary data collection template

Land Use Model Data Requirements



Land Use-Transport Interaction Model Data

1. Contact Details of Representatives

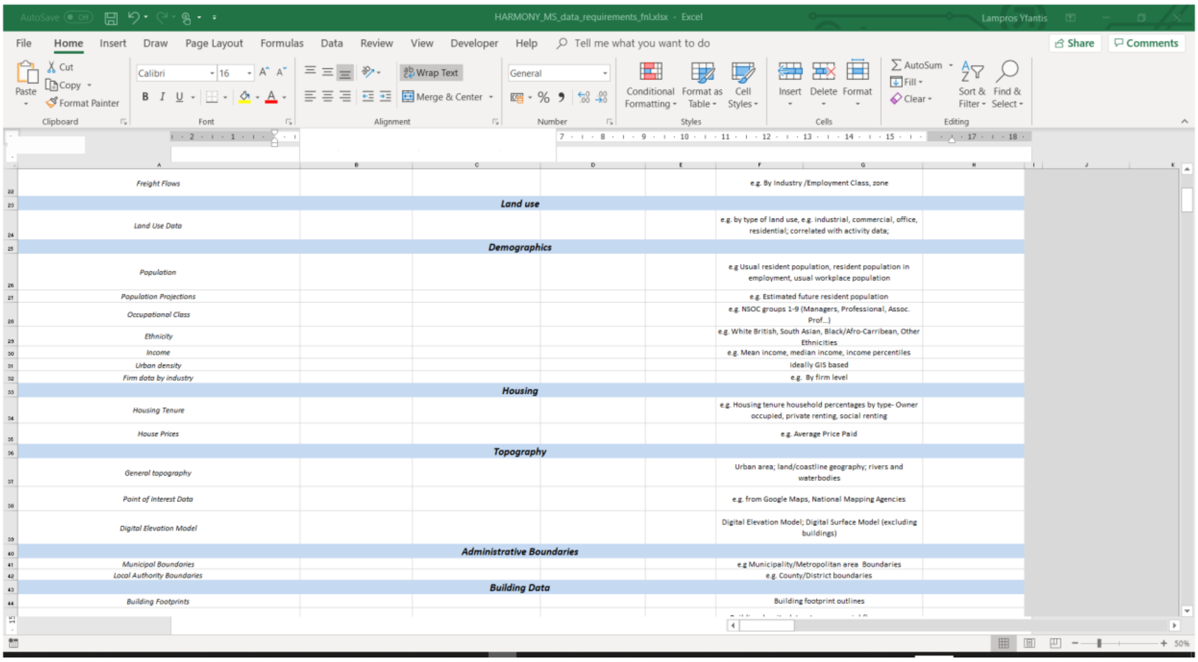
Full Name:	
Organisation/Department:	
E-mail:	

2. Existing Software and Model Information

Do you have any opeational land-use model for your metropolitan area- examples can be found in the next question? (if no then proceed to section 3)	
Simulation Software Type (e.g Tigris XL, LUISA, URBANSIM, TRANUS, MEPLAN, ILUTE, etc.):	
Model spatial coverage (e.g. boundery area or screen shot of the area):	
Model Baseyear:	
Number of Zones	
License costs:	

3. Data Requirements Specification - *Please, provide information regarding the availability of the requested data types and further descriptions*

Data Types	Can data be used in the project? (Yes/No)	When data will be available to the consortium (indicate project month e.g. M4; M1 is June 2019)?	Data Format and source? (e.g., omx, text file, ASCII, csv, shapefile...)	Data Year (e.g 2019)	Description (e.g. Level of disaggregation - temporal/spatial resolution)	Additional Comments (e.g. links to data sources, data source description)
Economic						
Employment					e.g. disaggregation by zone, SIC (Industry type), by occupation, by wage, by floorspace - if by SIC then all data to be indexed by point in time; if by occupation then more than one point in time to be given; if by floorspace then location referent is required;	
Retail Activities					e.g. disaggegation by zone, floorspace, retail sales, employment, sales/expenditure flows - if floorspace then data to be indexed by location, if retail sales then diffferent referents to be given from points to areas to networks	



Freight Flows					e.g. By Industry /Employment Class, zone	
Land use						
Land Use Data					e.g. by type of land use, e.g. industrial, commercial, office, residential; correlated with activity data;	
Demographics						
Population					e.g Usual resident population, resident population in employment, usual workplace population	
Population Projections					e.g. Estimated future resident population	
Occupational Class					e.g. NSOC groups 1-9 (Managers, Professional, Assoc. Prof...)	
Ethnicity					e.g. White British, South Asian, Black/Afro-Carribean, Other Ethnicities	
Income					e.g. Mean income, median income, income percentiles	
Urban density					ideally GIS based	
Firm data by industry					e.g. By firm level	
Housing						
Housing Tenure					e.g. Housing tenure household percentages by type- Owner occupied, private renting, social renting	
House Prices					e.g. Average Price Paid	
Topography						
General topography					Urban area; land/coastline geography; rivers and waterbodies	
Point of Interest Data					e.g. from Google Maps, National Mapping Agencies	
Digital Elevation Model					Digital Elevation Model; Digital Surface Model (excluding buildings)	
Administrative Boundaries						
Municipal Boundaries					e.g Municipality/Metropolitan area Boundaries	
Local Authority Boundaries					e.g. County/District boundaries	
Building Data						
Building Footprints					Building footprint outlines	

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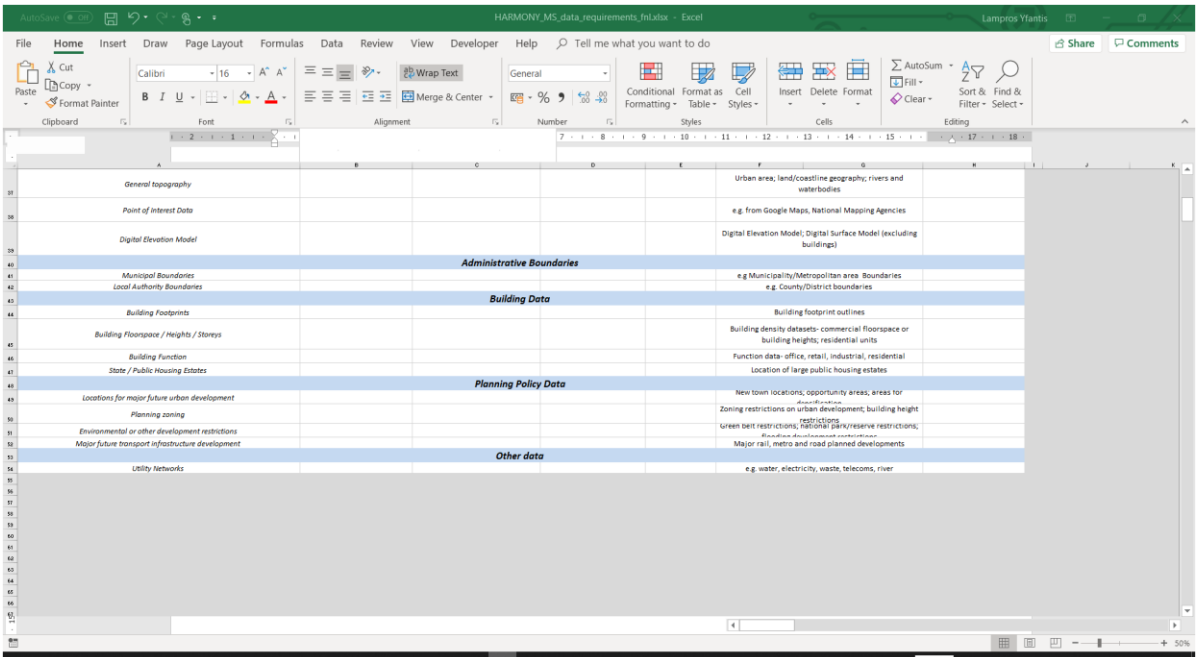
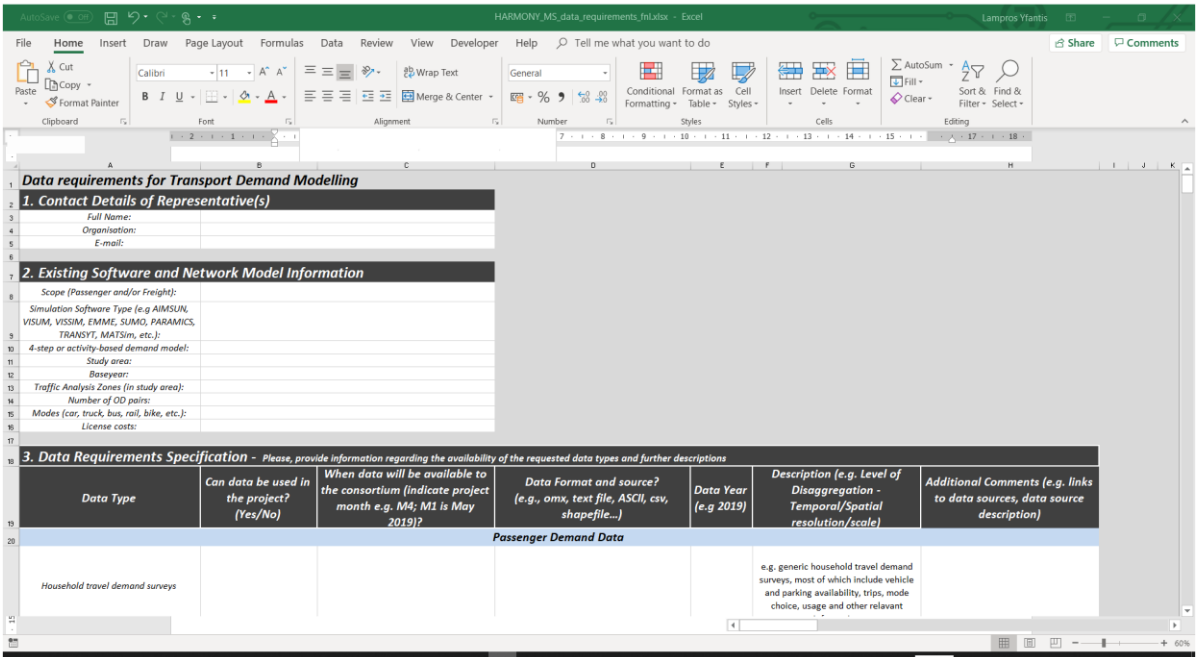


General topography	Urban area; land/coastline geography; rivers and waterbodies
Point of Interest Data	e.g. from Google Maps, National Mapping Agencies
Digital Elevation Model	Digital Elevation Model; Digital Surface Model (excluding buildings)
Administrative Boundaries	
Municipal Boundaries	e.g Municipality/Metropolitan area Boundaries
Local Authority Boundaries	e.g. County/District boundaries
Building Data	
Building Footprints	Building footprint outlines
Building Floorspace / Heights / Storeys	Building density datasets- commercial floorspace or building heights; residential units
Building Function	Function data- office, retail, industrial, residential
State / Public Housing Estates	Location of large public housing estates
Planning Policy Data	
Locations for major future urban development	New town locations; opportunity areas; areas for densification
Planning zoning	Zoning restrictions on urban development; building height restrictions
Environmental or other development restrictions	Green belt restrictions; national park/reserve restrictions; flooding development restrictions
Major future transport infrastructure development	Major rail, metro and road planned developments
Other data	
Utility Networks	e.g. water, electricity, waste, telecoms, river

Transport Demand Model Data requirements



Data requirements for Transport Demand Modelling

1. Contact Details of Representative(s)

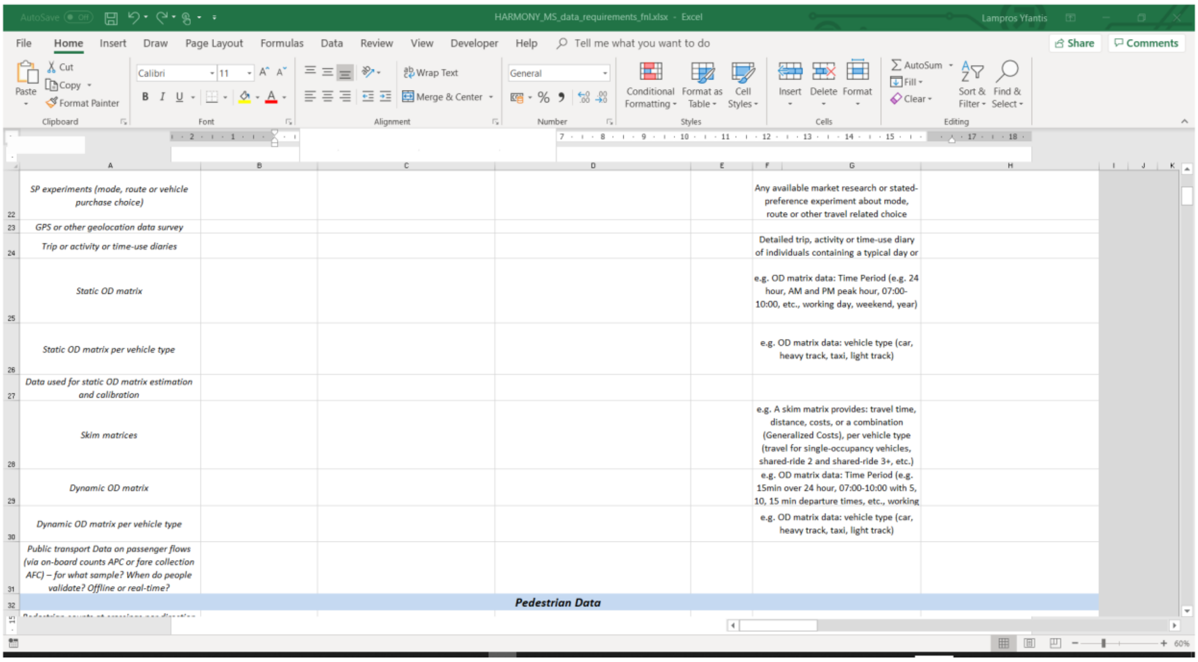
Full Name:	
Organisation:	
E-mail:	

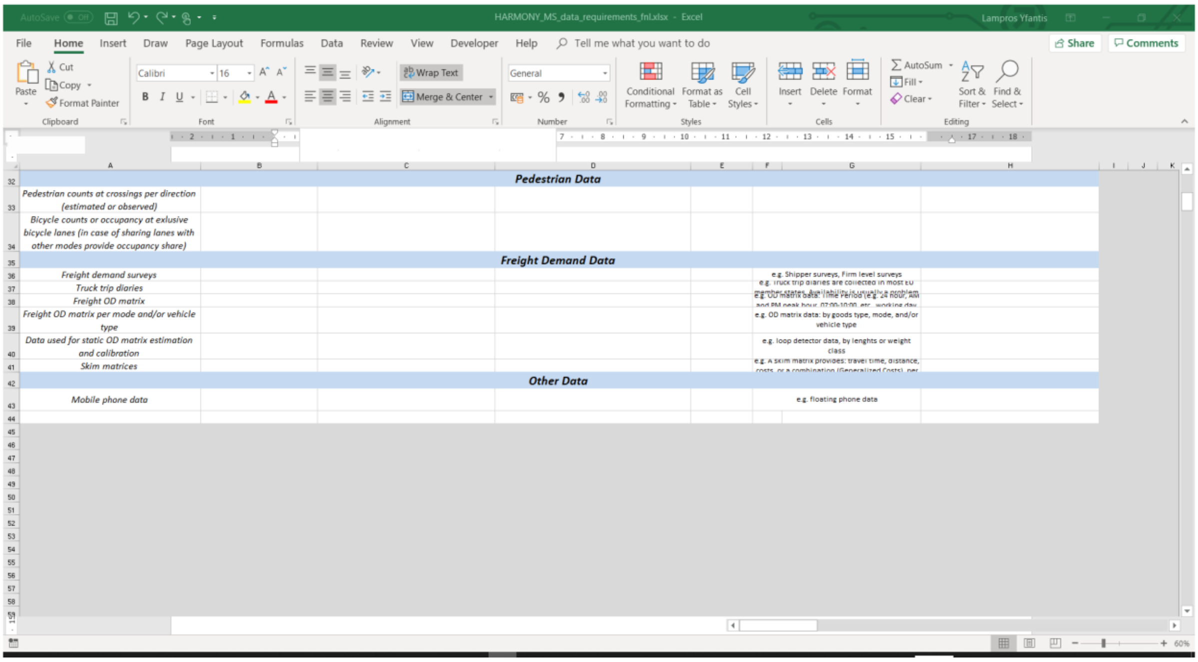
2. Existing Software and Network Model Information

Scope (Passenger and/or Freight):	
Simulation Software Type (e.g AIMSUN, VISUM, VISSIM, EMME, SUMO, PARAMICS, TRANSYT, MATSim, etc.):	
4-step or activity-based demand model:	
Study area:	
Baseyear:	
Traffic Analysis Zones (in study area):	
Number of OD pairs:	
Modes (car, truck, bus, rail, bike, etc.):	
License costs:	

3. Data Requirements Specification - *Please, provide information regarding the availability of the requested data types and further descriptions*

Data Type	Can data be used in the project? (Yes/No)	When data will be available to the consortium (indicate project month e.g. M4; M1 is May 2019)?	Data Format and source? (e.g., omx, text file, ASCII, csv, shapefile...)	Data Year (e.g 2019)	Description (e.g. Level of Disaggregation - Temporal/Spatial resolution/scale)	Additional Comments (e.g. links to data sources, data source description)
Passenger Demand Data						
Household travel demand surveys					e.g. generic household travel demand surveys, most of which include vehicle and parking availability, trips, mode choice, usage and other relavant	





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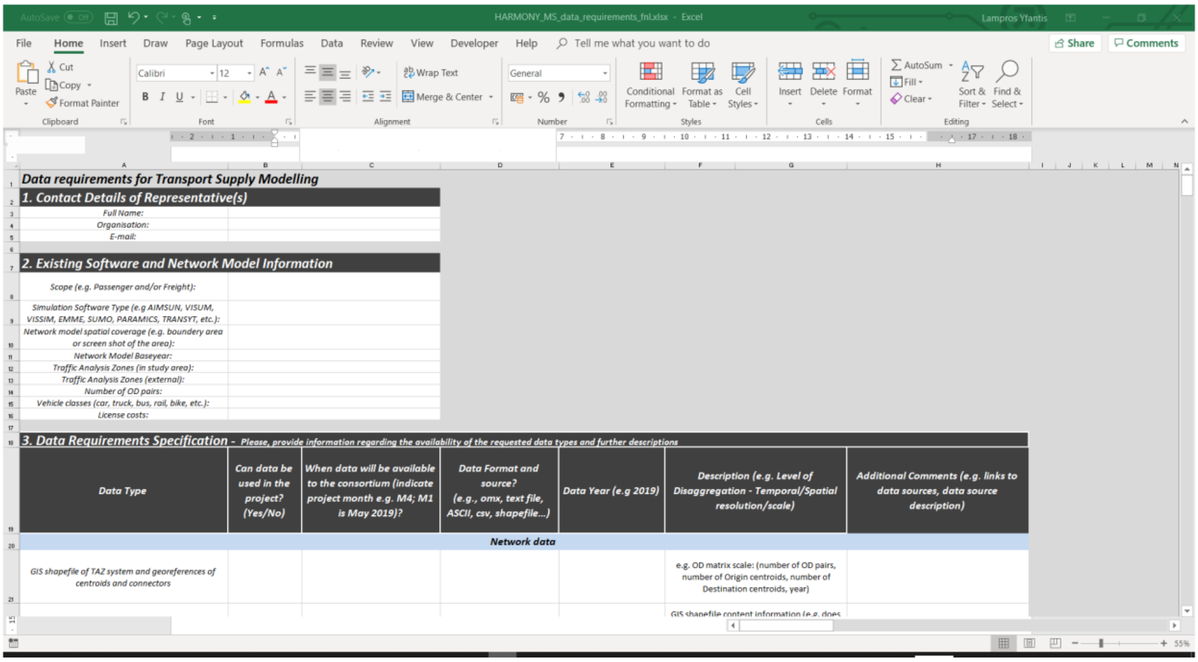
Transport Supply Model Data Requirements



Data requirements for Transport Supply Modelling

1. Contact Details of Representative(s)

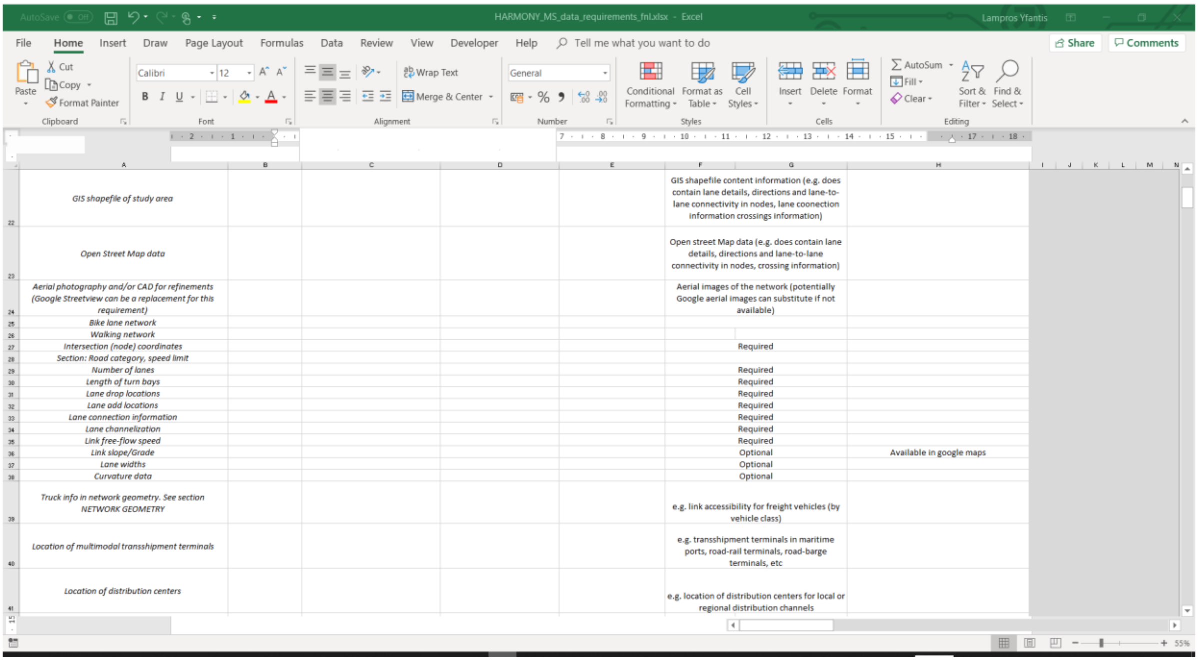
Full Name:	
Organisation:	
E-mail:	

2. Existing Software and Network Model Information

Scope (e.g. Passenger and/or Freight):	
Simulation Software Type (e.g AIMSUN, VISUM, VISSIM, EMME, SUMO, PARAMICS, TRANSYT, etc.):	
Network model spatial coverage (e.g. boundery area or screen shot of the area):	
Network Model Baseyear:	
Traffic Analysis Zones (in study area):	
Traffic Analysis Zones (external):	
Number of OD pairs:	
Vehicle classes (car, truck, bus, rail, bike, etc.):	
License costs:	

3. Data Requirements Specification - *Please, provide information regarding the availability of the requested data types and further descriptions*

Data Type	Can data be used in the project? (Yes/No)	When data will be available to the consortium (indicate project month e.g. M4; M1 is May 2019)?	Data Format and source? (e.g., omx, text file, ASCII, csv, shapefile...)	Data Year (e.g 2019)	Description (e.g. Level of Disaggregation - Temporal/Spatial resolution/scale)	Additional Comments (e.g. links to data sources, data source description)
Network data						
GIS shapefile of TAZ system and georeferences of centroids and connectors					e.g. OD matrix scale: (number of OD pairs, number of Origin centroids, number of Destination centroids, year)	



Data Type	Can data be used in the project? (Yes/No)	When data will be available to the consortium	Data Format and source?	Data Year	Description	Additional Comments
GIS shapefile of study area					GIS shapefile content information (e.g. does contain lane details, directions and lane-to-lane connectivity in nodes, lane coonection information crossings information)	
Open Street Map data					Open street Map data (e.g. does contain lane details, directions and lane-to-lane connectivity in nodes, crossing information)	
Aerial photography and/or CAD for refinements (Google Streetview can be a replacement for this requirement)					Aerial images of the network (potentially Google aerial images can substitute if not available)	
Bike lane network						
Walking network						
Intersection (node) coordinates					Required	
Section: Road category, speed limit						
Number of lanes					Required	
Length of turn bays					Required	
Lane drop locations					Required	
Lane add locations					Required	
Lane connection information					Required	
Lane channelization					Required	
Link free-flow speed					Required	
Link slope/Grade					Optional	Available in google maps
Lane widths					Optional	
Curvature data					Optional	
Truck info in network geometry. See section NETWORK GEOMETRY					e.g. link accessibility for freight vehicles (by vehicle class)	
Location of multimodal transshipment terminals					e.g. transshipment terminals in maritime ports, road-rail terminals, road-barge terminals, etc	
Location of distribution centers					e.g. location of distribution centers for local or regional distribution channels	

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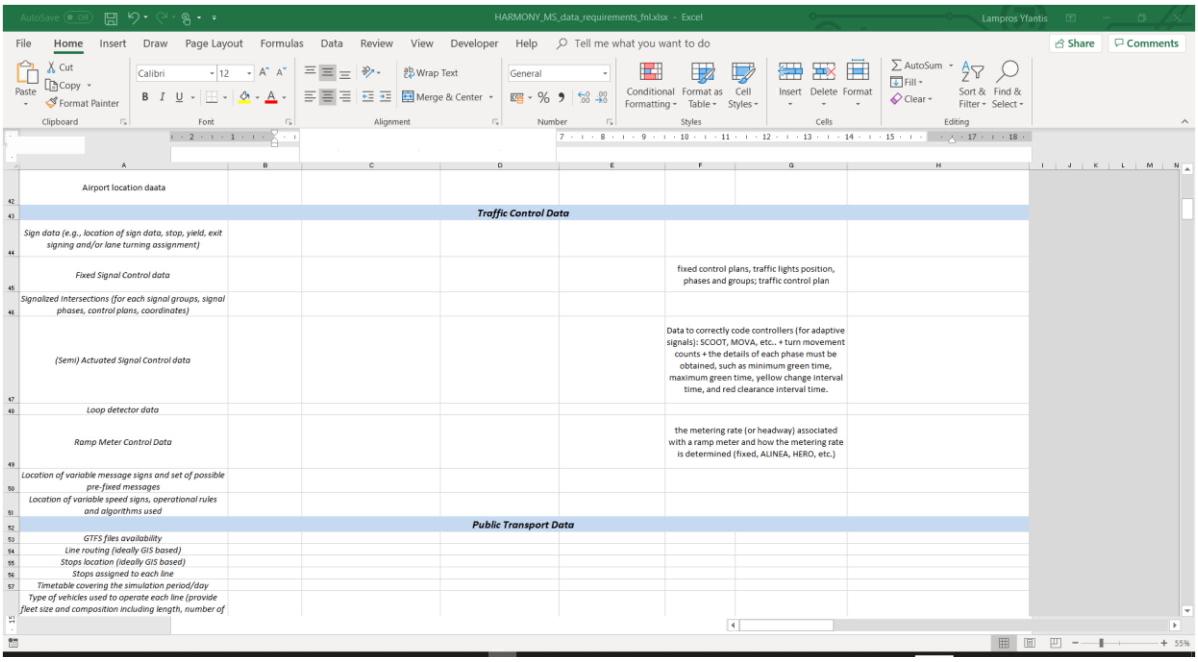
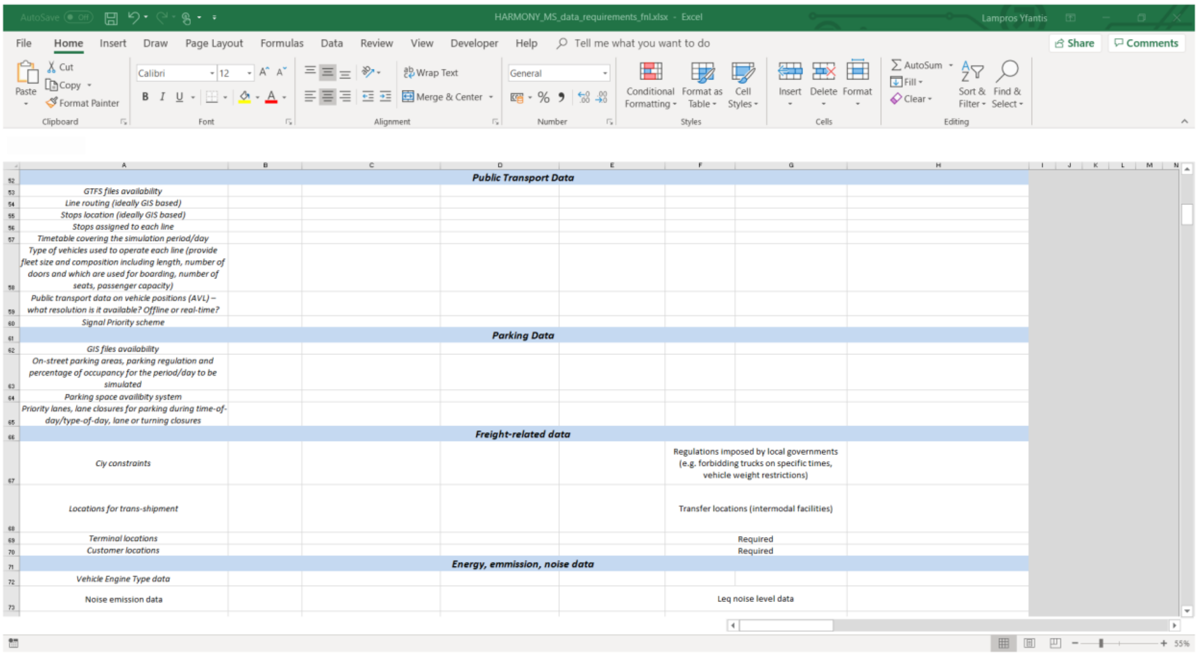


	A	B	C	D	E	F	G	H
42	Airport location daata							
43	**Traffic Control Data**							
44	*Sign data (e.g., location of sign data, stop, yield, exit signing and/or lane turning assignment)*							
45	*Fixed Signal Control data*					fixed control plans, traffic lights position, phases and groups; traffic control plan		
46	*Signalized Intersections (for each signal groups, signal phases, control plans, coordinates)*							
47	*(Semi) Actuated Signal Control data*					Data to correctly code controllers (for adaptive signals): SCOOT, MOVA, etc.. + turn movement counts + the details of each phase must be obtained, such as minimum green time, maximum green time, yellow change interval time, and red clearance interval time.		
48	*Loop detector data*							
49	*Ramp Meter Control Data*					the metering rate (or headway) associated with a ramp meter and how the metering rate is determined (fixed, ALINEA, HERO, etc.)		
50	*Location of variable message signs and set of possible pre-fixed messages*							
51	*Location of variable speed signs, operational rules and algorithms used*							
52	**Public Transport Data**							
53	*GTFS files availability*							
54	*Line routing (ideally GIS based)*							
55	*Stops location (ideally GIS based)*							
56	*Stops assigned to each line*							
57	*Timetable covering the simulation period/day*							
	Type of vehicles used to operate each line (provide fleet size and composition including length, number of							



	A	B	C	D	E	F	G	H
52	**Public Transport Data**							
53	*GTFS files availability*							
54	*Line routing (ideally GIS based)*							
55	*Stops location (ideally GIS based)*							
56	*Stops assigned to each line*							
57	*Timetable covering the simulation period/day*							
58	*Type of vehicles used to operate each line (provide fleet size and composition including length, number of doors and which are used for boarding, number of seats, passenger capacity)*							
59	*Public transport data on vehicle positions (AVL) – what resolution is it available? Offline or real-time?*							
60	*Signal Priority scheme*							
61	**Parking Data**							
62	*GIS files availability*							
63	*On-street parking areas, parking regulation and percentage of occupancy for the period/day to be simulated*							
64	*Parking space availibity system*							
65	*Priority lanes, lane closures for parking during time-of-day/type-of-day, lane or turning closures*							
66	**Freight-related data**							
67	*Ciy constraints*					Regulations imposed by local governments (e.g. forbidding trucks on specific times, vehicle weight restrictions)		
68	*Locations for trans-shipment*					Transfer locations (intermodal facilities)		
69	*Terminal locations*					Required		
70	*Customer locations*					Required		
71	**Energy, emmission, noise data**							
72	*Vehicle Engine Type data*							
73	Noise emission data					Leq noise level data		

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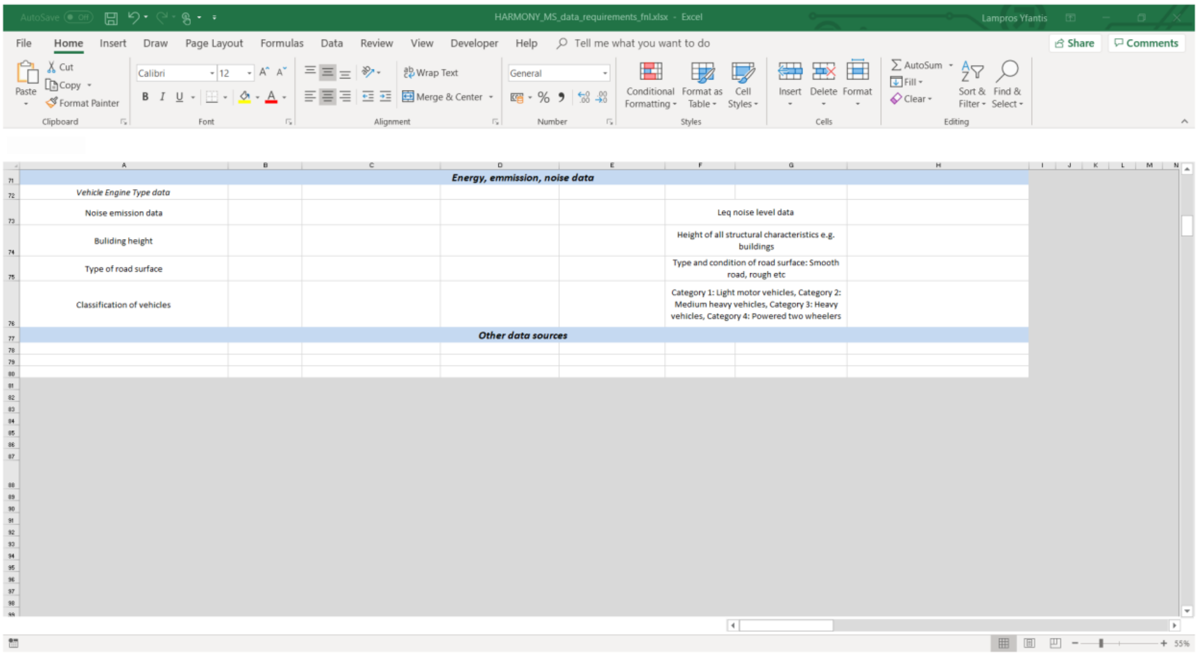
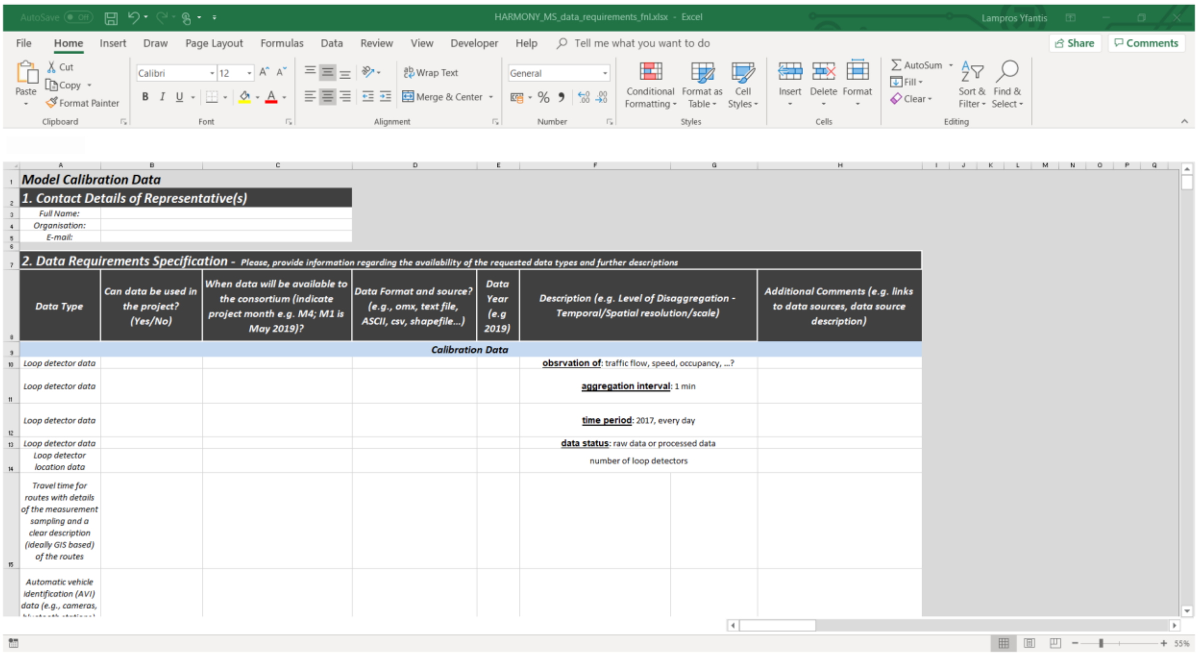


Calibration Data Requirements



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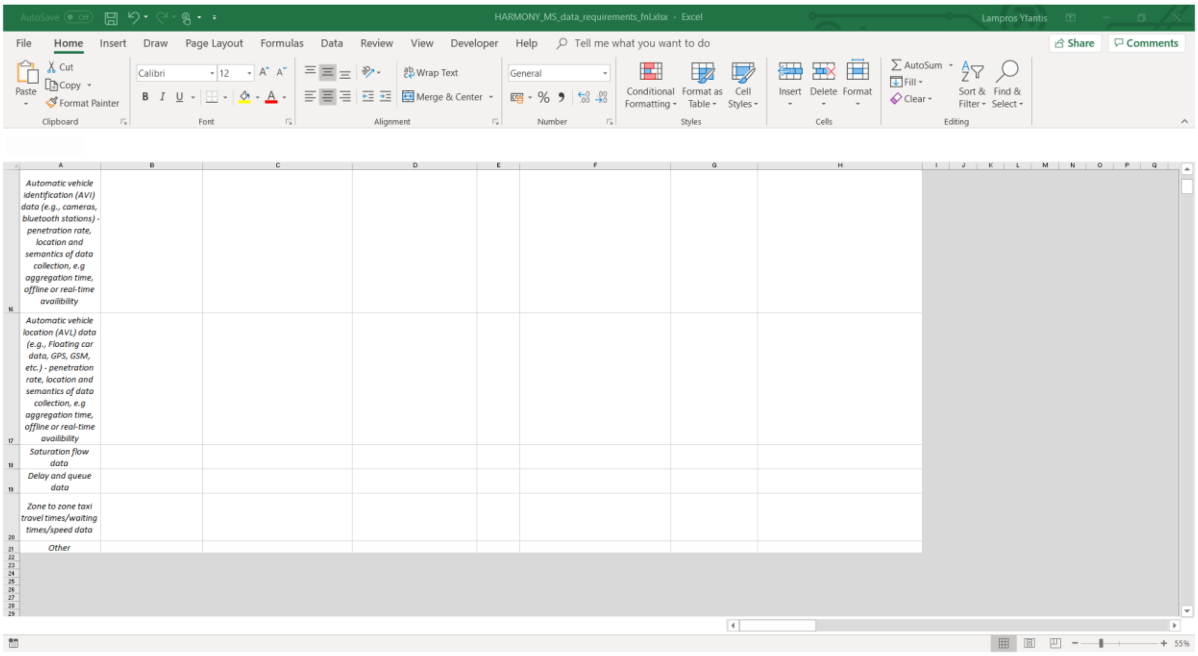
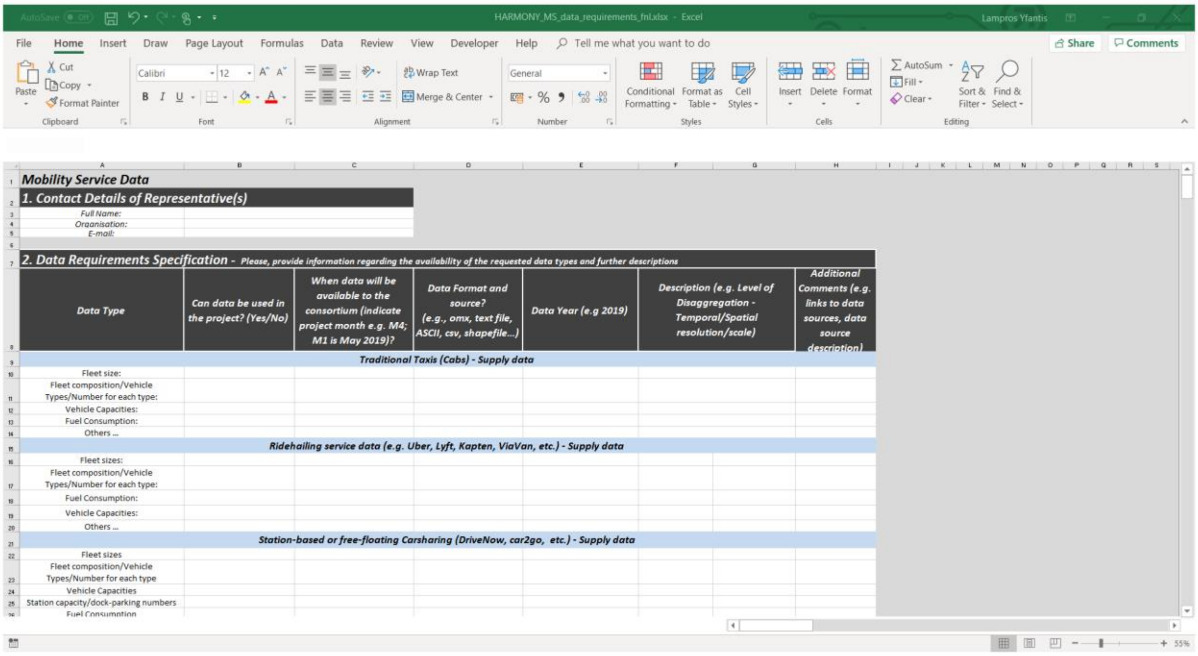


New Mobility Service Data Requirements



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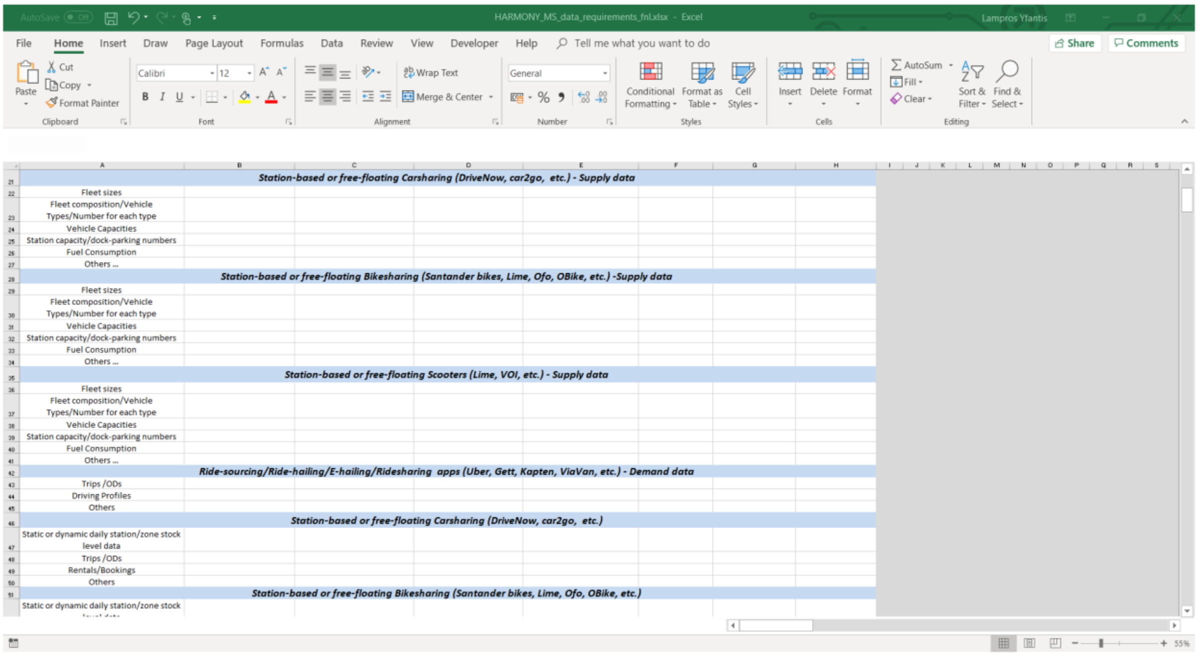

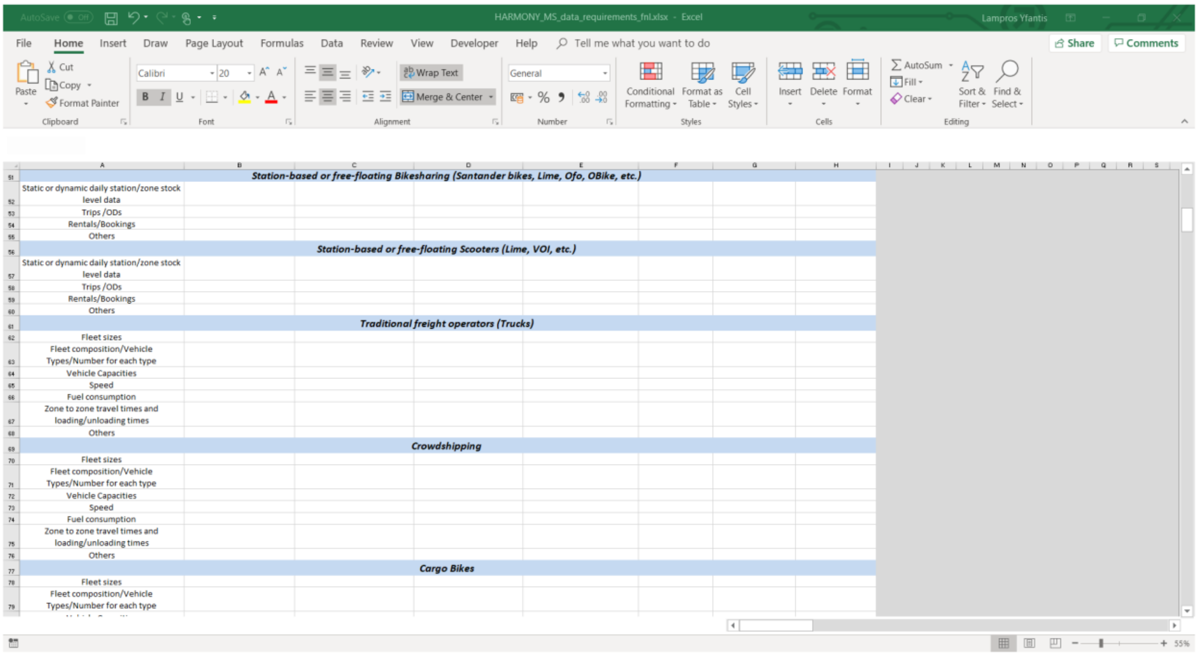

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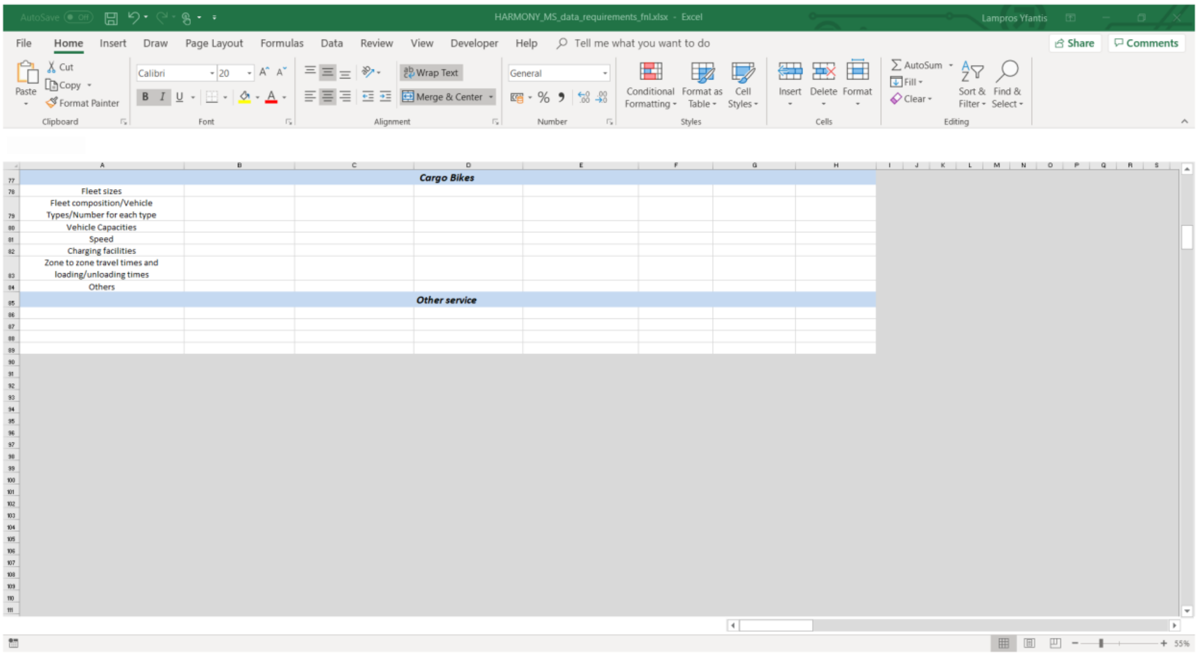

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