URBANITE

Supporting the decision-making in urban transformation with the use of disruptive technologies

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Deliverable D5.2

Detailed requirements specification

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Abstract:	This document will contain the revision of all the functional, non-functional, and technical requirements of the URBANITE ecosystem and the alignment with the requirements defined by the use cases. This deliverable is a result of task 5.1.
Keyword List:	Functional requirements, Non-Functional Requirements, Technology, requirements alignment.
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Document Description

Document Revision History

Version	Date	Modifications Introduced	
		Modification Reason	Modified by
v0.1	30/09/2021	First draft version with TOC	Tecnalia
V0.2	05/10/2021	Version with content from D5.1 to be upgraded	Tecnalia
V0.3	08/11/2021	Reorganized for Including discussions form the GA	Tecnalia and all
V0.4	15/11/2021	Technical requirements revision and the matrix to align them with the use cases requirements	Tecnalia, ENG
V0.5	18/11/2021	Revision of the matrix	Tecnalia and all
V1.0	23/11/2021	Complete version of the document sent to review	Tecnalia
Final	30/11/2021	Final version of the deliverable	Tecnalia

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Terms and abbreviations

AF	Analytical Framework
AM	Amsterdam
AV	Advanced Visualization
API	Application Programming Interface
BI	Bilbao
DC	Data Curation, Preparation, Transformation and Anonymization
DCA	Data Catalogue
DCL	Data Clustering
DF	Data Fusion/Aggregation
DH	Data Harvesting
DMP	Data Management Platform or Processes?
DoA	Description of Action
DP	Data Projection
DR	Data Retrieval
DS	Data Storage
FR	Functional Requirement
GUI	Graphical user Interface
HE	Helsinki
KR	Key Result
M	Month
ME	Messina
NFR	Non-Functional Requirement
PA	Public Administrations
PRED	Prediction
PSV	Policy Simulation and Validation
RE	Recommendation Engine
REG	Regression
SOM	Self Organizing Map
TS	Traffic Simulation
UC	Use Case
UUI	URBANITE User Interface or URBANITE UI
VSPL	Virtual SoPoLab
WIP	Work In Progress
WP	Work Package

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Executive Summary

This deliverable aims to reflect the evolution of the requirements envisioned at the beginning of the project and included in its previous version, D5.1 Detailed requirements specification [1]. The functional requirements have been analysed to upgrade them and describe the current status of the planned implementation in the different technical components.

The main objective of the work performed within the context of this revision is to provide the final version of the functional and non-functional requirements of the URBANITE Ecosystem and its components, as well as the upgrade of the prioritisation made.

URBANITE Ecosystem (KR5) has been already developed as a first prototype in Month 15, including the components as they were implemented at that time. The experience of integrating those components and the validations that the use cases are defining in WP6 support the upgrading of the requirements into a more stable and detailed version of them. However, considering the evolution of the use cases when implementing the scenarios, i.e., the implementation to be described in D6.2 [2]; these requirements can undergo some modifications to make them more detailed and more aligned with the requirements of the respective scenarios.

The different revisions of the requirements, both technical and "use case"-driven, are explained and described in the dedicated sections along the deliverable and specifically in a matrix for the purpose of aligning the two types of requirements' definitions. For the Non-Functional Requirements, the requirements have been combined per component considering the current structure of the architecture.

All these requirements will serve the continuous development and improvement of the URBANITE ecosystem through the different releases and validation processes.

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1 Introduction

1.1 About this deliverable

This document presents the evolution of the requirements from the first version described in the D5.1 deliverable [1]. The current development status of the components has been the main criteria to describe the evolution of already implemented ones. Furthermore, the plans for not yet implemented components are described.

The process followed for updating components' status has been described in the previous version of the deliverable 5.1 which specially addresses the last phases across the evaluation activities in case new requirements or improved requirements may arise. These new requirements have been added to the list of the technical requirements after being carefully analysed by the partners.

This document presents a matrix aligning the technical requirements and the requirements defined by the use cases. This alignment is considered as a very useful exercise in order to analyse the scope and the implementation of the different scenarios that are being defined by WP6 in parallel.

The benchmarking of the previously identified tools has been revised and modified to enable their integration into the URBANITE Ecosystem, considering the requirements or functionalities that they cover.

1.2 Document structure

The document is structured as follows. Section 2 presents the basic processes or steps that will be taken by a generic user when using the URBANITE Platform. A generic workflow has been provided to describe the different steps required for the implementation of each functionality for a specific use case.

In section 3, the current version of the URBANITE ecosystem requirements is presented, including the new requirements arisen from the analysis made in the matrix section as well. The non-functional and the use cases requirements have been revised and included in the same section.

Section 4 analyses the tools identified in the previous version of this deliverable and presents the revision made by the technical partners, including the current status of the component and the integration of technological tools.

Section 5 describes the alignment of the technical requirements and the requirements defined by the use cases. This alignment is presented in a matrix including further comments and considerations for implementing different functionalities.

The document concludes with a description of the next activities to be performed in the context of WP5.

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2 URBANITE Basic processes

This section includes the basic process that a general user of the URBANITE ecosystem may experience when entering the platform. This process describes the steps and actions to be followed from the point of view of the platform user and the option that he/she can see in the Urbanite User Interface. The flow of actions is not necessarily lineal and there are actions, e.g., regarding data management that need to be performed in advance.

The processes described in the first version of this deliverable have been analysed and implemented to cover the use cases requirements and will be evaluated as part of the WP6 work.

The steps described above have been considered as common for all the use cases, although they could be adjusted to fit into the casuistry of each use case scenario.

1. A user enters URBANITE platform to simulate and estimate the effects that some specific action (e. g. suppression of private vehicles through some point of the network traffic) would have in terms of the impact on the traffic.

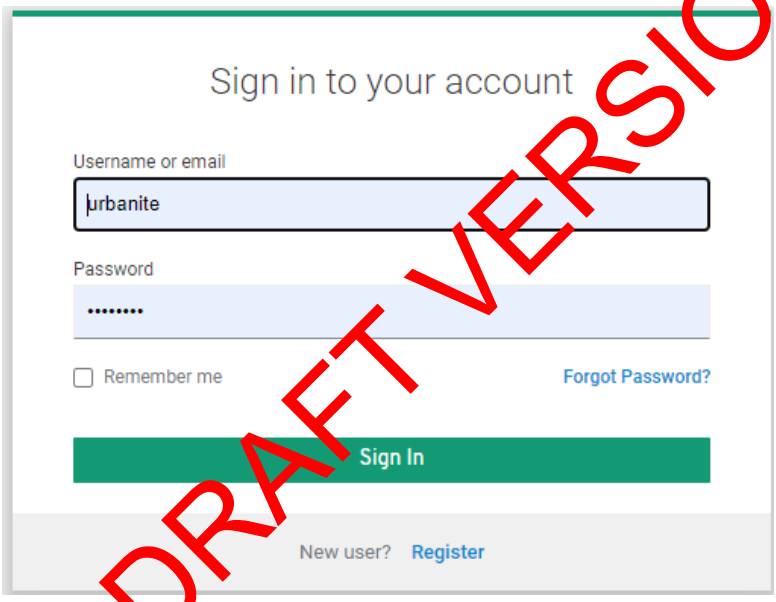

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Figure 1. URBANITE login

2. Once the users have accessed the Urbanite User Interface (UUI), they will select the relevant options related to some analysis in order to see and analyse the status of the traffic in their respective scenarios. These options are important for analysis since the information they provide defines the types of simulations to be run.
3. The current version of the platform includes the components developed at this point, and the analysis options which are integrated into the UUI as follows:
    a. Data Analysis section, presenting two modules related to traffic prediction and bike analysis.

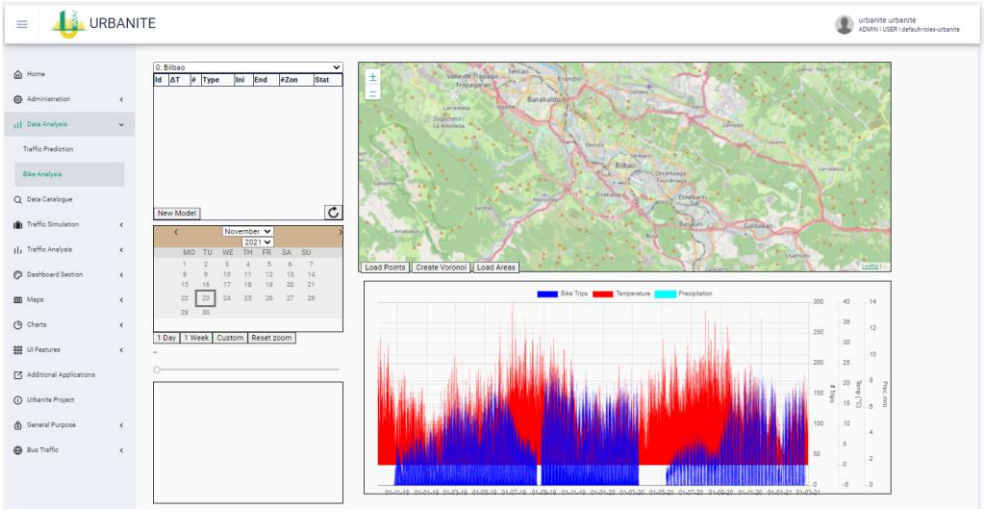

Figure 2. URBANITE User Interface: Data Analysis section

These modules currently are available for the cities of Bilbao and Helsinki.

b. Traffic Analysis based of acquired data from the city of Messina:

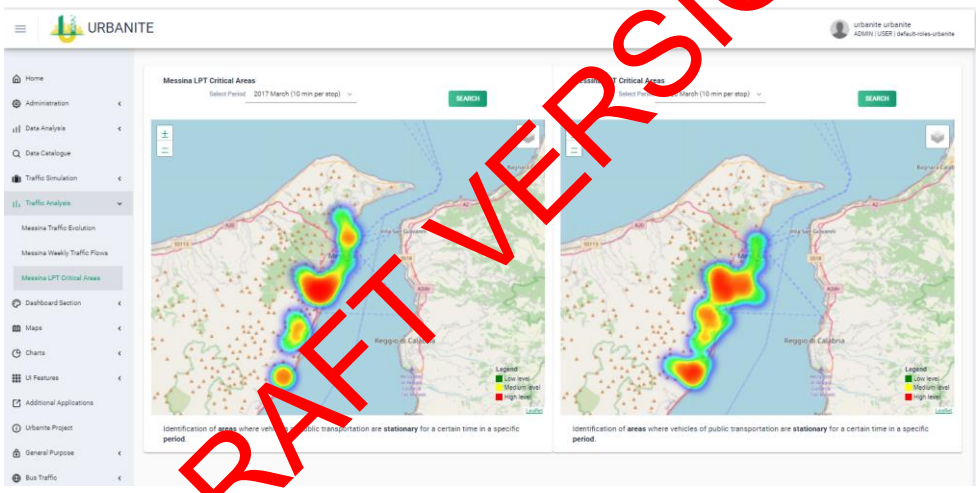

Figure 3. URBANITE User Interface: Traffic Analysis section

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4. Once the users observe the traffic behaviour with the help of the above-mentioned analysis, they can start considering the relevant simulation policies to be tested. This action will take place using the simulation option, which will allow to configure some parameters (period, action, …) and choose the desired KPIs and see what happens when modifying some traffic attributes. These KPIs are defined by every use case and depend on the simulation scenario.

   From here, it is important to establish the "storyboard" that the simulation component or module allows to navigate through. The storyboard includes the different "pages" that the user can see and the different options available on each page. A set of pre-packaged simulations are being defined within the context of the WP6 and WP4 analysing the requirements of the use cases and the scenarios they plan to evaluate. The layout of these options is not integrated yet, so in the Figure below, a general box is representative of the purpose of each step within the flow of the simulation process.

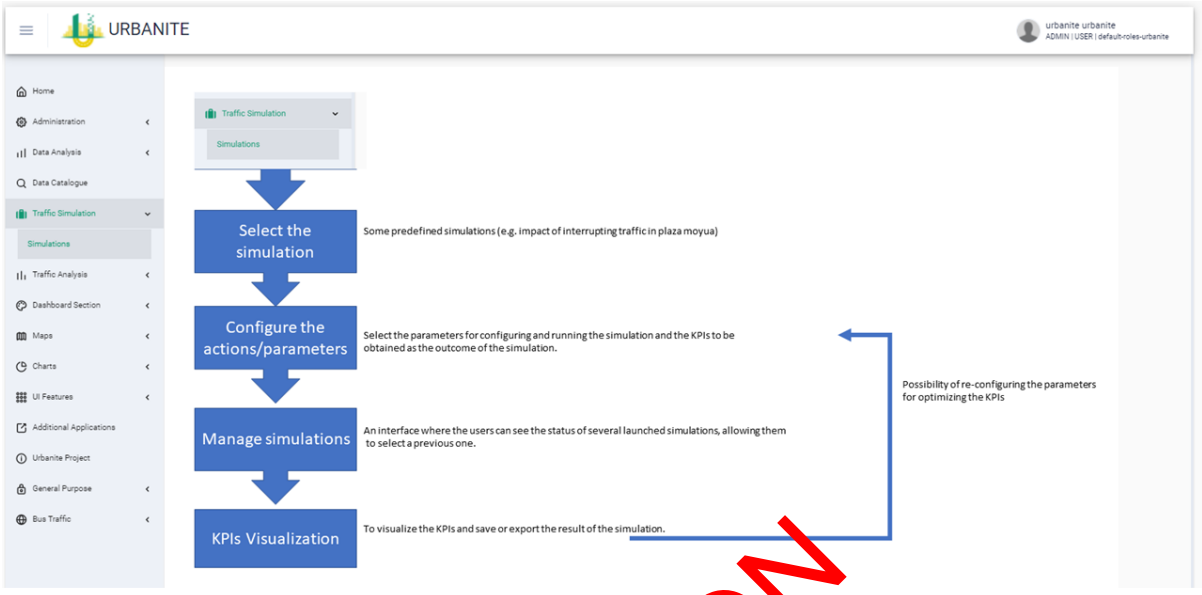

Figure 4. URBANITE User Interface: Simulation section (mock-up)

At this point, and with the KPIs as the outcome of the performed simulations, the policy makers can establish the rules they consider improving the traffic status in the selected areas.

In order to perform all these analyses and simulations, the appropriate type and amount of data are needed. As pre-requirements, the administrators of each city environment must have prepared and launched the corresponding script using the Piveau scheduler user interface:

Figure 5. Piveau User Interface

The data is harvested, prepared, transformed to be compliant with the data model accepted in the platform. At the ned of this pipeline of processes, the data is stored using the APIs provided by the storage and retrieval component.

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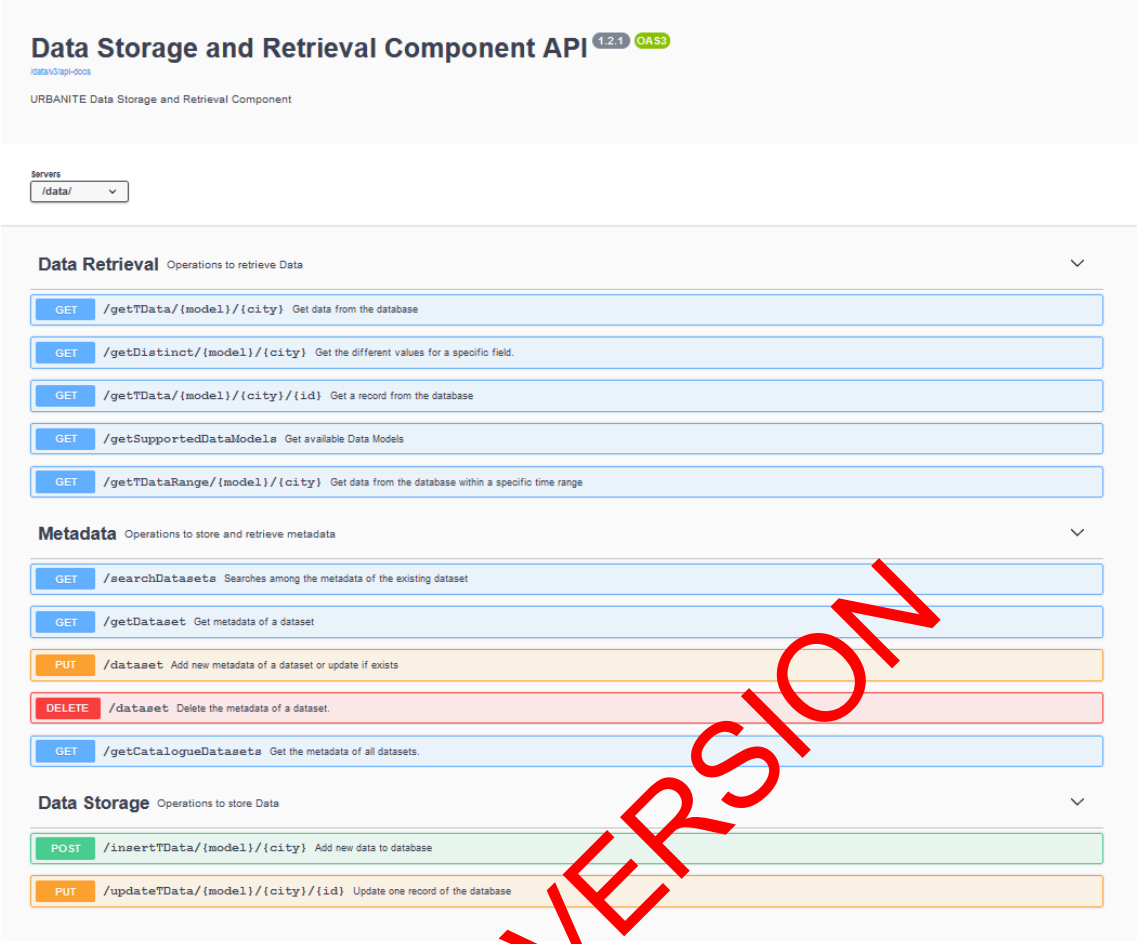

Figure 6. Data Storage and Retrieval available APIs

And finally, the data is accessible from the URBANITE User Interface through the Data Catalogue.

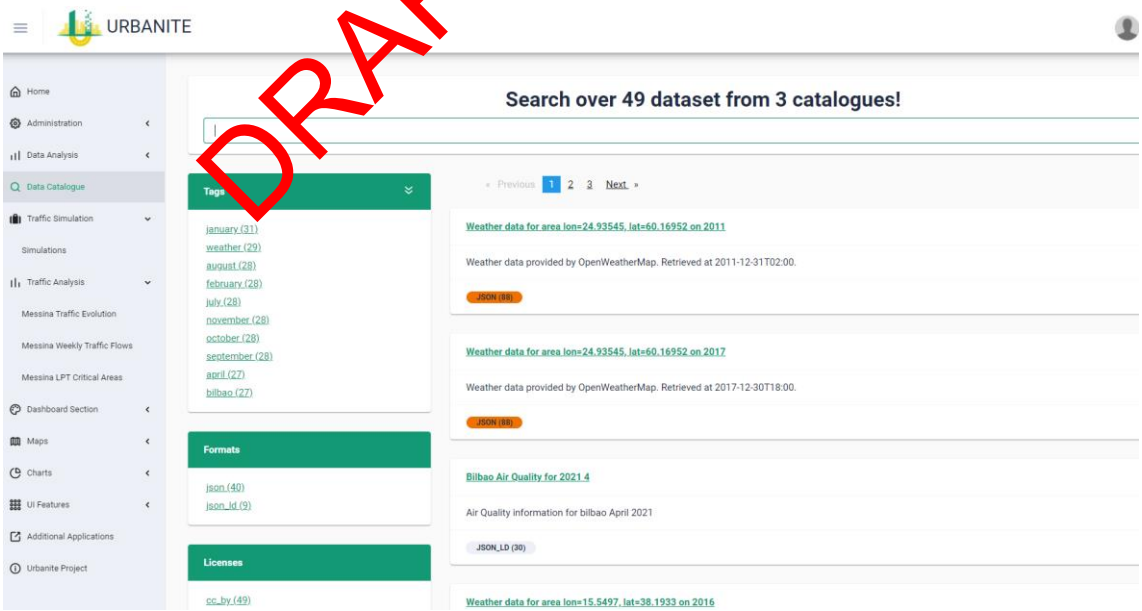

Figure 7. URBANITE User Interface: Data Catalogue

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The data Catalogue component allows sharing data managed by the urbanite Platform and is accessible for all the users in the municipality.

As the Figure 7 suggests, the UUI provides more options. Those options are for giving the users a more friendly experience, customising the layout of the UI, and exporting the results obtained from different simulations and analyses.

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3 URBANITE ecosystem requirements

3.1 Functional requirements

The following sections collect the revision of the first set of functional requirements of the different modules of the URBANITE ecosystem. The objective of this revision is to establish the final version of the requirements that are being transformed into functionalities provided by the different components.

As the overall schema has been updated based on the experience of the deployment of the first prototype of the URBANITE Ecosystem, the layout of the components must be aligned under the same criteria to conform with the architecture.

Considering the fact that the evaluations made by the use cases as well as the evolution of the technical components are subject to change, some of the requirements may change respectively. However, the core is described in this document and the modifications, if any, will be minor. The final situation will be included in the future deliverables, mainly in the D5.5 URBANITE Detailed architecture, due to March 2020.

Considering the current status of the architecture, depicted in the Figure 8, the description of the functional requirements is organised in groups following the structure of the architecture.

The architecture is not final and reflects the evolution of the different components and the functionalities to be provided to the users, in order to support the implementation of the use cases scenarios.

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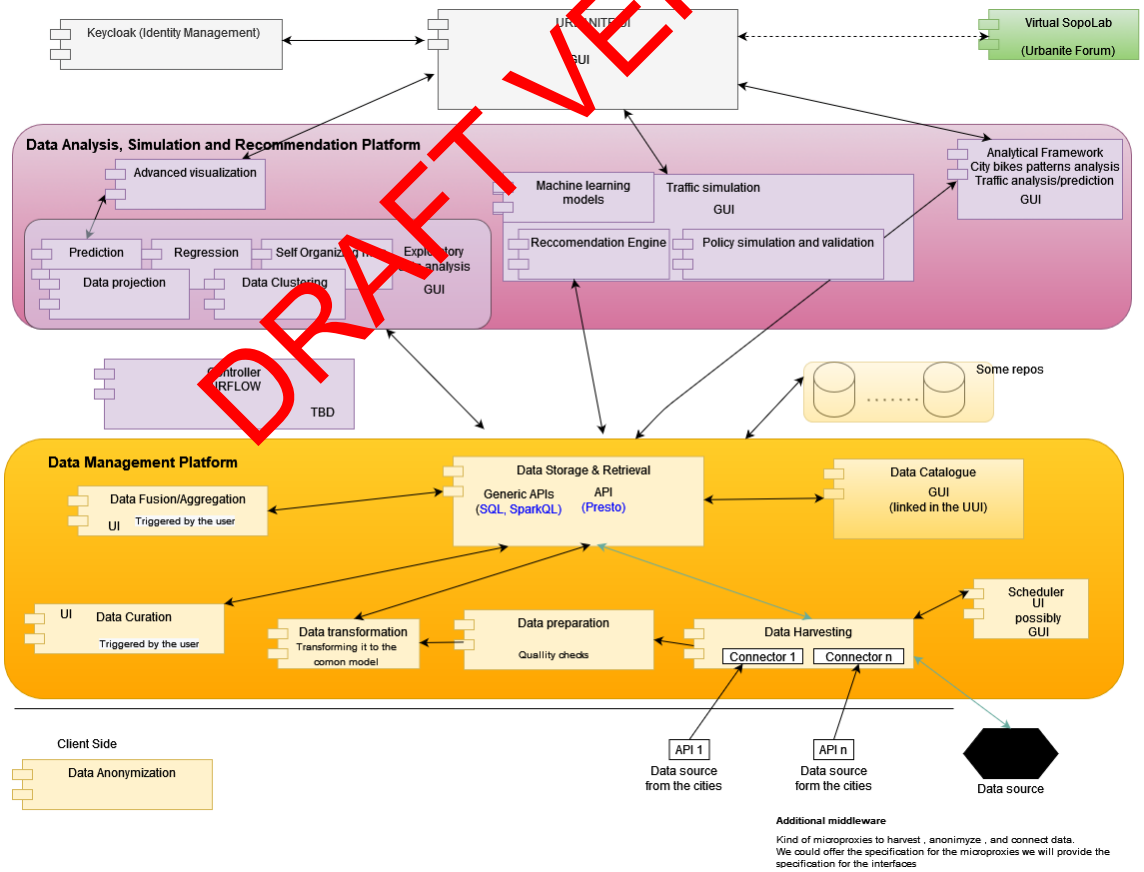

Figure 8. URBANITE Architecture status at M20

The list of components for which the requirements have been defined is as follows:

- Virtual SoPoLab (VSPL)
- Data Management Layer
    a. Data Harvesting (DH)
    b. Data Curation, Preparation, Transformation and Anonymization (DC)
    c. Data Fusion/Aggregation (DF)
    d. Data Storage (DS)
    e. Data Retrieval (DR)
    f. Data Catalogue (DCA)
- Data Analysis, Simulation and Recommendation Layer
    a. Advanced Visualization (AV)
    b. Exploratory Data Analysis (Prediction (PRED), Regression (REG), Self-Organizing Map (SOM), Data projection (DP) and Data Clustering (DCL))
    c. Traffic simulation (Recommendation Engine (RE), Policy Simulation and Validation (PSV) And traffic Simulations (TS))
- Urbanite UI (UUI)

The requirements with column Priority with values equal to M27 or M33, the M20 situation could be empty due to the implementation is not finished yet.

3.1.1 Virtual SoPoLab

The requirements planned for the Virtual Sopolab have been successfully covered at this point of the project and are already provided by the version of the application in use.

Virtual Sopolab (VSPL) is a tool that supports the work of the Sopolab sessions within the context of WP2. The functionality has been called URBANITE Forum, which is considered an extra functionality in URBANITE Ecosystem, but not as a part of it.

URBANITE Forum (formerly called VSPL) is the online tool, based on DECIDIM [3], that will serve as a complement and support to the SoPoLab sessions carried out during the project, allowing collaborative and asynchronous work in an online environment.

Table 1. Virtual SoPoLab requirements

Req ID	Req. Description	M20 situation	Priority
VSPL.01	VSPL should allow collaboration among its users, enabling co-creation approach. In the case of URBANITE, the co-creation sessions will be oriented to address and analyse the issues/barriers/ lack of trust of the usage of disruptive technologies in the public sector.	Completed.	M15
VSPL.02	The users of the VSPL should be able to report needs in the context of the analysis of the attitudes, trust, and barriers in the use of disruptive technologies	Completed. URBANITE Forum has different components and offers different functionalities which can facilitate smooth interaction between the SoPoLab participants and in general, all the Forum users.	M15

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		These components are: ”Blogs”, “Debates”, “Proposals”, etc.	
VSPL.03	The VSPL must allow to create challenges to solve the needs expressed related to the usage of disruptive technologies in the Public Sector.	Completed. Both "Blog" and "Debates" components are suitable for this action, depending on how the communication with the participant is meant to be oriented.	M15
VSPL.04	The users of the VSPL should be able to report ideas (possible solutions) to address the lack of trust, usage reticence, problems, needs of the usage of disruptive technologies in the Urban Mobility context.	Completed. The "Proposals" component is the most suitable for this action.	M15
VSPL.05	The VSPL must allow to evaluate those proposed ideas to address the problems /needs related to the usage of disruptive technologies by the Public Administrations (Pas) for urban mobility.	Completed. The "Proposals" component is the most suitable for this action.	M15
VSPL.06	The VSPL must allow selecting the best ideas to be refined and implemented in the context of the usage of disruptive technologies by the PAs for urban mobility.	Completed. The "Proposals" component is the most suitable for this action.	M15
VSPL.07	The VSPL must allow to suggest refinements for selected ideas.	Completed. The "Proposals" component is the most suitable for this action.	M15
VSPL.08	The VSPL must allow to select ideas to be implemented in the context of the usage of disruptive technologies by the PAs for urban mobility.	Completed. The "Proposals" component is the most suitable for this action.	M15
VSPL.09	The VSPL must allow to host different kinds of resources created by the project, i.e. guidelines, methodologies, best practices.	Completed. There is a placeholder where documents (files) can be shared with participants. The "Blog" and "Debates" components can be used, depending on how the communication with the participants is designed.	M15
VSPL.10	The VSPL must allow the exchange of information between different participants of different nodes and cities.	Completed. The URBANITE FORUM is based on the concept of assemblies. Both at the general level (general assembly), which allows interaction between all participants, and at the city level (one assembly for each	M15

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		city: Amsterdam, Bilbao, Helsinki, and Messina) allowing the discussion around specific topics tailored for each use case.	

3.1.2 Data Management Layer

The architecture diagram related to data management is a functional representation where the blocks represent the functionalities that need to be offered by Data Management Platform (DMP). These functionalities can be used at different stages of the data management process and do not necessarily need to be implemented as independent software components.

3.1.2.1 Data Harvesting

The requirements outlined in this section refer to the "Data Harvesting" functionality in the architecture diagram. This functionality refers to the process of downloading (meta-)data for further processing, albeit without making substantial changes to the data itself. Additionally, the (meta-)data needs to be downloaded in regular intervals to account for changes thereof. Managing these intervals is the responsibility of the Scheduler.

The Priority for these requirements is directly related to the data sources considered at the moment of the project and the release of the current revision. So, the requirement is covered at best possible level needed for now.

Table 2. Data Harvesting requirements

Req ID	Req. Description	M20 situation	Priority
DH01	The harvesting component will retrieve data from various sources (municipal services, open data portals, GIS, city private service providers) with varying formats (e.g. JSON, XML) from different data sources (e.g. open/private data portals, GIS system), raw data from APIs or data coming from sensors.	Covered. The considered data sources at M20 are connected. As more data sources are considered, they will be connected to the system.	Incremental starting on M15.
DH02	Data Harvester should allow pagination of large amounts of data. This means that in case some data source APIs cannot provide data in bulk, the harvesting component should be able to fetch only chunks of limited size until all data has been harvested.	Covered. The architecture of the importer allows for paginated fetching when applicable.	Incremental starting on M15.
DH03	Data Harvester should be extensible with new connectors if new, unsupported data sources are discovered.	Covered.	Incremental
DH04	Data harvester must support at least HTTP(S) and MQTT protocol to fetch the data.	Covered. Although for the moment, all harvesters use HTTP(S).	M27

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DH05	For client/server APIs, the harvester will download data from the configured APIs at recurring intervals of varying length (e.g. daily, weekly). The schedule will depend on the volatility of data. For example, weather data will change more frequently than map data highlighting current road construction work.	Covered by the scheduling component.	Incremental starting on M15.

3.1.2.2 Data Curation, Preparation, Transformation and Anonymization

As described in deliverable D3.5 [4] a distinction is made among the terms "anonymisation", "preparation", "transformation" and "curation". Anonymisation aims to address privacy protection by removing personally identifiable information from data sets, so that the people whom the data describe remain anonymous (this is compliant with GDPR regulations). Preparation refers to the process of ensuring a certain level of (meta-)data quality. This includes detecting and removing false/implausible data, for example. Validating against a given specific schema could be one way of achieving this. Transformation is the conversion from one format into another without altering the (meta-)data's semantics. Data curation is considered the maintenance and enrichment of data after the previous steps have been completed. Additionally, the steps mentioned above do not necessarily translate to dedicated components. For example, data quality checks may be performed right after harvesting or be part of the transformation process.

The anonymisation process is suggested to be carried out at the data source, i.e. on the client side. This way, all data harvested and managed by URBANITE Data Management Platform will be already anonymised. Within the context of the evolution of the Ecosystem, URBANITE will provide an external tool to support this functionality whenever needed at the client side. More details will be included in future deliverables, probably in the D5.5 [5].

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Table 3. Data Curation, Preparation, Transformation and Anonymisation requirements

Req ID	Req. Description	M20 situation	
DC01	The harvested data may not be in a format and/or structure suitable for data storage. In this case, the data will need to be transformed in an automated way.	Covered.	M15
DC02	Data curation functionality should be able to clean the data coming from the harvester eliminating duplicates or error.	Covered.	Incremental starting on M15.
DC03	Data Transformation functionality should add an annotation in the form of metadata to data to help the analysis. This metadata will be included in the data itself.	Covered.	Incremental starting on M15.
DC04	This functionality shall anonymise or pseudonymise data if the need arises. Data anonymization could be done at the source or before storing it, depending on the use case. In any case, URBANITE platform can provide the anonymization functionality	WIP	M27

	for users (UCs) to use it before the data is uploaded/used by the URBANITE platform		
DC05	Data validation and quality check. The data curation functionality must be able to validate the data provided by the data harvesting module and its quality based on a defined format if encountered data sources happen to contain sensitive information.	WIP Data is validated and some quality checks are already implemented but not all	M27
DC06	Functionalities should be provided to transform cleaned and annotated data to common semantics and data models to guarantee interoperability. It is important to note that there will not be one single common format that all data will be transformed into. Instead, established formats within the various domains will be targeted for transformation.	Covered.	Incremental starting on M15.
New DC07	The data preparation functionality must check the data licenses and provide understandable information to the owners and the user of the data. For combined data sets with different licenses, it detects possible compatibility issues and informs users how to use and share the data.	WIP	M27
New DC08	The data curation functionality (in case of being an algorithm or process) must: • provide an API REST for launching the process and passing the parameters • or allow an MQTT endpoint to be aware of data publication and the launch of the process	Covered in M18. Delayed because in M15 there was no such data connected yet. Under revision.	M15
New DC09	The data cleaning functionality must be capable of detecting and removing invalid or missing readings. The result should then be fit in terms of quality and type, for further processing.	Covered.	Incremental starting on M15.
New DC10	Some components in the architecture diagram are labelled as “triggered by user”, namely Data Curation and fusion/aggregation. For this to be possible, they must feature a UI that allows for configuration and triggering of the respective functionalities.	WIP	M27

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3.1.2.3 Data Fusion/Aggregation Component

The fusion and aggregation functionalities are under discussion at the time this deliverable is being written. The more detailed requirements from the use cases and the evolution of the different analyses and simulations provided, following the work-flows of the scenarios defined and validated by the cities will be the input for refining the detailed description of these requirements; either keeping them as they were initially planned or upgrading them to be coherent with the mentioned work-flows.

Table 4. Data Fusion/Aggregation requirements

Req ID	Req. Description	M20 situation	
DF01	The component should allow to aggregate curated data coming from different data sources if needed.	WIP Covered for traffic flow data and bike data.	M33
DF02	The component should allow the deduplication of the data.	WIP. Partially Covered for v1 data models	M27
DF03	The data should be mapped into EU vocabularies	Partially covered. Static values (e.g. data themes) are making use of EU vocabularies, but there is currently no capability to map dynamic values. Fulfilled for v1 data models	M15
DF04	The metadata should be mapped into DCAT-AP metadata. DF03 is required for this one.		Incremental
New DF05	Weather data coming from different data sources and weather services will be fused to create improved datasets covering more variables		M27
New DF06	The component should allow temporal aggregation of traffic data at given intervals, e.g. every 15 min.		M27
New DF07	The component should allow calculating maximum, minimum, average, and standard deviation values of datasets in a given interval, e.g. daily, monthly, etc.		M33

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3.1.2.4 Data Storage & Retrieval Component

Most of the requirements have been covered since the level of coverage is related to the data ingested from the data sources that have been considered to be part of the Ecosystem.

The Prioritization is incremental because in each release, the requirement will be implemented according to the data sources connected at that point of the project.

Table 5. Data Storage & retrieval requirements

Req ID	Req. Description	M20 situation	
DS01	The harvested data should be persistent with a big-data-storage solution capability.	Covered for data models that apply to the currently connected data sources.	Incremental starting on M15.
DS02	The data storage component should be able to process and store DCAT-AP compliant metadata.	Covered.	Incremental starting on M15.
DR01	The data retrieval component must expose API to retrieve and query the data stored in the different repositories	Covered for the following data types: TrafficFlowObserved, WeatherObserved, AirQualityObserved, Calendar, Event and daySpecification	Incremental starting on M15.
DR02	The metadata stored in the repositories should be accessible through a data hub in a uniform way taking advantage of the DCAT-AP standard and related profile.	Covered	Incremental starting on M15.

3.1.2.5 Data Catalogue

Data Catalogue requirements were not considered in the previous deliverable, but this component is part of the architecture. In this first prototype, the component contributes to providing functionalities to the user, so its requirements have been considered and included in a separate section.

Due to the fact that the data catalogue is based on the IDRA external tool developed by ENG, it can offer to the URBANITE users some additional functionalities. Although we do not consider the federation to external catalogues as a requirement in URBANITE, it has been offered as an additional functionality by deploying IDRA anyway.

Table 6. Data Catalogue requirements

Req ID	Req. Description	M20 situation	Priority
DCA01	The data catalogue should be able to retrieve existing metadata from existing heterogenous Open Data Portals.	Covered.	Incremental starting on M15.
DCA02	Data Harvester should be extensible with new connectors if new unsupported data sources are discovered.	Covered.	Incremental starting on M15.
DCA03	The Data Catalogue has a built-in scheduler that is able to synchronise the federated catalogues (collecting metadata) at recurring intervals.	Covered.	Incremental starting on M15.
DCA04	The data catalogue, being one of the main interfaces to the users, must feature a UI that covers all relevant functionalities of the data catalogue.	Covered.	Incremental starting on M15.

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New DC05	Data Catalogue will provide a wizard to create charts.	Covered depending on the format of the data. Not integrated into the UUI yet	M27
New DC06	The Data Catalogue should allow downloading of transformed data stored in the URBANITE repositories.		M27

3.1.3 Data Analysis, Simulation and Recommendation layer

Within the layer of simulation, there are several groups of functionalities considered as logical components. The following sub-sections describe them in more detail.

3.1.3.1 Advanced Visualization component

The Advanced Visualization component will provide visualisation for mobility patterns, highlighting important events and results of policies.

The AV01 has been rephrased for reflecting the correct meaning i.e., the data in the URBANITE Ecosystem should be used to make the analysis and simulations needed for the policy-makers in all the use cases.

The AV02 has been improved with a list of examples of "kinds of visualizations" that emerged from the revision of the use cases requirements reflected in section 5 of this document.

The harvested data should be visualised as part of the different analyses and simulations, but not all the data is intended to be visualised as a whole.

Table 7. Advanced Visualization requirements

Req ID	Req. Description	M20 situation	
AV01	The harvested data must be available to be visualised through analysis and simulations provided by the URBANITE Ecosystem	Covered and must be provided for all the analysis and simulations developed within the WP4.	Incremental
AV02	The component must allow to visualize the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of visualization to help with understanding data e. g.: • a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers • allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access to the results of the analysis	Partially covered. Full coverage planned for the second release of URBANITE components through the integration with other data analysis components and the Traffic Simulation component.	M27

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AV03	The component must allow users to interact with the visualized data by, for instance, zooming, highlighting, and displaying additional information.	Partially covered. Implemented visualizations are interactive and allow zooming and displaying additional information.	M27

3.1.3.2 Exploratory Data Analysis component

The component covers the requirements regarding the Data Projection (DP), Data Clustering (DCL), Self Organizing Map (SOM), Regression (REG) and Prediction (PRED) functionalities.

These requirements have been replanned for M27 and they are in progress, so the technical partners are currently developing them.

Table 8. Exploratory Data Analysis requirements

Req ID	Req. Description	M20 situation	
DP01	Data projection component will provide dimensionality reduction methods for a better understanding and interpretation of the data.	WIP	M15 re-planned for M27
DCL01	Data Clustering component will provide methods that will identify groups of similar objects in the data (based on user-defined attributes) and interactively present them to the user.	WIP	M15 re-planned for M27
SOM01	The Self-Organizing Maps will provide the user with a visual topological representation of the data, able to highlight potential clusters.	WIP	M15 re-planned for M27
REG01	The regression component will enable the user to investigate the relationship between different variables, and to actively search for causal relations in the data.		M27
PRED.01	The prediction component will provide an engine to produce prediction for a traffic/mobility variable defined as a time series considering a series of time defined features.		M27

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3.1.3.3 Traffic Simulation

The Traffic Simulation component provides a GUI and is composed of three main functionalities or subcomponents as Policy Simulation and Validation (PSV), Recommendation Engine (RE) and Traffic Simulation (TS). The requirements associated are in the table below.

Table 9. Traffic Simulation requirements

Req ID	Req. Description	M20 situation	
TS01	Traffic Simulation component will provide urban traffic simulation based on the collected data, describing the traffic flow locally, for specific parts of interest in the city and combining it in a hierarchical manner.	WIP	M27
TS02	Traffic Simulation component will provide the ability to simulate hypothetical situations and the effects of different measures.	Partially covered. Full coverage planned for second release of the URBANITE components, by providing partially automated generation of simulations of hypothetical situations.	Incremental starting on M15
PSV01	The component should support policy-makers for identifying possible policies that tackle events based on specific criteria.		M27
PSV02	The component should predict and classify traffic flow changes according to the changes in the policies.		M27
PSV03	Users must be able to select the defined KPIs to evaluate policies.		M27
PSV04	The component must assign a score to each policy to help the decision-making process.		M27
PSV05	Policy-makers will be able to make an informed decision about which policies should be deployed in the city.		M27
RE01	The Recommendation Engine will provide suggestions to tackle the potential problems in the city traffic. This component will also provide support for identifying possible policies that tackle events based on specific criteria.		M27
RE02	The recommendation engine must identify and predict events related to mobility (samples could be congestion situations, high-emission scenarios, unbalanced modal share, etc.) based on the analysis of existing models and/or simulated data. Such analysis will be supported by the previously mentioned component as those related to regression, clustering, simulation, or additional ones.		M27

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RE03	The recommendation engine should provide support and suggestions to the policy-makers for identifying possible policies that tackle identified problems and undesired events related to mobility based on specific criteria. Effective hierarchical multi-criteria decision models based on aggregated data and a rule-based approach will be adopted.		M27

3.1.3.4 Analytical Framework

Some analyses performed with the data stored in the system are provided as part of this component. These are new requirements arisen from the work done within the WP4 and due to the evolution of the sessions with the use cases and the SopoLab, more analysis modules can be developed.

In addition, these analyses can be improved and upgraded considering the future needs of the Ecosystem and the different pilots to be deployed.

These modules are developed and integrated currently in the M20:

- City bikes pattern analysis (AF01)
- Traffic analysis/prediction (AF02)

Table 10. Analytical Framework requirements

Req ID	Req. Description	M20 situation	
AF01	The bike analysis sub-component provides an engine to produce models to compute OD matrixes for bike city services considering different timing attributes such as the day of the week or a specific hour in a day. In addition, different zoning options can be considered for the calculation.		Incremental starting on M15
AF02	The traffic prediction sub-component allows to produce prediction models to compute prediction for the flow of vehicles at the locations of the traffic flow sensors considering the day of the week or for a specific hour. In addition to the raw prediction, the models are capable to provide an interval of confidence for the generated result values.		Incremental starting on M15
New AF03	The application SHOULD automate part of the analysis performed on the collected data (e.g. extract relevant information and provide it in a more usable manner)	Under revision. The Orange external tool allows to save workflows for avoiding repetitive tasks (check if this is possible and use its capabilities,	M27

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		predefining some workflows).	

3.1.4 URBANITE UI Component

The Urbanite UI is the unique entry point to the URBANITE Ecosystem. Three new requirements have been included regarding the Identity manager functionality and provided by adapting the external tool Keycloak [1].

Other new requirements have been added from the use cases revision.

Table 11. URBANITE UI requirements

Req ID	Req. Description	M20 situation	
UUI01	The UI must provide uniform access to URBANITE tools and components.	Partially covered. The UI is integrated with the IDM, Data Catalogue, Bike analysis, Traffic estimation, etc.	Incremental starting on M15
UUI02	The UI must be integrated with the DSS visualization capabilities.	Partially covered for the bike analysis and traffic estimation as a DSS.	Incremental starting on M15
UUI03	The UI must support different user profiles, offering different functionalities for administrators and final users.	Covered. The UI, through the IDM, manages different roles. The Administration functionalities are provided only for the Admin of the platform.	M15
UUI04	The UI must be responsive to support different types of devices.	Covered. The UI framework itself is responsive and supports different types of devices. The component provided by the partners should fulfil responsiveness criteria in their implementation.	M15
New UUI05	The UI must allow personalisation through custom dashboards.	WIP	M27
New UUI06	The UI should allow sharing custom dashboards among the users.	The functionality is still in an early version	M27
New UUI07	The UI must include functionalities for the identification of URBANITE users.	Covered.	Incremental starting on M15

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New UUI08	The UI must allow the management of roles and groups of the users.	Covered.	Incremental starting on M15
New UUI09	The UI must provide functions for user management (e.g. searching for users, creating and/or editing and/or deleting users).	Covered.	Incremental starting on M15
New UUI10	The application MUST be accessible through a Web Browser.	Covered.	M15

3.2 Non-functional requirements

These requirements remain as decided in the first deliverable. The new structure can be considered if the architecture allows the combination of some of the components in a bigger function and reflects the same non-functional requirements.

Table 12. URBANITE Non-Functional requirements

URBANITE component	Performance	Security	Deployment	Availability
Virtual SoPoLab (URBANITE Forum)	< 1,5 sec	Only authenticated and authorized users can access the restricted areas of the VSPL	Ubuntu 18.04LTS - Ruby v2.5.1 - PostgreSQL v10 8GB Ram - HD 40GB - 2CPU	100
Data Harvesting	> 5 datasets/sec	Must be able to query secured APIs	Docker	95
Data Curation	NA	Must be capable of anonymization	Docker	95
Data Fusion/Aggregation			Docker	95
Data Storage		Only authenticated and authorized users can read/write data	Docker, Apache Hadoop, Keycloak	100
Exploratory data analysis	< 1,5 sec	Only authenticated and authorized users can trigger processing	Docker	95
Traffic simulation	off-line (up to a day)	Only authenticated and authorized users can trigger processing	Docker, Java	95
Advanced Visualisation	< 1,5 sec		Angular - Spring Boot - Docker	95
Recommendation Engine	1 minute	Only authenticated and authorized users can trigger processing	Docker, DEXi	95
Policy Simulation and validation	1 minute	Only authenticated and authorized	Docker, WEKA	95

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		users can trigger processing		
Urbanite UI	< 1,5 sec	Only authenticated and authorized users can access the UI	Angular - Spring Boot - MongoDB - Docker	100
Analytical Framework	Minutes, depending on the amount of data	Only authenticated and authorized users can access the UI	Docker	95

3.3 Use Cases requirements

The WP6 is working in the implementation of the use cases; therefore a deep revision of the scenarios and the requirements associated with them has been performed. This analysis is currently in progress, and the status of the requirements can be modified during the process. Nevertheless, the alignment of the use cases requirements with the technical ones has been made as a starting point for adjusting the technical implementation and the functionalities (to be) provided by the URBANITE Ecosystem. The final version of these requirements will be reported in the future deliverables of the WP6.

The following sections reflect the new UC requirements which were not included in the previous version of the deliverable [1]. nor in the first version of the URBANITE use cases requirements [6]

Some of the requirements has undergone minor modifications in order to make them more understandable from the technical perspective. The current version is reflected in the matrix of section 5. All of these requirements are new and will be included in the requirements alignment matrix (section 5) with the requirement id order indicated below.

3.3.1 Helsinki Use Case

Requirement id	**UC.HE.02**
Description	The application MUST allow the user to navigate the map
Status	Proposed
Priority	Must have

Requirement id	**UC.HE.09**
Description	The application SHOULD harmonise acquired data following standard data formats
Status	Proposed
Priority	Should have

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Requirement id	UC.HE.13
Description	The application MUST be accessible through a Web Browser
Status	Proposed
Priority	Must have

Requirement id	UC.HE.14
Description	The application SHOULD allow the user to share information among different departments
Status	Proposed
Priority	Should have

Requirement id	UC.HE.15
Description	The application COULD validate the quality of data checking, for instance, that all mandatory fields are present
Status	Proposed
Priority	Could have

Requirement id	UC.HE.16
Description	The application SHOULD be able to integrate with other platforms and services
Status	Proposed
Priority	Should have

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3.3.2 Bilbao Use Case

Requirement id	UC.BI.07
Description	The application SHOULD allow to filter available data according to different criteria (e.g. by transport mode)
Status	Proposed
Priority	Should have

Requirement id	UC.BI.08
Description	The application MUST facilitate the connection of data sources
Status	Proposed
Priority	Must have

Requirement id	UC.BI.10
Description	The application SHOULD facilitate the setup and execution of simulations (e.g. through preconfigured simulations that need few inputs)
Status	Proposed
Priority	Should have

Requirement id	UC.BI.13
Description	The application MUST allow integrating in an easy way information coming from different sources
Status	Proposed
Priority	Must have

Requirement id	UC.BI.14
Description	The application SHOULD be able to visualise in a map the mobility flows by transport mode
Status	Proposed
Priority	Should have

Requirement id	UC.BI.15
Description	The application MUST allow configuring the parameters of the simulations.
Status	Proposed

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Priority	Must have

Requirement id	**UC.BI.16**
Description	The application MUST allow the activation and deactivation of map layers.
Status	Proposed
Priority	Must have

Requirement id	**UC.BI.17**
Description	The application MUST allow the calculation of SUMP indicators.
Status	Proposed
Priority	Must have

Requirement id	**UC.BI.18**
Description	The application SHOULD allow comparing performed simulations.
Status	Proposed
Priority	Should have

Requirement id	**UC.BI.19**
Description	The application MUST allow the publication of the information related to a mobility intervention
Status	Proposed
Priority	Must have

Requirement id	**UC.BI.20**
Description	The application SHOULD allow performing actions on the Map, for instance zooming or to select specific areas in the city
Status	Proposed

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Priority	Should have

Requirement id	**UC.BI.21**
Description	The application SHOULD allow the users to subscribe to a specific topic in order to receive notifications
Status	Proposed
Priority	Should have

3.3.3 Messina Use Case

Requirement id	**UC.ME.01**
Description	The application MUST provide the user with a map to "visualise" information
Status	Proposed
Priority	Must have

Requirement id	**UC.ME.02**
Description	The application MUST allow the user to navigate the map
Status	Proposed
Priority	Must have

Requirement id	**UC.ME.03**
Description	The application MUST provide functionalities to select and display information layers
Status	Proposed
Priority	Must have

Requirement id	**UC.ME.08**
Description	The application COULD allow the user to make publicly accessible selected charts, graphs, map layers

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Status	Proposed
Priority	Could have

Requirement id	**UC.ME.10**
Description	The application SHOULD allow the users to share information (such as results of analysis/simulations, map layers, charts, graphs) with people working in the same or a different department.
Status	Proposed
Priority	Should have

Requirement id	**UC.ME.15**
Description	The application MUST provide two types of access for its users: full-access and read-only-access
Status	Proposed
Priority	Must have

Requirement id	**UC.ME.16**
Description	The application MUST be accessible through a Web Browser
Status	Proposed
Priority	Must have

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Requirement id	**UC.ME.17**
Description	The application SHOULD offer simulations/analysis to estimate optimised paths for both private cars and public transport
Status	Proposed
Priority	Should have

Requirement id	**UC.ME.18**
Description	The application SHOULD allow to collect data from different data sources (also from third parties) including advanced smart devices

	and virtual devices (abstracted components characterized by specific high-level functionalities)
Status	Proposed
Priority	Should have

Requirement id	**UC.ME.19**
Description	The application SHOULD allow to export information (e.g. in CSV or JSON formats)
Status	Proposed
Priority	Should have

3.3.4 Amsterdam Use Case

Requirement id	**UC.AM.01**
Description	The application MUST provide analytical and simulation tools to support decision-makers
Status	Proposed
Priority	Must have

Requirement id	**UC.AM.02**
Description	The application MUST include a dashboard providing insights about bicycle mobility
Status	Proposed
Priority	Must have

Requirement id	**UC.AM.04**
Description	The application MUST be able to manage metadata
Status	Proposed
Priority	Must have

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Requirement id	UC.AM.05
Description	The application MUST allow searching among the collected metadata to identify datasets following specific criteria
Status	Proposed
Priority	Must have

Requirement id	UC.AM.06
Description	The application SHOULD provide the means to integrate and combine data of different domains
Status	Proposed
Priority	Should have

Requirement id	UC.AM.07
Description	The application MUST provide the means to visualize and manage map layers
Status	Proposed
Priority	Must have

Requirement id	UC.AM.09
Description	The application MUST provide the means to gather data from heterogenous data sources
Status	Proposed
Priority	Must have

Requirement id	UC.AM.10
Description	The application SHOULD be able to interact with existing data platforms
Status	Proposed
Priority	Should have

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Requirement id	UC.AM.14
Description	The application SHOULD provide tools and models to simulate how decisions and policies affect traffic and (bike) mobility
Status	Proposed
Priority	Should have

Requirement id	UC.AM.15
Description	The application SHOULD allow to compare simulation scenarios
Status	Proposed
Priority	Should have

Requirement id	UC.AM.16
Description	The application SHOULD allow publishing the results of the analysis and/or simulations
Status	Proposed
Priority	Should have

Requirement id	UC.AM.17
Description	The application SHOULD allow enriching the datasets produced by analysis/simulations with additional metadata to easily understand the results.
Status	Proposed
Priority	Must have

Requirement id	UC.AM.18
Description	The application MUST provide the means to zoom the Map
Status	Proposed
Priority	Must have

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4 Existing tools

In the previous version of this deliverable, a benchmarking of existing tools was performed and analysed in the context of the WP5 as well as the requirements which will be covered by them.

Some of those tools have not been considered as part of the current versions of the technical components and removed from the initial list.

The requirements with any external tool associated are covered by specific development in the context of the corresponding technical component and WP.

The references related to these external tools are included in the first version of this deliverable, benchmarking section [1].

Colours code: The green colour represents that the functional requirement is fully covered by the tool, the yellow colour represents that the functional requirement is partially covered, and the empty cell represents that the functional requirement is not covered by the tool.

Table 13. Requirements covered by existing tools

RQ ID	ARX	Piveau Consus	Piveau UI	Piveau incognito	MATsim	DEXI	Orange 3	Idra	Decidim
VSPL.01									
VSPL.02									
VSPL.03									
VSPL.04									
VSPL.05									
VSPL.06									
VSPL.07									
VSPL.08									
VSPL.09									
VSPL.10									
DH.01									
DH.02									
DH.03									
DH.04									
DH.05									
DC.01									
DC.02									
DC.03									
DC.04									
DC.05									
DC.06									
DC.07									
DC.08									
DC.09									
DC.10									
DF.01									
DF.02									
DF.03									
DF.04									
DF.05									

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DF.06									
DF.07									
DS.01									
DS.02									
DR.01									
DR.02									
DCA01									
DCA02									
DCA03									
DCA04									
DCA05									
DCA06									
DP.01									
DCL.01									
SOM.01									
REG.01									
PRED.01									
TS.01									
TS.02									
AV.01									
AV.02									
AV.03									
RE.01									
RE.02									
RE.03									
PSV.01									
PSV.02									
PSV.03									
PSV.04									
PSV.05									
AF01									
AF02									
AF03									
UUI.01									
UUI.02									
UUI.03									
UUI.04									
UUI.05									
UUI.06									
UUI.07									
UUI.08									
UUI.09									
UUI.10									

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5 Requirements alignment matrix

This section shows the alignment between the functional requirements (offered by the technical components) and the Use Cases requirements (coming from the use case cities). However, upgraded versions of both categories of requirements have been considered. As a result of this alignment, some new technical requirements have arisen and are included in the corresponding part of section 3.

The revision of the previous version of the matrix reveals some UC requirements which are not correctly covered or not described sufficiently. In some cases, the comments in the "Technical requirements" column will be useful for the implementation as well as a better understanding of the use cases.

Considering the fact that evaluation of the Ecosystem from the use cases' point of view could call for modifications in some of the requirements and their corresponding implementations, this matrix should be considered as an approach to the final coverage of the use cases requirements.

The last column means the month version of the URBANITE Ecosystem for which the technical requirement has been planned to be implemented. In the case of the M15 version as a version already delivered, all the requirements are covered.

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Table 14. URBANITE requirements alignment matrix

Req. ID	Description	Components involved	Technical requirements	Version
UC.HE.01	The application MUST provide a map	Advanced Visualization (WP4)	AV02: The component must allow to visualise the analysis results on a combination of map layers, heat maps, traffic flow graphics and another kind of visualisation for helping to understand the data, e. g.: • a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers	M27

			• allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access the results of the analysis	
UC.HE.02	The application MUST allow the user to navigate the map	Advanced Visualization (WP4)	AV03: The component must allow users to interact with the visualised data by, for instance, zooming, highlighting, and displaying additional information.	M27
UC.HE.03	The application MUST allow the user to zoom on areas and districts of the map	Advanced Visualization (WP4)	AV03: The component must allow users to interact with the visualised data by, for instance, zooming, highlighting, and displaying additional information.	M27
UC.HE.04	The map MUST allow the user to visualise thematic layers (e.g. parking, transport, bike-sharing, planned development vs actual, urban planning, traffic planning, etc.)	Advanced Visualization (WP4) Traffic Simulation (WP4) Analytical Framework (Wp4)	This map must support the visualisation of all the simulations and analysis provided by the WP4 components, so it is related to the wp4 requirements in general. The aspects indicated in this UC.HE.04 are possible aspects to consider when implementing them over a map. The simulations and analysis available in the URBANITE Ecosystem must allow this kind of visualization of thematic layers. The evolution of the WP4 components will provide these features.	M27

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UC.HE.05	Thematic layers and base maps SHOULD be enriched with a description	Advanced Visualization (WP4)	AV02: The component must allow to visualise the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of visualisation to help with understanding data, e. g.: • a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers • allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access to the results of the analysis	M27
UC.HE.06	The application SHOULD provide pre-packaged simulations (e.g. impact of urban planning on the traffic) Examples: • Add new car lines • Change traffic light cycle • Impact of the arrival of ferries (change) • Land use	Traffic Simulation (WP4)	TS01: Traffic Simulation component will provide urban traffic simulation based on the collected data, describing the traffic flow locally for specific parts of interest in the city and combining it in a hierarchical manner. Under revision: To check the simulations planned within the context of the WP4 and decide in collaboration with the WP6 about which simulations will be implemented, in case they have not been considered initially.	M27

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UC.HE.07	The application SHOULD provide a wizard to create charts	Data Catalogue (WP3)	New UUI05 covers simple visualisations and depending on the format of the data. Not integrated yet in the UUI.	M27
UC.HE.08	The application MUST provide a unique point of access to the data offered by the different departments	Urbanite UI (WP5) Data catalogue (Wp3)	UUI01: The UI must provide uniform access to URBANITE tools and components. So, the data catalogue is accessible from the UUI by users from different departments.	Incremental
UC.HE.09	The application SHOULD harmonise acquired data following standard data formats	Data Curation (WP3)	DC01: The harvested data may not be in a format and/or structure suitable for data storage. In this case, the data will need to be transformed in an automated way.	M15
UC.HE.10	The application SHOULD automate part of the analysis performed on the collected data (e.g. extract relevant information and provide it in a more usable manner)	Analytical Framework (WP4)	General requirement for all the analysis available. At the moment of submitting this deliverable (M20), there are two types of analysis available and are described as AF01 and AF02. These analyses should avoid the repetition of actions to obtain certain results. This feature should be provided by all the simulations implemented and provided by the URBANITE platform.	M33

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			The Orange external tool allows to save workflows for avoiding repetitive tasks (to be verified later).	
UC.HE.11	The application SHOULD allow the user to download collected data	Data catalogue (WP3)	New DC06: The Data Catalogue allows to download of transformed data stored in the URBANITE repositories.	M33
UC.HE.12	The application SHOULD highlight relevant information reducing the time to search it	Advanced Visualization component (WP4)	AV01: The component must allow to visualise the analysis results on a combination of map layers, heat maps, traffic flow graphics and another kind of visualization. Under revision: to define "relevant information" and add more details about that as part of the use case requirement.	M15
UC.HE.13	The application MUST be accessible through a Web Browser	UUI (WP5)	New UUI10: The application MUST be accessible through a Web Browser	M15
UC.HE.14	The application SHOULD allow the user to share information among different departments	UUI (WP5) Data catalogue (WP3)	Covered by UUI01: The UI must provide uniform access to URBANITE tools and components. So, the data catalogue is accessible from there by the users from different departments. Two new requirements related to the UUI complement the access to the data catalogue for all the users: UUI05 (the UI	M27

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			must allow personalisation through custom dashboards.) and UUI06 (the UI should allow sharing custom dashboards among the users). Regarding the Data Catalogue, the capability of notifying other users/send will be a potential development depending on the evaluation of the use cases.	
UC.HE.15	The application COULD validate the quality of data checking, for instance, that all mandatory fields are present	Data Curation (WP3)	DC05: Data validation and quality check. The data curation functionality must be able to validate the data provided by the data harvesting module and its quality based on a defined format	M27
UC.HE.16	The application SHOULD be able to integrate with other platforms and services	Data harvester (WP3)	DH03: Data Harvester should be extensible with new connectors if new unsupported data sources are discovered.	Incremental
UC.BI.01	The application MUST be able to show different charts and graph in the same view	Advanced Visualization (WP4)	AV02: The component must allow the visualisation of the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of visualisation to help with understanding data e. g.: • a description of the layers and base maps.	M27

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			• show different charts and graphs in the same view • allow the activation and deactivation of map layers • allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access the results of the analysis	
UC.BI.02	The application MUST provide a data catalogue to allow the user to discover the data (e.g. by transport mode)	Data Catalogue (WP3) Data Harvester (WP3)	DCA01: The data catalogue should be able to retrieve existing metadata from existing heterogenous Open Data Portals. DH03: Data Harvester should be extensible with new connectors if new unsupported data sources are discovered.	M15
UC.BI.03	The application COULD check if data is updated (e.g. check time constraints)	Data curation (WP3)	It is still under evaluation if the Data Curation component will provide this functionality.	
UC.BI.04	The application COULD allow the user to define custom KPIs	Policy Simulation and Validation (WP4)	PSV03: Users must be able to select the defined KPIs to evaluate policies.	M27
UC.BI.05	The application MUST provide a unique point of access to the data collected from scattered data sources	Data catalogue (WP3) Data Storage (WP3)	DC04: The data catalogue, being one of the main interfaces to the users, must feature a UI that covers all relevant functionalities of the data catalogue. DR01: The data retrieval component must expose API to retrieve and query	M27

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			the data stored in the different repositories.	
UC.BI.06	The application SHOULD allow to perform pre-processing of collected data	Data Projection (WP4) Data Clustering (WP3)	DP01: Data projection component will provide dimensionality reduction methods for a better understanding and interpretation of the data. DCL01: Data Clustering component will provide methods that will identify groups of similar objects in the data (based on user defined attributes) and interactively present them to the user. The needed pre-processing actions are under discussion.	M27 M27
UC.BI.07	The application SHOULD allow to filter available data according to different criteria (e.g. by transport mode)	Data Catalogue (WP3)	The Data Catalogue provides the functionality of filtering data with metadata. If the "transport mode" is considered as a valid criterion, it should be included among the metadata, using the capabilities of Data Curation. (DC03: Data Transformation functionality should add an annotation in the form of metadata to data to help the analysis. This metadata will be included in the data itself)	M33
UC.BI.08	The application MUST facilitate the connection of data sources	Data Harvester (WP3)	DH01: The harvesting component will retrieve data from various sources (municipal services, open data portals,	Incremental

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			GIS, city private service providers) with varying formats (e.g. JSON, XML) from different data sources (e.g. open/private data portals, GIS system), raw data from APIs or data coming from sensors.	
UC.BI.09	The application MUST allow to setup and execute simulations	Traffic Simulation (WP4)	TS02: Traffic Simulation component will provide the ability to simulate hypothetical situations and the effects of different measures.	Incremental
UC.BI.10	The application SHOULD facilitate the setup and execution of simulations (e.g. through preconfigured simulations that need few inputs) Examples: • Traffic lights cycle changes • Limited Traffic Zones	Traffic Simulation (WP4)	TS01: Traffic Simulation component will provide urban traffic simulation based on the collected data, describing the traffic flow locally, for specific parts of interest in the city and combining it in a hierarchical manner. Under revision: To check the simulations planned within the context of the WP4 and decide in collaboration with the WP6 about which simulations will be implemented, in case they have not been considered initially.	M27
UC.BI.11	The application SHOULD allow the users to exchange of information	URBANITE UI (WP5) Data Catalogue (WP3)	Covered by UUI01: The UI must provide uniform access to URBANITE tools and components.	M27

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			So, the data catalogue is accessible from UI by the users from different departments. Two new requirements related to the UUI complement the access to the data catalogue for all the users: UUI05 (the UI must allow personalisation through custom dashboards.) and UUI06 (the UI should allow sharing custom dashboards among the users). Regarding the Data Catalogue, the capability of notifying other users/send, will be a potential development depending on the evaluation of the use cases.	
UC.BI.12	The application MUST harmonise the collected data according to common and well-defined data models	Data Curation (WP3)	DC01: The harvested data may not be in a format and/or structure suitable for data storage. In this case, the data will need to be transformed in an automated way.	M15
UC.BI.13	The application MUST allow integrating into an easy way information coming from different sources	Data Harvesting (WP3)	DH01: The harvesting component will retrieve data from various sources (municipal services, open data portals, GIS, city private service providers) with varying formats (e.g. JSON, XML) from different data sources (e.g. open/private	Incremental

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			data portals, GIS system), raw data from APIs or data coming from sensors.	
UC.BI.14	The application SHOULD be able to visualise in a map the mobility flows by transport mode	Advanced Visualization (WP4)	AV02: The component must allow the visualisation of the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of visualisation to help with understand data e. g.: • a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers • allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access to the results of the analysis	M27
UC.BI.15	The application MUST allow configuring the parameters of the simulations.	Traffic Simulation (WP4)	TS02: Traffic Simulation component will provide the ability to simulate hypothetical situations and the effects of different measures.	M27
UC.BI.16	The application MUST allow the activation and deactivation of map layers.	Advanced Visualization (WP4)	AV02: The component must allow the visualisation of the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of visualisation to help with understanding data e. g.:	M27

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			• a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers • allow the user to make publicly accessible selected charts, graphs, map layers allow users to access to the results of the analysis	
UC.BI.17	The application MUST allow the calculation of SUMP indicators	Traffic Simulation (WP4)	SV03: User must be able to select the defined KPIs to evaluate policies.	M27
UC.BI.18	The application SHOULD allow comparing performed simulations.	Traffic Simulation (WP4)	RE02: The recommendation engine must identify and predict events related to mobility (samples could be congestion situations, high-emission scenarios, unbalanced modal share, etc.), based on the analysis of existing models and/or simulated data. Such analysis will be supported by the previously mentioned component as those related to regression, clustering, simulation, etc.	M27
UC.BI.19	The application MUST allow the publication of the information related to a mobility intervention	Data catalogue (WP3)	Some capabilities to be explored (potential development depending on the evaluation of the use cases): To make Dashboards publicly accessible.	

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UC.BI.20	The application SHOULD allow performing actions on the Map, for instance zooming or to select specific areas in the city	Advanced visualization (wp4)	AV03: The component must allow users to interact with the visualized data by, for instance, zooming, highlighting, and displaying additional information.	M27
UC.BI.21	The application SHOULD allow the users to subscribe to a specific topic in order to receive notifications	Traffic Simulation (WP4)	PSV01: The component should support policy-makers for identifying possible policies that tackle events based on specific criteria. The evolution of this requirement is connected to the definition of a topic, that could be a dataset (managed by the data storage) matching a keyword. That definition should be clarified within the context of use cases validation.	M27
UC.ME.01	The application MUST provide the user with a map to "visualise" information	Advanced Visualization (WP4)	AV02: The component must allow the visualisation of the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of visualisation to help with understanding data e. g.: • a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers	M27

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			• allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access to the results of the analysis	
UC.ME.02	The application MUST allow the user to navigate the map	Advanced Visualization (WP4)	AV03: The component must allow users to interact with the visualised data by, for instance, zooming, highlighting, and displaying additional information.	M27
UC.ME.03	The application MUST provide functionalities to select and display information layers	Advanced Visualization (WP4)	AV02: The component must allow the visualization of the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of visualization to help with understanding data e. g.: • a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers • allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access to the results of the analysis	M27
UC.ME.04	The application COULD provide the user with map layers to "visualise" information related to habitual transfer (e.g. well-	Advanced Visualisation component (WP4)	AV02: The component must allow visualisation of the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of	M27

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	trodden roads), pollution (noise, air, electromagnetic), traffic levels, road network quality		visualisation to help with understanding data e. g.: • a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers • allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access to the results of the analysis This map MUST support the visualisation of all the simulations and analysis provided by the WP4 components and it is related to the wp4 requirements in general. AF01 and AF02 are analysis modules for Bilbao and Helsinki and the application for Amsterdam and Messina depends on the availability of the required data.	
UC.ME.05	The application SHOULD allow the user to create customised dashboards	URBANITE UI (WP5)	UUI05: The UI must allow personalization through dynamic dashboards.	M27
UC.ME.06	The application SHOULD offer simulations/analysis to support	Traffic Simulation (WP4)	TS01: Traffic Simulation component will provide urban traffic simulation based on the collected data, describing the traffic flow locally, for specific parts of interest	M27

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	the identification of multimodal transportation paths More Examples of pre-packaged simulations: • Add new public transport services (frequency, itineraries, stops, bus capacity) • Add new on-demand services • New bike lines/ pedestrian paths • Limited Traffic Zones (LTZ) • Multi-modality		in the city and combining it in a hierarchical manner. Under revision: To check the simulations planned within the context of the WP4 and decide in collaboration with the WP6 about which simulation will be implemented in case they have not been considered initially.	
UC.ME.07	The application SHOULD offer simulations/analysis to estimate the number of transportation (vehicles) and drivers available in a specific moment, (e.g. for the planning maintenance interventions of public transportation vehicles	Traffic Simulation (WP4)	TS01: Traffic Simulation component will provide urban traffic simulation based on the collected data, describing the traffic flow locally, for specific parts of interest in the city and combining it in a hierarchical manner. Under revision: : To check the simulations planned within the context of the WP4 and decide in collaboration with the WP6 about which simulation will be implemented, in case they have not been considered initially.	M27

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			This requirement and the one above are examples of pre-packaged analysis or simulations that can be provided.	
UC.ME.08	The application COULD allow the user to make publicly accessible selected charts, graphs, map layers	Data catalogue (WP3)	Some capabilities to be explored (potential development depending on the evaluation of the use cases): To make Dashboards publicly accessible.	M27
UC.ME.09	The application COULD allow the user to enrich publicly accessible selected charts, graphs, map layers with a description	Traffic Simulation (WP4)	AV02: The component must allow the visualization of the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of visualization to help with understanding data e. g.: • a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers • allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access to the results of the analysis Linked to UC.ME.09 regarding the part of "make it publicly accessible"	M27

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UC.ME.10	The application SHOULD allow the users to share information (such as results of analysis/simulations, map layers, charts, graphs) with people working in the same or a different department.	Data Catalogue (WP3) UUI (WP5)	Covered by UUI01: The UI must provide uniform access to URBANITE tools and components. So, the data catalogue is accessible from UI by the users from different departments. Two new requirements related to the UUI complement the access to the data catalogue for all the users: UUI05 (the UI must allow personalization through custom dashboards.) and UUI06 (the UI should allow sharing custom dashboards among the users). Regarding the Data Catalogue, the capability of notifying other users/send, will be a potential development depending on the evaluation of the use cases.	M27
UC.ME.11	The application MUST provide a unique point to different departments to access collected data	Data Storage (WP3) Data catalogue (WP3)	DS01: The harvested data should be persistent with a big-data-storage solution capability. DCA04: The data catalogue as one of the main interfaces to the users must provide	Incremental

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			a UI that covers all relevant functionalities of the data catalogue.	
UC.ME.12	The application COULD support the user to identify problems in public transportation (e.g. delays, broken vehicles, traffic jams)	Analytical Framework (WP4)	Under discussion: to add new Analysis modules.	
UC.ME.13	The application COULD support the user to identify roads and streets that need maintenance interventions	Analytical Framework (WP4) Traffic Simulation (WP4)	Under discussion: to add new Analysis modules.	
UC.ME.14	The application COULD support the user to identify intervention for public safety	Analytical Framework (WP4) Traffic Simulation (WP4)	Under discussion: to add new Analysis modules.	
UC.ME.15	The application MUST provide two types of access for its users: full-access and read-only-access	UUI (WP5)	UUI09: The UI must provide functions for users' management (e.g. searching for users, creating and/or editing and/or deleting users).	Incremental
UC.ME.16	The application MUST be accessible through a Web Browser	UUI (WP5)	UUI10: The application MUST be accessible through a Web Browser	M15
UC.ME.17	The application SHOULD offer simulations/analysis to estimate optimised paths for both private cars and public transport	Analytical framework (WP3)	Under discussion: to add new Analysis modules.	

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UC.ME.18	The application SHOULD allow to collect data from different data sources (also from third parties), including advanced smart devices and virtual devices (abstracted components characterised by specific high-level functionalities)	Data harvester (WP3)	DH01: The harvesting component will retrieve data from various sources (municipal services, open data portals, GIS, city private service providers) with varying formats (e.g. JSON, XML) from different data sources (e.g. open/private data portals, GIS system), raw data from APIs or data coming from sensors.	Incremental
UC.ME.19	The application SHOULD allow to export information (e.g. in CSV or JSON formats)		Under discussion: to define in more details the information to be exported and to assign the corresponding component which will implement it. The involved component depends on the kind of information to be exported. It can be the storage and retrieval or the data catalogue components.	
UC.AM.01	The application MUST provide analytical and simulation tools to support decision-makers	Traffic Simulation (Wp4)	RE03: The recommendation engine should provide support and suggestions to the policy-makers for identifying possible policies that tackle identified problems and undesired events related to mobility based on specific criteria. Effective hierarchical multi-criteria decision models based on aggregated data and a rule-based approach will be adopted.	M27

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UC.AM.02	The application MUST include a dashboard providing insights about bicycle mobility	Analytical Framework (Wp4)	AF01: The bike analysis sub-component provides an engine to produce models to compute OD matrixes for bike city services considering different timing attributes such as the day of the week or a specific hour in a day. In addition, it has the ability to consider different zoning options for the analysis. This is not covered yet because the data from Amsterdam is not available.	M33
UC.AM.03	The application SHOULD allow users to exchange information	UUI (WP5)	Covered by UUI01: The UI must provide uniform access to URBANITE tools and components. So, the data catalogue is accessible from UI by the users from different departments. Two new requirements related to the UUI complement the access to the data catalogue for all the users: UUI05 (the UI must allow personalisation through custom dashboards.) and UUI06 (the UI should allow sharing custom dashboards among the users). Regarding the Data Catalogue, the capability of notifying other users/send, will be a potential development	M27

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			depending on the evaluation of the use cases.	
UC.AM.04	The application MUST be able to manage metadata	Data Curation (WP3)	DC03: Data Transformation functionality should add an annotation in the form of metadata to data to help the analysis. This metadata will be included in the data itself.	Incremental
UC.AM.05	The application MUST allow searching among the collected metadata to identify datasets following specific criteria	Data catalogue (WP3)	The Data Catalogue provides the functionality of filtering data with metadata. The specific criteria should be defined, and it should be included among the metadata, using the capabilities of Data Curation (DC03: Data Transformation functionality should add an annotation in the form of metadata to data to help the analysis. This metadata will be included in the data itself).	M27
UC.AM.06	The application SHOULD provide the means to integrate and combine data of different domains	Data Harvesting (WP3)	DH01: The harvesting component will retrieve data from various sources (municipal services, open data portals, GIS, city private service providers) with varying formats (e.g. JSON, XML) from different data sources (e.g. open/private data portals, GIS system), raw data from APIs or data coming from sensors.	Incremental

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UC.AM.07	The application MUST provide the means to visualize and manage map layers	Advanced Visualization (WP4)	AV02: The component must allow the visualisation of the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of visualisation to help with understanding data, e. g.: • a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers • allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access the results of the analysis	M27
UC.AM.08	Map layers SHOULD be provided with additional information, such as a description	Traffic Simulation (WP4)	AV02: The component must allow the visualisation of the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of visualisation to help with understanding data e. g.: • a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers	M27

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			• allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access the results of the analysis	
UC.AM.09	The application MUST provide the means to gather data from heterogenous data sources	Data Harvesting (WP3)	DH01: The harvesting component will retrieve data from various sources (municipal services, open data portals, GIS, city private service providers) with varying formats (e.g. JSON, XML) from different data sources (e.g. open/private data portals, GIS system), raw data from APIs or data coming from sensors.	Incremental
UC.AM.10	The application SHOULD be able to interact with existing data platforms	Data Harvesting (WP3) Data Storage and retrieval (WP3)	Considering the interaction as bi-directional, it can be considered covered: • Retrieval from the existing data platforms to the urbanite through the data harvester. DH01: The harvesting component will retrieve data from various sources (municipal services, open data portals, GIS, city private service providers) with varying formats (e.g. JSON, XML) from different data sources (e.g. open/private data portals, GIS system), raw data from APIs or data coming from sensors.	Incremental

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			• Retrieval from the urbanite platform to other platforms is possible through the data storage and retrieval. DR01: The data retrieval component must expose API to retrieve and query the data stored in the different repositories.	
UC.AM.11	The application SHOULD provide a unique point of access to the data collected from scattered data sources	Data catalogue (WP3)	DC04: The data catalogue as one of the main interfaces to the users must provide a UI that covers all relevant functionalities of the data catalogue.	M27
UC.AM.12	The application SHOULD allow the user to enrich metadata of collected data to facilitate the identification of relevant data (e.g. data related to bike usage)	Data Storage (WP3) Data Curation (WP3) Data Harvester (WP3)	DS02: The data storage component should be able to process and store DCAT-AP compliant metadata. DR02: The metadata stored in the repositories should be accessible through a data hub in a uniform way taking advantage of DCAT-AP standard and related profiles. DC03: Data Transformation functionality should add an annotation in the form of metadata to data to help the analysis. This metadata will be included in the data itself.	Incremental

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			It is still under discussion if the metadata can be associated with the data by the user.	
UC.AM.13	The application MUST allow to setup and execute analysis/simulations Examples: • Add a bridge (bikes, pedestrian) (ferries) • Limited Traffic Zones (temporal)	Traffic Simulation (WP4)	TS01: Traffic Simulation component will provide urban traffic simulation based on the collected data, describing the traffic flow locally, for specific parts of interest in the city and combining it in a hierarchical manner. Under discussion: to check the simulations planned within the context of the WP4 and decide in collaboration with the WP6 about which simulations will be implemented, in case they have not been considered initially.	M27
UC.AM.14	The application SHOULD provide tools and models to simulate how decisions and policies affect traffic and (bike) mobility	Analytical Framework (WP4)	AF01: The bike analysis sub-component provides an engine to produce models to compute OD matrixes for bike city services considering different timing attributes such as the day of the week or a specific hour in a day. In addition, it has the ability to consider different zoning options for the analysis. AF02: The traffic prediction sub-component allows to produce prediction models to compute prediction for the flow of vehicles at the locations of the traffic flow sensors considering timing attributes such as the day of the week or	M33

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			a specific hour in a day. In addition to the raw prediction the models provide an interval of confidence for the generated results values. It is not covered yet because the required data from Amsterdam is not available.	
UC.AM.15	The application SHOULD allow to compare simulation scenarios	Traffic Simulation (WP4)	RE02: The recommendation engine must identify and predict events related to mobility (samples could be congestion situations, high-emission scenarios, unbalanced modal share, etc.) based on the analysis of existing models and/or simulated data. Such analysis will be supported by the previously mentioned component as those related to regression, clustering, simulation, etc..	M27
UC.AM.16	The application SHOULD allow publishing the results of analysis/simulations	Data catalogue (WP3)	Some capabilities to be explored (potential development depending on the evaluation of the use cases): To make Dashboards publicly accessible.	
UC.AM.17	The application SHOULD allow enriching the datasets produced by analysis/simulations with additional metadata to easily understand the results.	Data Curation (WP3) Data Storage (WP3)	DC03: Data Transformation functionality should add an annotation in the form of metadata to data to help the analysis. This metadata will be included in the data itself.	Incremental

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			It is still under discussion if the outcome of a simulation/analysis will be stored in the system repositories.	
UC.AM.18	The application MUST provide the means to zoom the Map	Advanced Visualization (WP4)	AV03: The component must allow users to interact with the visualised data by, for instance, zooming, highlighting, and displaying additional information.	M27
UC.AM.19	The application MUST allow users to access to the results of the analysis	Advanced Visualization (WP4)	AV02: The component must allow the visualisation of the analysis results on a combination of map layers, heat maps, traffic flow graphics and other kind of visualisation to help with understanding data, e. g.: • a description of the layers and base maps. • show different charts and graphs in the same view • allow the activation and deactivation of map layers • allow the user to make publicly accessible selected charts, graphs, map layers • allow users to access to the results of the analysis	M27

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6 Conclusions

The revision of the requirements made in this deliverable provides a more stable version of them but not a final one. The implementation of the different components and their deployment in the municipalities could affect the current status of the technical requirements and their plan.

The alignment of the technical requirements and the requirements defined by the use cases turns out to be a reliable approach to follow in case of implementing these functionalities and provides a guideline for evaluation of the scenarios in the context of the WP6.

The URBANITE Ecosystem is continuously evolving, and different revisions are expected to be released because of the incremental knowledge obtained through the continuous evaluation of the use case requirements and as a result of the SopoLab sessions.

Accordingly, the experience of the integration and deployment of the first URBANITE Ecosystem prototype has served for adapting the functionalities envisioned in previous analysis to the use case requirements. Moreover, the outcomes of different deployments in the corresponding pilots' environments will contribute to the improvement of the final solution and to the better alignment with the use cases requirements.

No future deliverables are planned to describe refined versions of the requirements, so the deliverables of the WP5 will contain the evolution of them as well as their integration status at particular points of time in the future. Although no major modifications are expected, potential minor changes will be described in conjunction with the next versions of the architecture or URBANITE Ecosystem description. The evolution of the use case requirements will also be described in the deliverables by the WP6 and, in parallel, will be aligned with the technical components to provide the required functionalities.

In the case of non-functional requirements, they remain intact as the early versions of the components that are implemented and integrated into the first version of the Ecosystem. However, the use cases deployment could impact them and call for some minor modifications.

The document also includes the revision of the benchmarking of the potential tools that can support the functionalities of the URBANITE solution. In addition to the revision of the tools which are already integrated to cover the components, some refinements have been considered to adjust the behaviour of the final Ecosystem as desired.

As a final remark, although the functionalities of the URBANITE Ecosystem are already defined and the approach is established, minor adjustments can be probably needed in order to make a better and useful Ecosystem.

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[4] URBANITE Consortium, “D3.5 Data curation module implementation,” 2021.

[5] URBANITE Consortium, “D5.5 URBANITE Detailed architecture,” 2022.

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