URBANITE

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

Deliverable D5.8

URBANITE Ecosystem-v2

Editor(s):	María José López
Responsible Partner:	TECNALIA
Status-Version:	Final – v2.0
Date:	30.06.2022
Distribution level (CO, PU):	PU

Project Number:	GA 870338
Project Title:	URBANITE

Title of Deliverable:	URBANITE Ecosystem-v1
Due Date of Delivery to the EC:	30.06.2022

Workpackage responsible for the Deliverable:	WP5 - URBANITE ecosystem integration and DevOps
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Recommended/mandatory readers:	WP3, WP4, WP5

Abstract:	Report related to the URBANITE Ecosystem-v2, describing the environment where it is deployed, and the methods and resources used for the integration of the corresponding components.
Keyword List:	DevOps framework, integration, environments, prototype.
Licensing information:	The license of the URBANITE Ecosystem software is not decided yet and depends on the licences of the different components integrated in it. The document itself is delivered as a description for the European Commission about the released software, so it is public.
Disclaimer	This document reflects only the author's views and neither Agency nor the Commission are responsible for any use that may be made of the information contained therein

Document Description

Document Revision History

Version	Date	Modifications Introduced	
		Modification Reason	Modified by
v0.1	24/05/2022	First draft version with TOC	TEC
v0.2	28/06/2022	First internal version for checking within TECNALIA integration team	TEC
V0.3	28/09/2022	Version ready for internal review with technical partners contributions	TEC
V0.4	30/06/2022	Commented by the internal reviewer	TEC
V1.0	30/06/2022	Version addressing internal review comments and Ready for submission	TEC

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Terms and abbreviations

JSON	JavaScript Object Notation
XML	eXtensible Markup Language
API	Application Programming Interface
REST	REpresentational State Transfer
MQTT	Message Queuing Telemetry Transport
DCAT-AP	Data Catalogue vocabulary Application profile for data portals in Europe
UI	User Interface
GUI	Graphical User Interface
DSS	Decision Support System
OD	Origin/Destination
IDM	IDentity Manager

Executive Summary

This deliverable is the description of the second version of the URBANITE Ecosystem, integrating the current version of the components developed by the technical work packages. The architecture of this version was reported in the D5.5 [1] deliverable as the final structure of the URBANITE platform. Nevertheless, some of the components are not in their final version although the final version of this deliverable due to end of December will integrate the final features of all of the components.

The requirements coverage for this version is almost complete. The next version of this deliverable, D5.9, will cover them all.

1 Introduction

1.1 About this deliverable

This deliverable shows the architecture of the intermediate release of the integrated URBANITE Ecosystem, and the updated versions of the components as well as the usage of the platform, the continuous integration strategy followed and the instructions for installation.

The technical features of this release are detailed in previous deliverables describing the requirements in D5.2 [2] and the general architecture D5.5 [1]. Moreover, the milestone number 5 corresponds with this deliverable since the second version of the URBANITE components are integrated in this second release of the URBANITE Ecosystem.

Furthermore, this document presents the current approach for the deployment of the DevOps framework, that is the strategy used for the integration and execution of the platform in the three planned releases of the URBANITE Ecosystem.

The work towards the platform development and integration is performed in three iterations in total, each of them described by documents associated to them. The final release will be published in deliverable D5.9 due to December 2022.

1.2 Document structure

The document is structured in four main sections:

- First section introducing the context related to this deliverable within the project, explaining the objectives and the structure of the document.
- Second section gathers the main requirements and functionalities covered by this prototype and the architecture reflected the components integrated in it.
- Third section presenting the installation process of the prototype and its deployment, so users can run and test it.
- Fourth section consists of the conclusions and the further work to be accomplished in the final version of the URBANITE Ecosystem.

2 Implementation

2.1 Functional description

The D5.8 URBANITE Ecosystem-v2 integrates the majority of the key results envisioned in the DoA, including the main objective of deploying the versions of the components that support the requirements reported in D5.2.

This deliverable is also considered as a Milestone with the title of "Second release of the URBANITE Ecosystem integrating the second version of URBANITE components", which is the second prototype of URBANITE platform with almost all functionalities implemented.

Different platforms have been deployed for supporting the four use cases functionalities including particular components developed for each of them. Depending on the available data sources, the use case platforms include access to the technical components developed for their conditions. Not all the components are integrated at this time since their software is not still available in a stable version in the common repository (git).

The platform provides an entry point to the URBANITE UI from where the users can access the developed functionalities. Four additional entry points are provided, one for each use case, deployed in four different environments in addition to the integration one. These dedicated environments for the use cases aim to be a way to test and support the URBANITE platform for the use cases before the deployment in production in the infrastructure of the municipalities.

The Integration environment is focused on compiling the code and performing the unit test and integration test reports until the code is ready for deployment in the use cases environments. Therefore, the available components have been deployed in every pilot, providing the corresponding features planned for every use case in the different municipalities.

Requirements:

The final version of the detailed requirements specification of the URBANITE ecosystem was described in D5.2 deliverable [2] and the degree of fulfilment by this M27 prototype is gathered in the tables below.

At this time, some of the requirements are not considered as covered by the prototype because they are not yet integrated in the different platforms, but they are being handled by the technical work packages that will provide the final versions of them for the final release at the end of December.

Table 1: Virtual SoPoLab requirements.

Req ID	Req. Description	Prototype situation
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.	Covered.
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	Covered.

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.	Covered.
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.	Covered.
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.	Covered.
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.	Covered.
VSPL.07	The VSPL must allow to suggest refinements for selected ideas.	Covered.
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.	Covered.
VSPL.09	The VSPL must allow to host different kinds of resources created by the project, i.e. guidelines, methodologies, best practices.	Covered.
VSPL.10	The VSPL must allow the exchange of information between different participants of different nodes and cities.	Covered.

Table 2 Data Harvesting requirements.

Req ID	Req. Description	Prototype situation
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.
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.
DH03	Data Harvester should be extensible with new connectors if new, unsupported data sources are discovered.	Covered.
DH04	Data harvester must support at least HTTP(S) and MQTT protocol to fetch the data.	Covered.
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.

Table 3. Data Curation, Preparation, Transformation and Anonymisation requirements (WP3)

Req ID	Req. Description	prototype 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.
DC02	Data curation functionality should be able to clean the data coming from the harvester eliminating duplicates or error.	Covered.
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.
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 for users (UCs) to use it before the data is uploaded/used by the URBANITE platform	Not covered, as the current prototype does not handle sensitive data. Data is provided anonymized.
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.	Covered. Quality checks are done on the data values and format for all data sources without distinguishing whether data is sensitive information or not.
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.
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.	Not covered
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
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.
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.	Covered. All components offer an interface to configure and trigger them directly or through the scheduler.

Table 4. Data Fusion/Aggregation requirements (WP3)

Req ID	Req. Description	Prototype situation
DF01	The component should allow to aggregate curated data coming from different data sources if needed.	Not Covered (M33)
DF02	The component should allow the deduplication of the data.	Not Covered
DF03	The data should be mapped into EU vocabularies	Covered
DF04	The metadata should be mapped into DCAT-AP metadata. DF03 is required for this one.	Covered
DF05	Weather data coming from different data sources and weather services will be fused to create improved datasets covering more variables	Not Covered
DF06	The component should allow temporal aggregation of traffic data at given intervals, e.g. every 15 min.	Covered (Aggregation component)
DF07	The component should allow calculating maximum, minimum, average, and standard deviation values of datasets in a given interval, e.g. daily, monthly, etc.	Covered (Aggregation component)

Table 5. Data Storage & retrieval requirements (WP3)

Req ID	Req. Description	Prototype situation
DS01	The harvested data should be persistent with a big-data-storage solution capability.	Covered
DS02	The data storage component should be able to process and store DCAT-AP compliant metadata.	Covered.
DR01	The data retrieval component must expose API to retrieve and query the data stored in the different repositories	Covered.
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

Table 6. Data Catalogue requirements (WP5)

Req ID	Req. Description	Prototype situation
DCA01	The data catalogue should be able to retrieve existing metadata from existing heterogenous Open Data Portals.	Covered.
DCA02	Data Harvester should be extensible with new connectors if new unsupported data sources are discovered.	Covered.
DCA03	The Data Catalogue has a built-in scheduler that is able to synchronise the federated catalogues (collecting metadata) at recurring intervals.	Covered.
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.
DC05	Data Catalogue will provide a wizard to create charts.	Covered

DC06	The Data Catalogue should allow downloading of transformed data stored in the URBANITE repositories.	Covered

Table 7. Advanced Visualization requirements (WP4)

Req ID	Req. Description	Prototype situation
AV01	The harvested data must be available to be visualised through analysis and simulations provided by the URBANITE Ecosystem	Partially Covered.
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.
AV03	The component must allow users to interact with the visualized data by, for instance, zooming, highlighting, and displaying additional information.	Partially covered.

Table 8. Exploratory Data Analysis requirements (WP4)

Req ID	Req. Description	Prototype situation
DP01	Data projection component will provide dimensionality reduction methods for a better understanding and interpretation of the data.	Covered
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.	Covered
SOM01	The Self-Organizing Map will provide the user with a visual topological representation of the data, able to highlight potential clusters.	Covered
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.	Covered
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.	Covered

Table 9. Traffic Simulation requirements (WP4)

Req ID	Req. Description	Prototype 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.	Partially covered
TS02	Traffic Simulation component will provide the ability to simulate hypothetical situations and the effects of different measures.	Partially covered

PSV01	The component should support policy-makers for identifying possible policies that tackle events based on specific criteria.	Not covered
PSV02	The component should predict and classify traffic flow changes according to the changes in the policies.	Partially covered
PSV03	Users must be able to select the defined KPIs to evaluate policies.	Not covered
PSV04	The component must assign a score to each policy to help the decision-making process.	Partially covered
PSV05	Policy-makers will be able to make an informed decision about which policies should be deployed in the city.	Not covered
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.	Not covered
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.	Not covered
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.	Not covered

Table 10. Analytical Framework requirements (WP4)

Req ID	Req. Description	Prototype 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.	Covered
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.	Covered
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)	Covered

Note: More analysis modules have been developed, but not reported as requirements. They will be included in section 2.2.3 as part of the components of the prototype.

Table 11. URBANITE UI requirements (WP5)

Req ID	Req. Description	Prototype situation
UUI01	The UI must provide uniform access to URBANITE tools and components.	Covered
UUI02	The UI must be integrated with the DSS visualization capabilities.	Not Covered
UUI03	The UI must support different user profiles, offering different functionalities for administrators and final users.	Covered.
UUI04	The UI must be responsive to support different types of devices.	Covered.
UUI05	The UI must allow personalisation through custom dashboards.	Covered
UUI06	The UI should allow sharing custom dashboards among the users.	Covered
UUI07	The UI must include functionalities for the identification of URBANITE users.	Covered.
UUI08	The UI must allow the management of roles and groups of the users.	Covered.
UUI09	The UI must provide functions for user management (e.g., searching for users, creating and/or editing and/or deleting users).	Covered.
UUI10	The application MUST be accessible through a Web Browser.	Covered.

2.2 Technical description

2.2.1 Continuous integration overview

The technical strategy adopted in the URBANITE development is described in the D5.3 deliverable [3], and it is based on a DevOps approach for the development of the components.

The software components that form part of this M27 prototype have been implemented by different partners, using different technologies. All of them are *dockerized* -that is, they are prepared to be deployed as docker containers- so that the construction of the URBANITE ecosystem and its deployment is eased. All the micro-services communicate with each other through RESTful APIs over the HTTPS secure protocol.

As detailed in the Integration Strategy, the DevOps approach was based on three environments, as depicted in Figure 1. The Development environment is owned by each developer, provided by each partner, and is where the software is developed. The Integration environment is provided by Tecnalia, and is where the code is compiled, merged, and tested. Finally, the Pilots environment is where the compiled software is deployed and executed.

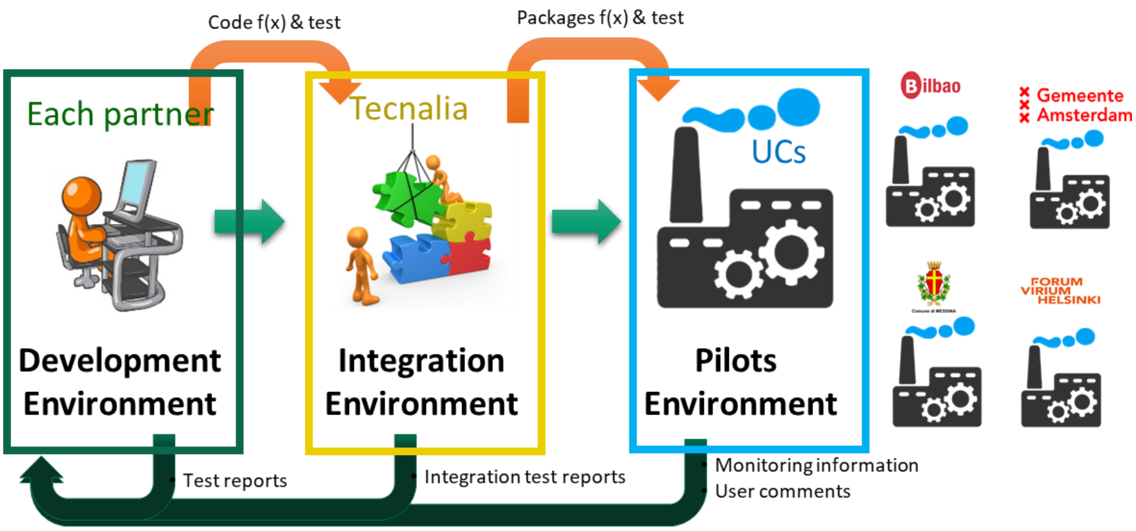


Figure 1. The three environments in URBANITE.

The actual version does not include yet the deployment of the URBANITE platform in each municipality (*real Pilots*), that is foreseen for the final version if the municipalities choses this option. Besides, to facilitate to Use Cases a way to run particular configurations and validations tailored to each municipality, four parallel environments have been set up (*demo Pilots*), one for each city that participates in the Use Cases (Amsterdam, Bilbao, Helsinki, and Messina). The different environments used for the continuous integration within the URBANITE Ecosystem are depicted in Figure 3, where the blue color is used to indicate the elements available at M27.

Our solution uses Continuous Integration (CI), Continuous Deployment (CD) practices. The Continuous Integration practice includes the management of the software source code through a versioning control system and for this purpose all the URBANITE projects are available on a private GitLab repository. The GitLab tool is also used for CI/CD in URBANITE. It provides the option of using branches and virtual environments, that we have mapped to the real environments described before. Thus, we have the *feature* branch, the *develop* branch, the *master* branch, and the *pilots* branch. At the same time, we have defined the environments develop, master, and one environment for each pilot.

The pipeline implemented ad-hoc for URBANITE is composed by the jobs Build, Deploy, Clean and Promote. The Build pipeline is triggered automatically at every push of the project in GitLab, and it automatizes the build of the project, the creation of the Docker image and its push to the Artifactory. If this previous pipeline succeeds, the second Deploy pipeline is triggered and will automatically deploy the component to the development environment.

The workflow is the following: when a developer uploads a new version of their components to the integration environment, the integration process starts compiling the code and testing it in a temporary environment (*Feature branch*). Afterwards, the code is merged in the *develop* environment, where the whole ecosystem is built and tested again. From this environment, in a further step, the developer can manually promote the code to the *demo Pilots* environments.

At any moment, the integrator can clone the actual version to the *Master* environment to maintain a stable version accessible, out of the integration up and downs.

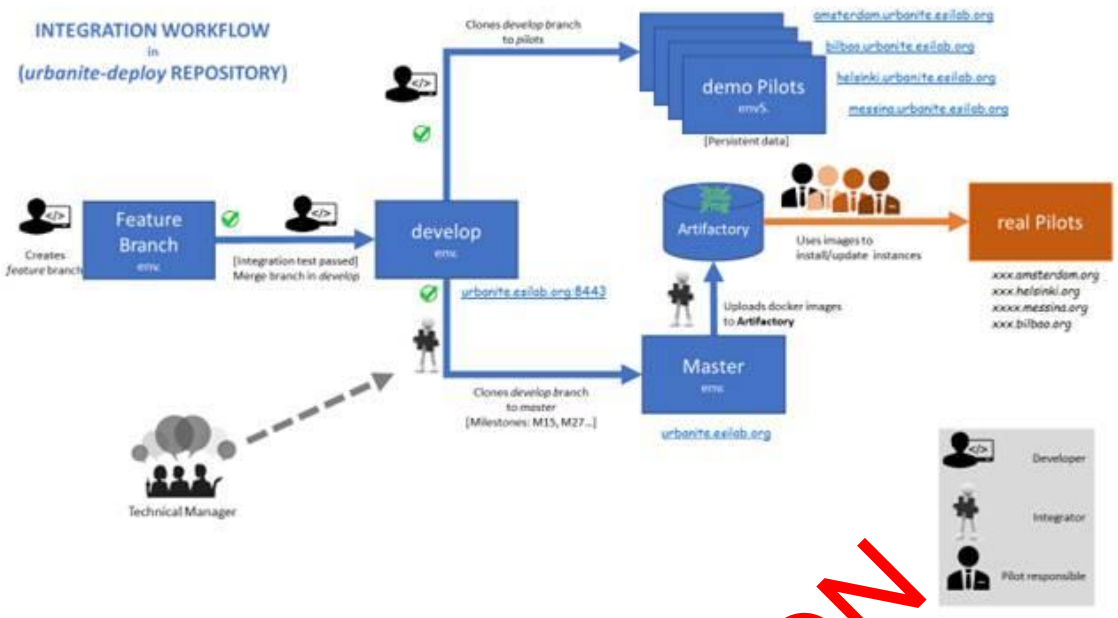


Figure 2.URBANITE integration workflow

A brief description of these environments and their function follows (this can also be consulted in the README.md file of the integration repository[1], where the description of the environments, the components and their access points and the installations instructions are included).

- **FEATURE BRANCH:** Temporary environment that is created each time a developer wants to integrate a new version of his component. It just checks that the new version of the urbanite platform builds without problems and is destroyed afterwards.

- **DEVELOP:** Environment that contains the last version of the components running together. Dedicated to test new features, interfaces, and communications among components. Available at urbanite.esilab.org:8443.

- **MASTER:** Contains a specific version of the platform, frozen for determined Milestones. Can be accessed at urbanite.esilab.org.

- **DEMO PILOTS:** Four environments, one for each city, where the integrated platform is replicated and adjusted to the characteristics of the use cases. It is a previous step for testing the platform before setting it up in the infrastructure of the municipalities, and some of these municipalities can evaluate their use cases using these environments:

  - amsterdam.urbanite.esilab.org
  - bilbao.urbanite.esilab.org
  - helsinki.urbanite.esilab.org
  - messina.urbanite.esilab.org

- **REAL PILOTS**: the installation of the platform in each municipality's infrastructure. The municipalities that want to deploy the URBANITE Ecosystem in their own infrastructure once the final version is available, for evaluating the use cases.

[1] https://git.code.tecnalia.com/urbanite/private/urbanite-deploy/-/blob/develop/README.md

Apart from that, in order to support developers during the integration, we provide:

- A **Portainer** [4] instance that allows to access the logs and the console of every container in every environment.
- An **Artifactory** instance to store the images of the containerized components. These images will be used to deploy the final version of the platform in the real Pilots.

2.2.2 Prototype architecture

This intermediate version of the URBANITE Ecosystem relies on the architecture reported in D5.5 deliverable [1]. Every pilot follows the same structure, based on this architecture and including its particular components, mostly related to the analysis and simulations provided and the data sources collected.

The particular details are explained in the D5.5 [1] and the components that make up this second version of the URBANITE Ecosystem are depicted in Figure 3.

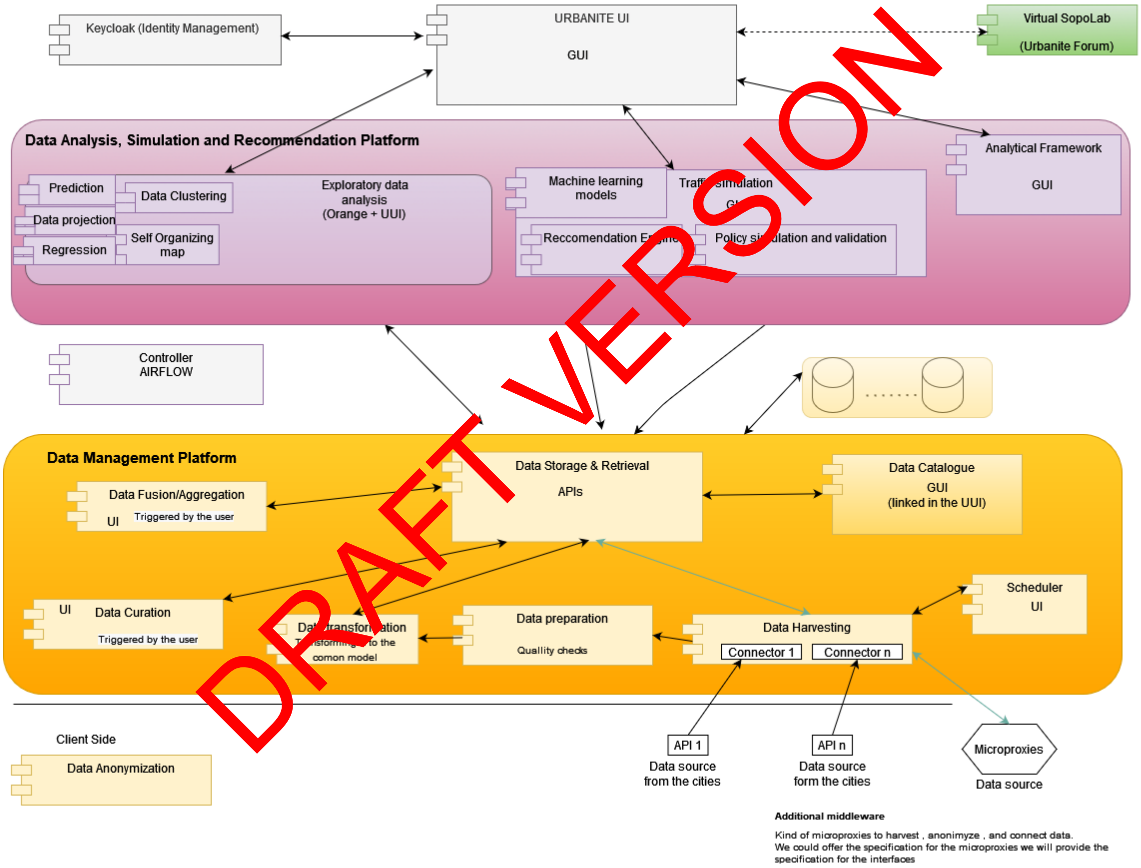


Figure 3.URBANITE Ecosystem-v2 Architecture

The different modules related to every pilot and included as part of the Analytical Framework will be indicated in the 2.2.3 section. Every Analysis module provides its specific GUI, integrated and accessible from the URBANITE User Interface.

The integration process encapsulates all the components as containers for facilitating future deployments of the URBANITE Ecosystem in different installations. Every component is composed by one or more Docker containers and presents a REST interface to the rest of them.

The diagram with the M27 components and their corresponding containers is depicted in Figure 4. The URBANITE ecosystem in its intermediate version is composed by 60 components.

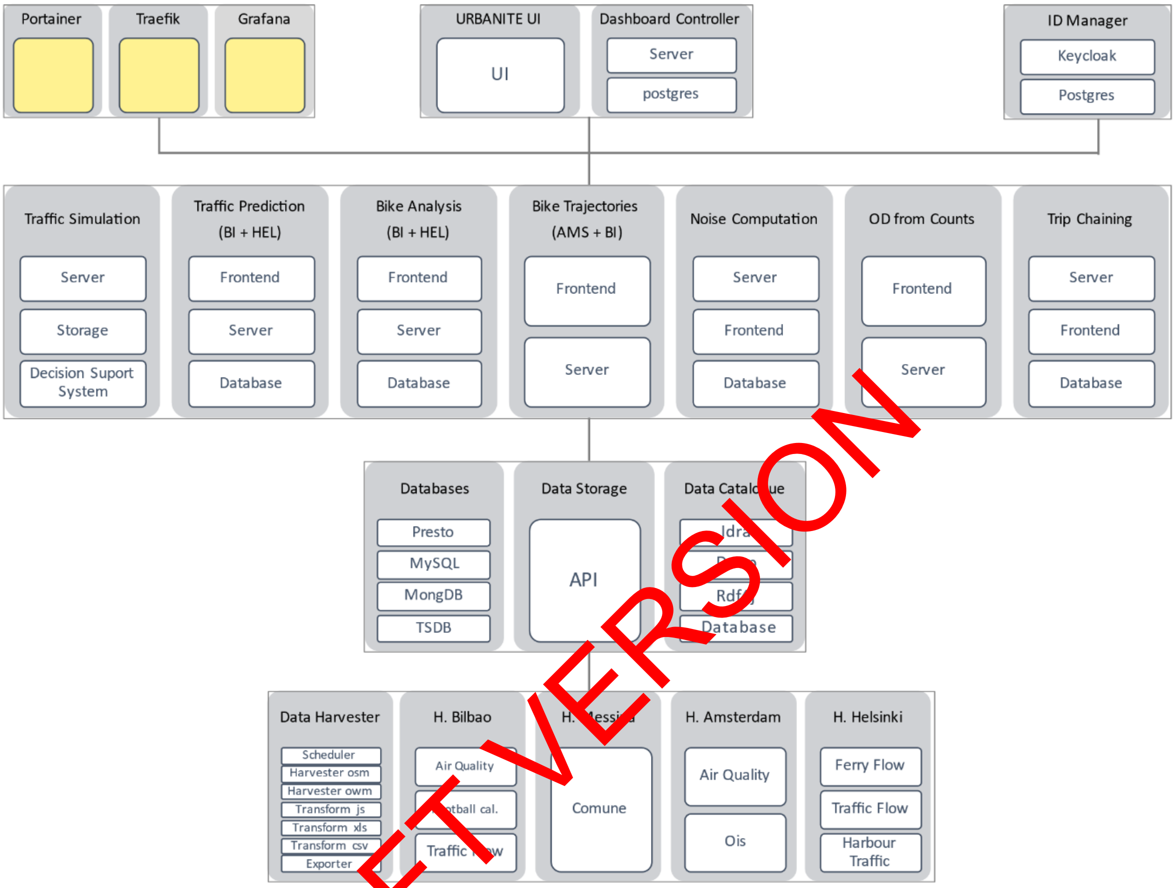


Figure 4.URBANITE Ecosystem-v1 containerized components

The URBANITE UI is the component that provides the graphical User Interface, wrapping the rest of components that provides some graphical interfaces to the final user. The Portainer (integration tool that allows developers to interact with the containers in development and testing) and the Traefik (router that allows publishing the services offered by the different components integrated in the same environment) are utility components provided by the integration environment.

2.2.3 Component description

The technical partners have developed the components that form the complete, integrated version of the URBANITE Ecosystem. The functionalities provided cover the requirements established by the deliverable D5.2 [2] and reflect the status of each work package at this moment of the project.

The technologies followed by the URBANITE UI component are the base for creating the specific UIs of the different components, needed for interactions with the user. The UI development team provided a template with detailed descriptions in the readme file of the URBANITE UI repository. This template is built on NGX-Admin [5], an open source dashboard based on Angular [6], Nebular [7] with Eva Design System [8].

The different components are grouped by several layers or platforms, attending to the nature of the functionality provided. This structure is depicted in Figure 3.

2.2.3.1 URBANITE Data Management Layer

The Data Management Platform gathers distinct software components that work together to deliver the key functionalities:

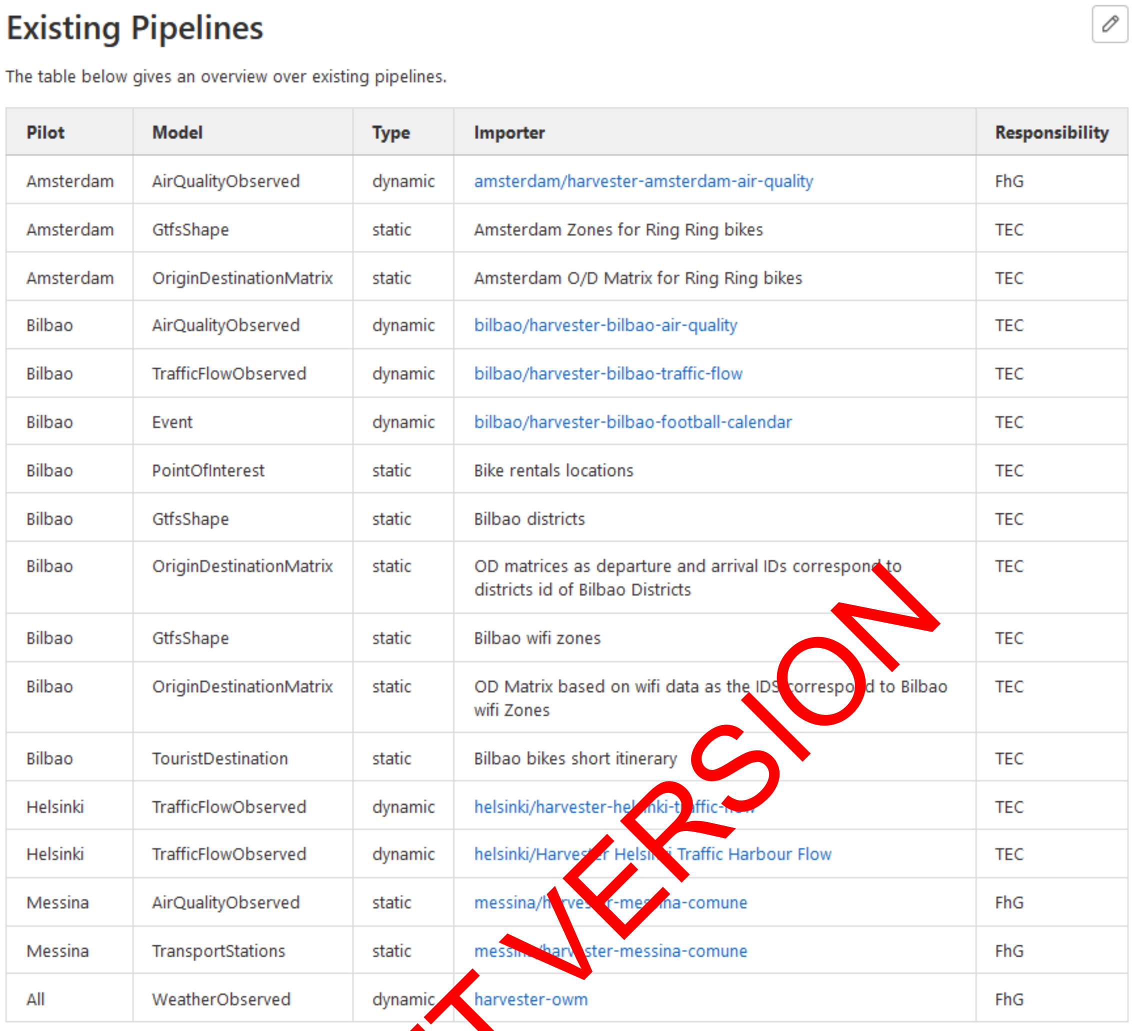
- data harvesting
- data preparation
- data transformation
- data curation
- data anonymisation
- data aggregation/fusion
- data storage.
- data catalogue

Detailed information on these components is available in their corresponding description deliverables D3.2 [9], D3.5 [10], and D3.7 [11]. The Data Management Layer follows a microservice architecture.

All the data processes follow a pipeline of steps, i.e., first to import data and metadata from endpoints on the web, by the harvesting module, second to check, clean and harmonise the different kinds of data and metadata by the data preparation, transformation, and curation components, and third, once the data and metadata are brought into a common format, to store in dedicated databases.

Additionally, the Scheduler component manages the regular intervals for downloading the data (and metadata), triggering the data importers which in turn download the data.

These components are not accessible from the URBANITE GUI and need to be run from a particular UI. The data collected following the services provided by this Layer are used for different components to run their analysis and simulations. Moreover, through the data catalogue, the data collected are presented to the users.



Existing Pipelines

The table below gives an overview over existing pipelines.

Pilot	Model	Type	Importer	Responsibility
Amsterdam	AirQualityObserved	dynamic	amsterdam/harvester-amsterdam-air-quality	FhG
Amsterdam	GtfsShape	static	Amsterdam Zones for Ring Ring bikes	TEC
Amsterdam	OriginDestinationMatrix	static	Amsterdam O/D Matrix for Ring Ring bikes	TEC
Bilbao	AirQualityObserved	dynamic	bilbao/harvester-bilbao-air-quality	TEC
Bilbao	TrafficFlowObserved	dynamic	bilbao/harvester-bilbao-traffic-flow	TEC
Bilbao	Event	dynamic	bilbao/harvester-bilbao-football-calendar	TEC
Bilbao	PointOfInterest	static	Bike rentals locations	TEC
Bilbao	GtfsShape	static	Bilbao districts	TEC
Bilbao	OriginDestinationMatrix	static	OD matrices as departure and arrival IDs correspond to districts id of Bilbao Districts	TEC
Bilbao	GtfsShape	static	Bilbao wifi zones	TEC
Bilbao	OriginDestinationMatrix	static	OD Matrix based on wifi data as the IDS correspond to Bilbao wifi Zones	TEC
Bilbao	TouristDestination	static	Bilbao bikes short itinerary	TEC
Helsinki	TrafficFlowObserved	dynamic	helsinki/harvester-helsinki-traffic-flow	TEC
Helsinki	TrafficFlowObserved	dynamic	helsinki/Harvester Helsinki Traffic Harbour Flow	TEC
Messina	AirQualityObserved	static	messina/harvester-messina-comune	FhG
Messina	TransportStations	static	messina/harvester-messina-comune	FhG
All	WeatherObserved	dynamic	harvester-owm	FhG

Figure 5 Existing Pipelines per pilot in URBANITE Ecosystem-v2

The available datasets related to the use case and stored in every pilot are shown in the following tables.

Table 12: Amsterdam available Datasets in URBANITE Ecosystem-v2.

Dataset	Values	Harvester/Manual
Calendar data	2015-2022	M
Open Weather data	2010-now	H + M (historic data)
Air quality data (no, no2, so2, o3, pm10, pm25, c6h6)	Feb 2022-now	H
GtfsShapes (Districts north neighbourhood)		M
OD Matrix	Calculated from Ring Ring bike data	M

Table 13: Bilbao available Datasets in URBANITE Ecosystem-v2.

Dataset	Values	Harvester/Manual
Calendar data	2015-2022	M
Open Weather data	2010-now	H + M (historic data)
Air quality data (co, no, no2, nox, pm10 and so2)	2019-now	H + M (histori H + M (historic data)data)
Schedule of football matches in Bilbao	Seasons: 2020-2021, 2021-2022	H
Traffic flow in Bilbao	2019-now	H
Transport stations (for bikes)		M
GtfsShapes (Districts and wifi zones)		M
Points of Interest (bike stations)		M
TouristTrip (bike trips from one bike station to another)	Oct 2018-Feb 2021	M
OD matrix	2 types: from wifi access points and calculated for bike data	M

Table 14: Helsinki available Datasets in URBANITE Ecosystem-v2.

Dataset	Values	Harvester/Manual
Calendar data	2015-2022	M
Open Weather data	2010-now	H + M (historic data)
Schedules of ferry arrivals and departures from Port of Helsinki	Nov 2021-now	HH
Traffic flow in the city of Helsinki	2019-now	H
Traffic flow from ferries in Port of Helsinki (cars & heavy traffic)	Nov 2021-now	H (2)

Table 15: Messina available Datasets in URBANITE Ecosystem-v2.

Dataset	Values	Harvester/Manual
Calendar data	2015-2022	M
Open Weather data	2010-now	H + M (historic data)
Bus Public Transportation		H

The main functionalities of the Data Catalogue are related to the discovery of datasets managed by the Data Storage and Retrieval. It also allows the federation with other existing data catalogues. The Idra tool is integrated into the platform and adapted to interact with the API exposed by the Data Storage and Retrieval. Furthermore, it is able to schedule the update period to check the availability of new datasets or updates related to datasets already available.

2.2.3.2 URBANITE data analysis, simulation, and recommendation layer

The components that are integrated in this intermediate prototype are:

- Analytical Framework

Within the context of the WP4 and as an analysis for helping the end user to make decisions in order to make the policies needed to improve the aspects considered in each pilot, some modules have been developed.

Table 16: Data Analysis Components per pilot.

Data Analysis component	Data	AMSTERDAM	BILBAO	HELSINKI	MESSINA
Traffic Prediction	Traffic Counts		X	X	
Global Traffic Prediction	Traffic Counts		X	X	
Noise Computation	Simulated Data	X	X	X	X
Bike OD Matrix	Bike Rentals		X	X	
Bike Trajectories	Bike Trajectories	X	X		
Bus OD Matrix	Bus Smart Card		X		
Traffic OD Matrix	Traffic Counts		X		
Traffic Weekly	Traffic				X
Weekly Traffic Flows	Traffic				X
LPT Critical Areas	Traffic				X

- Traffic Simulation

The traffic simulation component represents the proposed policies as simulations and simulates both the baseline and proposed scenarios. The outcomes of the simulation can be analysed by the decision support system.

The machine learning models use the simulations for learning models and making connections between traffic patterns and the represented policies.

The integrated version of the traffic simulation module supports basic traffic simulation and some KPI estimations.

- Decision Support System (DSS)

As part of the Simulation module, the DSS uses multi-attribute decision analysis (MADA) methodology to analyse and compare different policy proposals.

  - KPIs were defined for each pilot and developed based on simulation results.
  - Decision models were created for each pilot, utilising the estimated KPIs.
  - DEXi, an open source MADA toolkit was integrated.

- Exploratory Data Analysis

The exploratory data analysis component includes the libraries for prediction and regression, self-organising map, clustering, and projection. The main function is to provide interactive, and visualisation supported data exploration and analysis for presenting the user with a powerful data analysis toolkit.

2.2.3.3 URBANITE virtual SoPoLab

The main aim of the VSPL is to enable and facilitate on-line collaboration among users, following co-creation principles. A URBANITE Forum has been integrated, supported by the digital platform for citizen participation Decidim.

2.2.3.4 Integrated URBANITE UI

The URBANITE UI is the main interaction and entry point between the URBANITE Platform and the end users. It is conceived as an integration framework at the UI level and acts as a wrapper of the different components of the platform.

The URBANITE UI is composed of three main elements: a central panel that provides the user interface of the accessed functionality, a left column that provides the menu of the available functionalities, and a top bar that provides a button to resize the left columns.

More functionalities related to the customization of the dashboard and the sharing of them have been included in this version of the prototype.

2.2.3.5 Identity/Authorization Management

The Identity/Authorization Management is the tool for managing users and permissions. It offers a login page, integrated into the general URBANITE UI.

The administration console included allows to configure the realms, the registration of users and client applications, the management of their roles and the assignments to the users.

2.2.3.6 Controller

The Controller component manages and executes the workflows orchestrating the different steps in implementing a data processing pipeline.

3 Delivery and usage

3.1 Package information

The structure of the software of each component depends on the technology used by the different partners. Once the versions are uploaded to the gitlab, they are encapsulated as a docker image. The schema with this representation can be observed in Figure 4 and the list of the different components in the table below.

Table 17: Status of the components.

Component	Owner	Work Package	in GitLab	Containerized	Integrated	Built	Deployed
Data Catalog	Engineering	WP3	yes	yes	yes	yes	yes
Databases	TEC	WP3	yes	yes	yes	yes	yes
Data Storage	TEC	WP3	yes	yes	yes	yes	yes
Harvester (Scheduler, Transformers, Exporters)	FhG	WP3	yes	yes	yes	yes	yes
Harvesters BILBAO (3)	TEC	WP3	yes	yes	yes	yes	yes
Harvesters HELSINKI (3)	TEC	WP3	yes	yes	yes	yes	yes
Harvesters AMSTERDAM (2)	FhG	WP3	yes	yes	yes	yes	yes
Harvesters MESSINA (1)	FhG	WP3	yes	yes	yes	yes	yes
Bike Trajectories (BILBAO)	TEC	WP4	yes	yes	yes	yes	yes
Bike Analysis	TEC	WP4	yes	yes	yes	yes	yes
ODFromTripChainning	TEC	WP4	yes	yes	yes	yes	yes
Traffic Prediction BILBAO	TEC	WP4	yes	yes	yes	yes	yes
Traffic Prediction HELSINKI	TEC	WP4	yes	yes	yes	yes	yes
Noise Computation	TEC	WP4	yes	yes	yes	yes	yes
Traffic Simulation	JSI	WP4	yes	yes	yes	yes	yes
Traffic Simulation Storage	JSI	WP4	yes	yes	yes	yes	yes
DSS - Decision Support System	JSI	WP4	yes	yes	yes	yes	yes
Exploratory Data Analysis	JSI	WP4	yes	(Not needed)	-	-	-
OD from Counts	TEC	WP4	yes	yes	yes	yes	yes

Bike Trajectories AMSTERDAM	TEC	WP4	yes	yes	yes	yes	yes
Bike Analysis BILBAO	TEC	WP4	yes	yes	yes	yes	yes
Bike Analysis HELSINKI	TEC	WP4	yes	yes	no	no	no
Grafana	TEC	WP5	yes	yes	yes	yes	yes
Urbanite UI	Engineering	WP5	yes	yes	yes	yes	yes
ID Manager	Engineering	WP5	yes	yes	yes	yes	yes
Dashboard Controller	Engineering	WP5	yes	yes	yes	yes	yes

3.2 Installation instructions

To deploy the URBANITE Ecosystem in an easy way we provide a docker-compose configuration file, so that the user can install everything in one step, that starts the initialization of all the required components in a background task. Alternatively, the user can also build the Docker images for each component separately, compiling the respective Docker file included in each module directory.

Installation requirements

- To have Docker tool installed in your machine and accessible.
- To have Git installed.
- We recommend running the URBANITE framework in a powerful machine, because the project is composed by 48+ Docker containers (minimum: 8 CPU; 32Gb RAM; 100GB free storage depending on the datasets used).

Getting started

1. Clone the GitLab repository[2] of the project in your computer.
2. Navigate to the main root directory of the project
3. Define the required environment variables (see .env) file, e.g.
    - export HTTPS_PORT=8443
    - export SERVER_HOST=192.168.56.1.nip.io
    - ...
4. Run in the console the command docker-compose up
   This will automatically deploy all the component containers in your *localhost* domain. This deployment may take some minutes.
5. Access to the local URBANITE UI web page in the different pilots, with a browser:
    - https://amsterdam.urbanite.esilab.org
    - https://bilbao.urbanite.esilab.org
    - https://helsinki.urbanite.esilab.org
    - https://messina.urbanite.esilab.org

[2] The project software will be made available in its public repository (https://git.code.tecnalia.com/urbanite/public) at the end of the project, as the licenses of the software components are still in discussion and parts of them could be proprietary.

3.3 User Manual

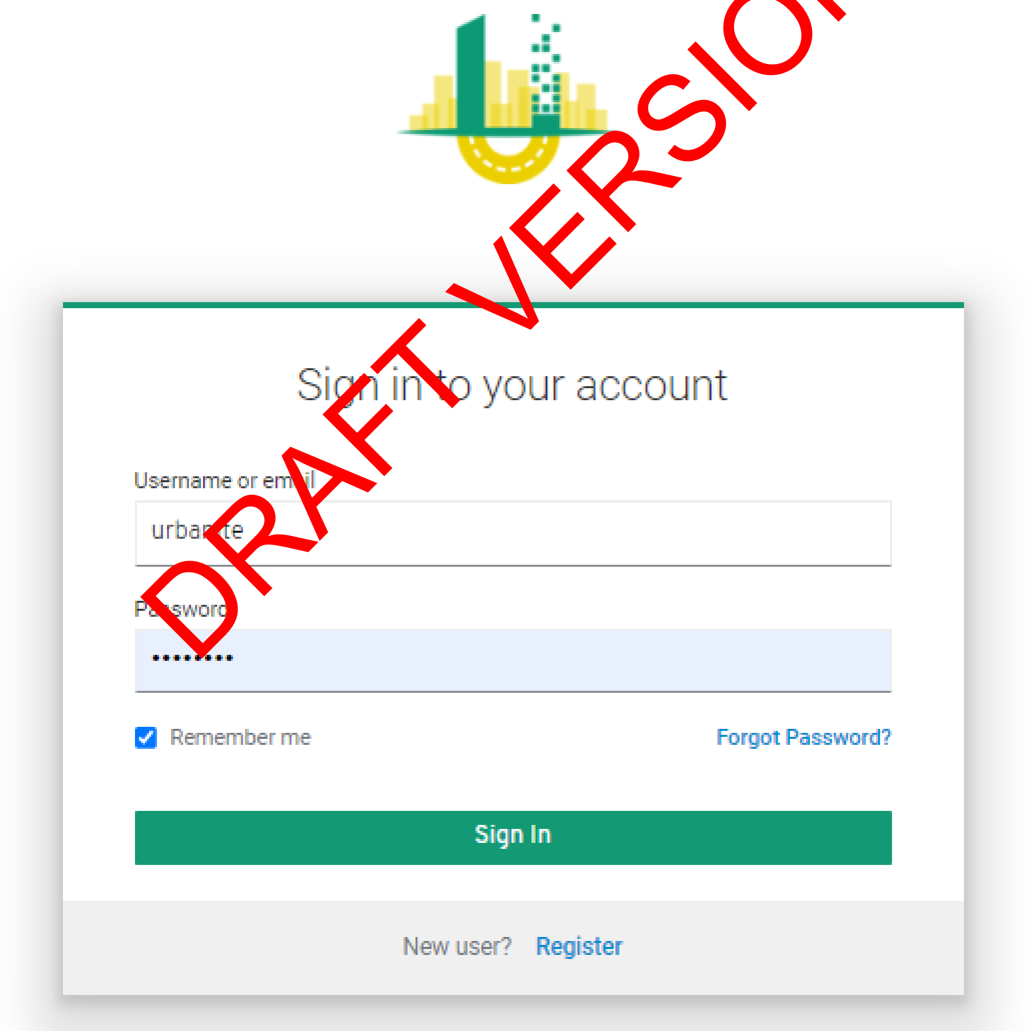
This prototype is the intermediate version of the URBANITE Ecosystem. Most of the functionalities are implemented and covered by the different components although some of them are still in progress and not stable enough for integration. The final version is due to the end of December and then all the functionalities will be available and integrated in that final version of the URBANITE Ecosystem.

The instructions for using the Ecosystem are the same for each of the pilots, so this section will indicate the Bilbao pilot information since it is, at this point of the project, the pilot with more analytical and simulation options. There are two modules implemented for the Messina pilot that are also included below.

The entry point to the Ecosystem is the URBANITE UI, available at this URL:

https://bilbao.esilab.org

The user needs to introduce the credentials (urbanite, urbanite) to enter the Ecosystem.



Sign in to your account

Username or email

urbanite

Password

•••••••••

☑ Remember me

Forgot Password?

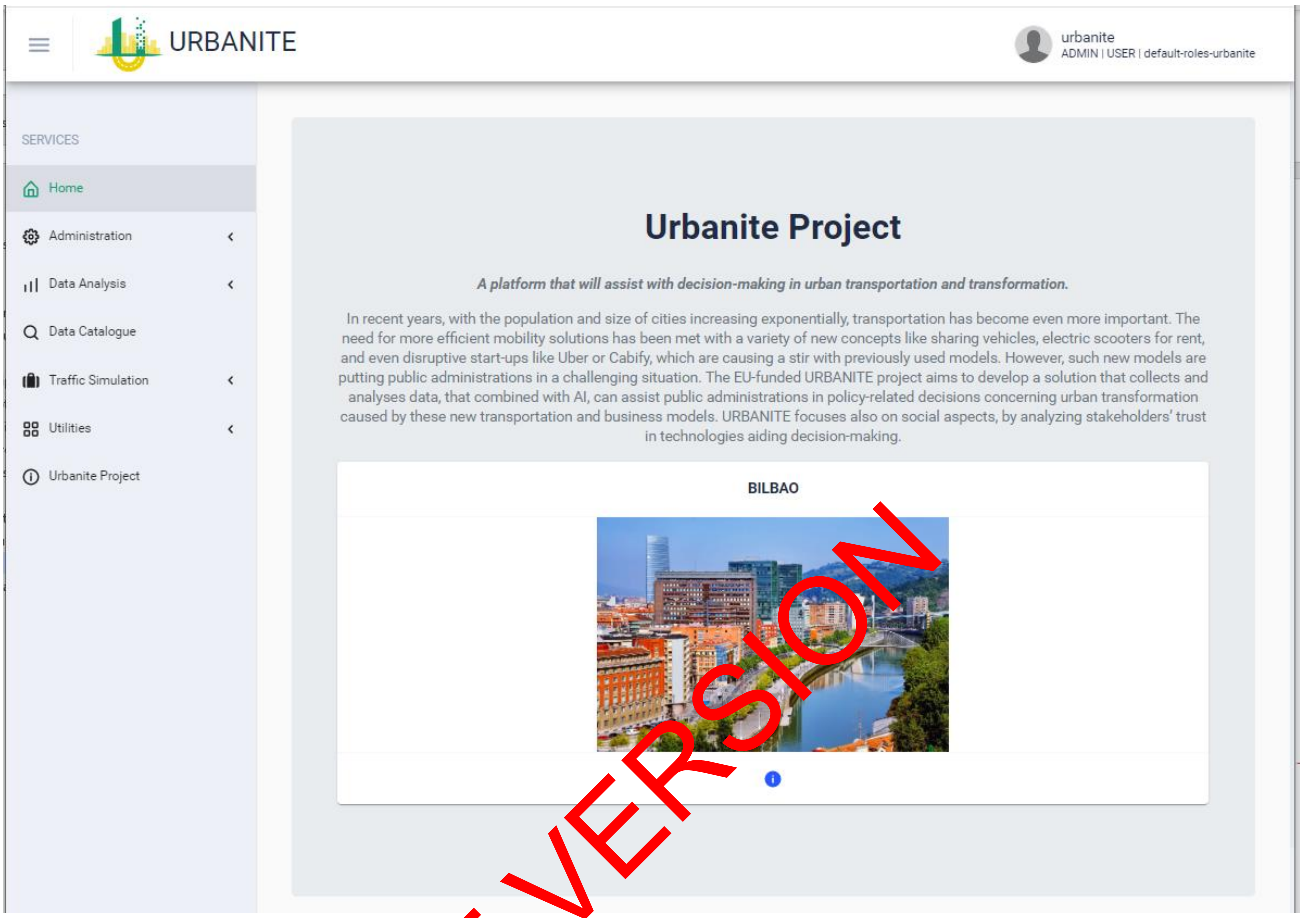
Sign In

New user? Register

Figure 6.URBANITE login page

The URBANITE UI presents two main sections: a central panel that provides the information of the selected functionality, and a left column with the menu of the available functionalities.

The main features provided are placed in the left side of the page:



Urbanite Project

A platform that will assist with decision-making in urban transportation and transformation.

In recent years, with the population and size of cities increasing exponentially, transportation has become even more important. The need for more efficient mobility solutions has been met with a variety of new concepts like sharing vehicles, electric scooters for rent, and even disruptive start-ups like Uber or Cabify, which are causing a stir with previously used models. However, such new models are putting public administrations in a challenging situation. The EU-funded URBANITE project aims to develop a solution that collects and analyses data, that combined with AI, can assist public administrations in policy-related decisions concerning urban transformation caused by these new transportation and business models. URBANITE focuses also on social aspects, by analyzing stakeholders' trust in technologies aiding decision-making.

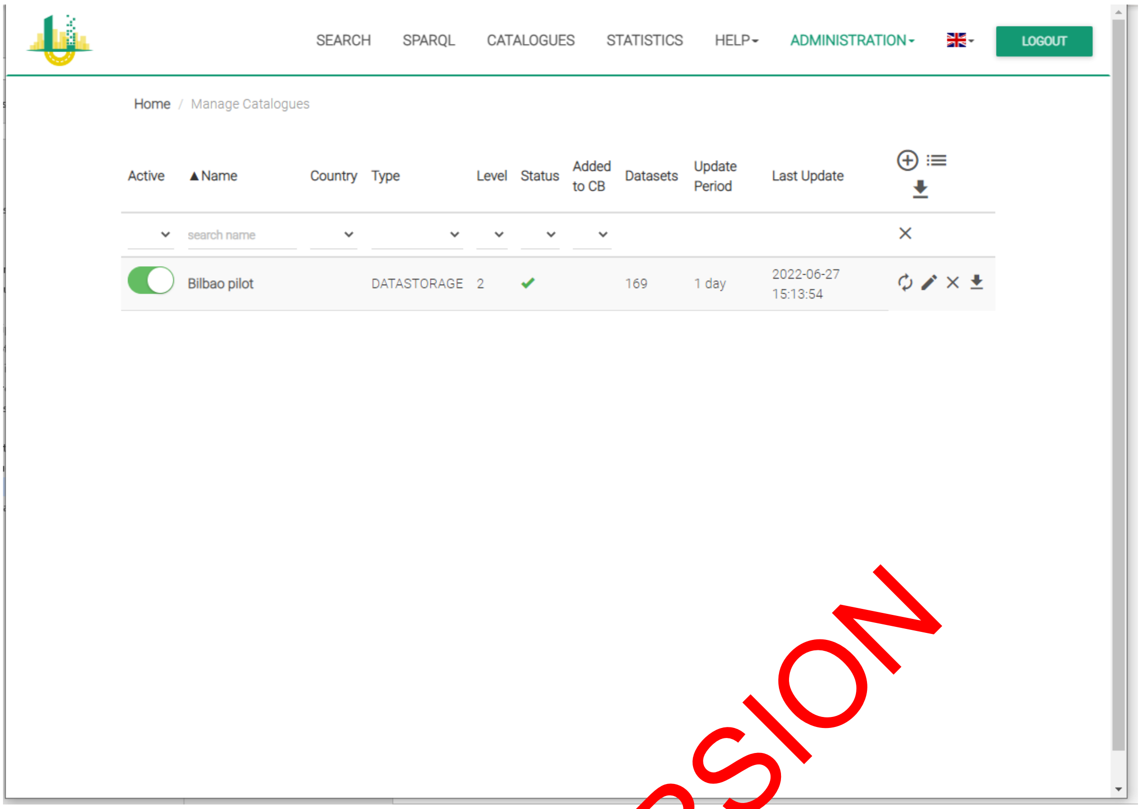
BILBAO

Figure 7 URBANITE UI home page

The integrated functionalities are:

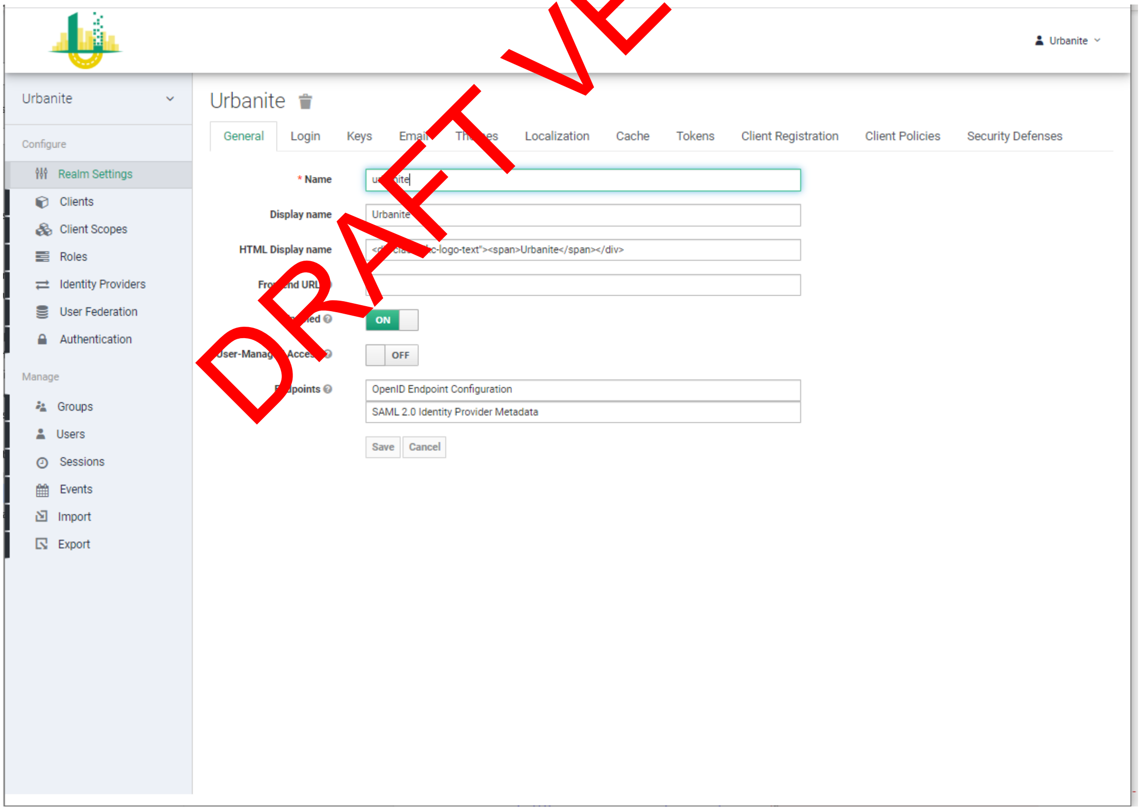
- Administration

The administration section gathers a list of options related to the general aspects of the data and the user management.



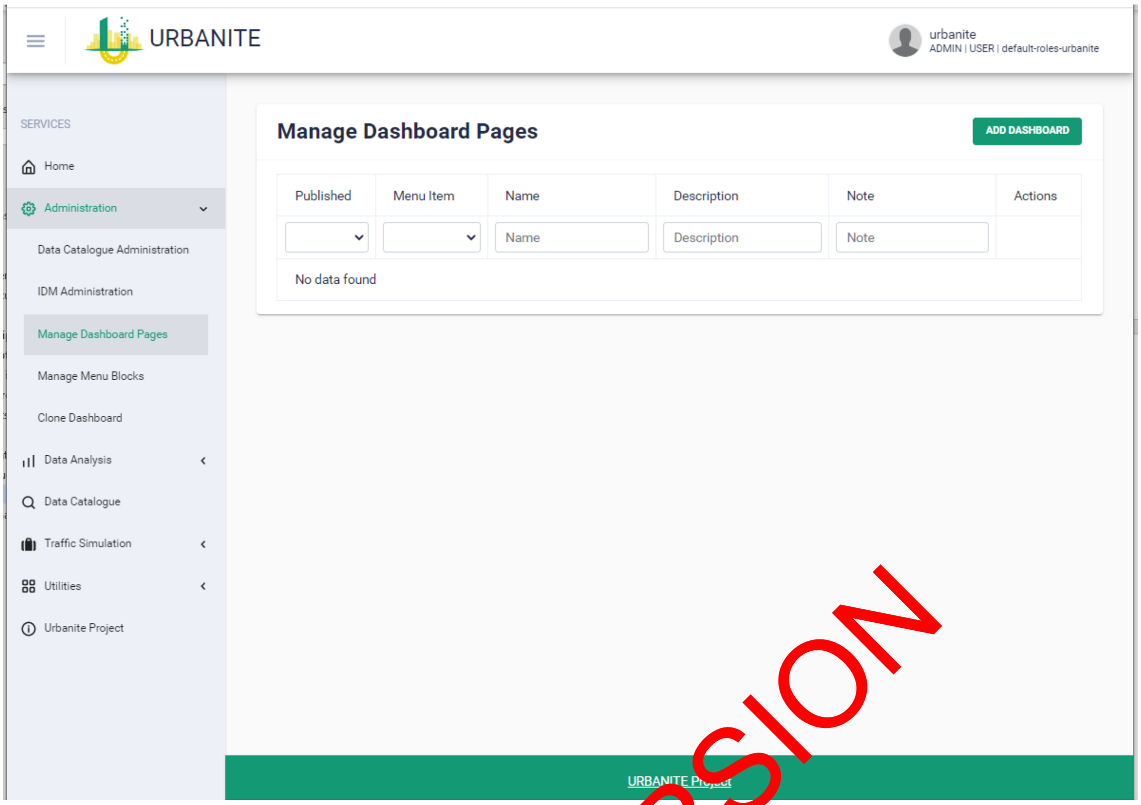
Active	▲Name	Country	Type	Level	Status	Added to CB	Datasets	Update Period	Last Update
ON	Bilbao pilot		DATASTORAGE	2	✓		169	1 day	2022-06-27 15:13:54

Figure 8.Administration: Data Catalogue Administration.



* Name	urbanite
Display name	Urbanite
HTML Display name	<div class="kc-logo-text"><span>Urbanite</span></div>
Frontend URL	
Enabled	ON
User-Managed Access	OFF
Endpoints	OpenID Endpoint Configuration SAML 2.0 Identity Provider Metadata

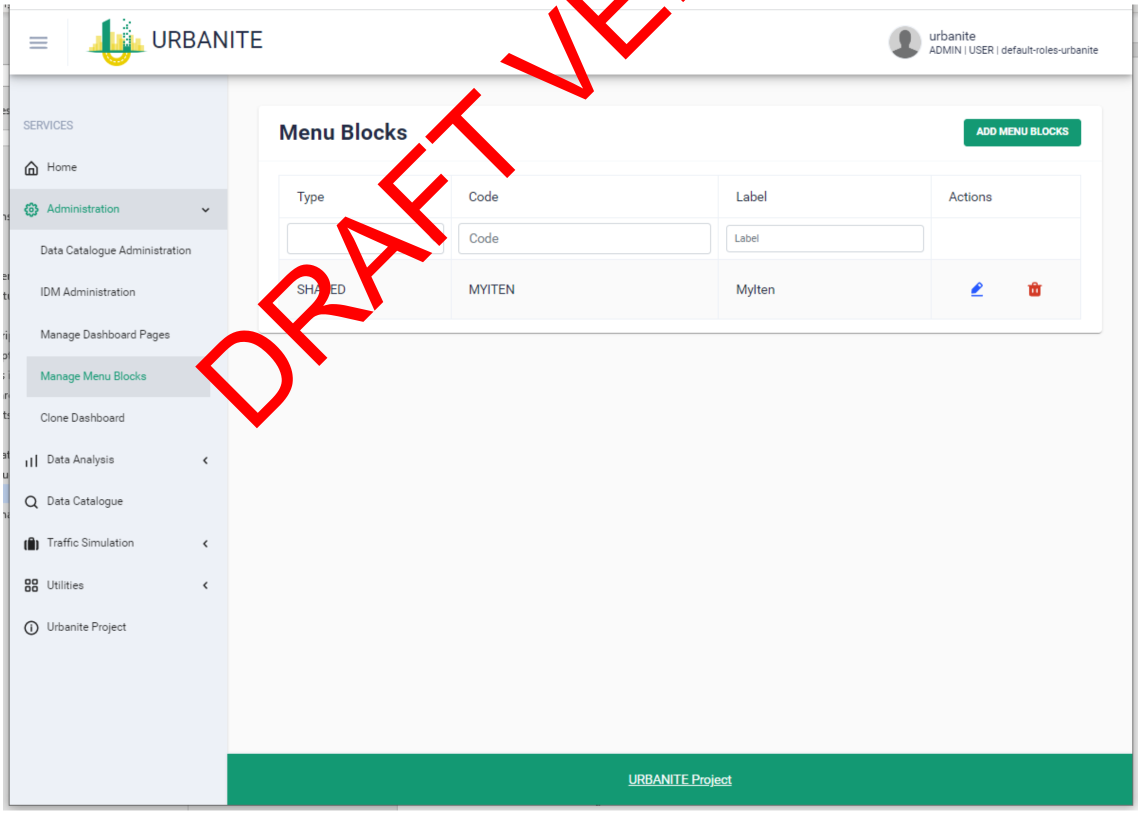
Figure 9.Administration: IDM Administration.



Manage Dashboard Pages

Published	Menu Item	Name	Description	Note	Actions
		Name	Description	Note	
No data found					

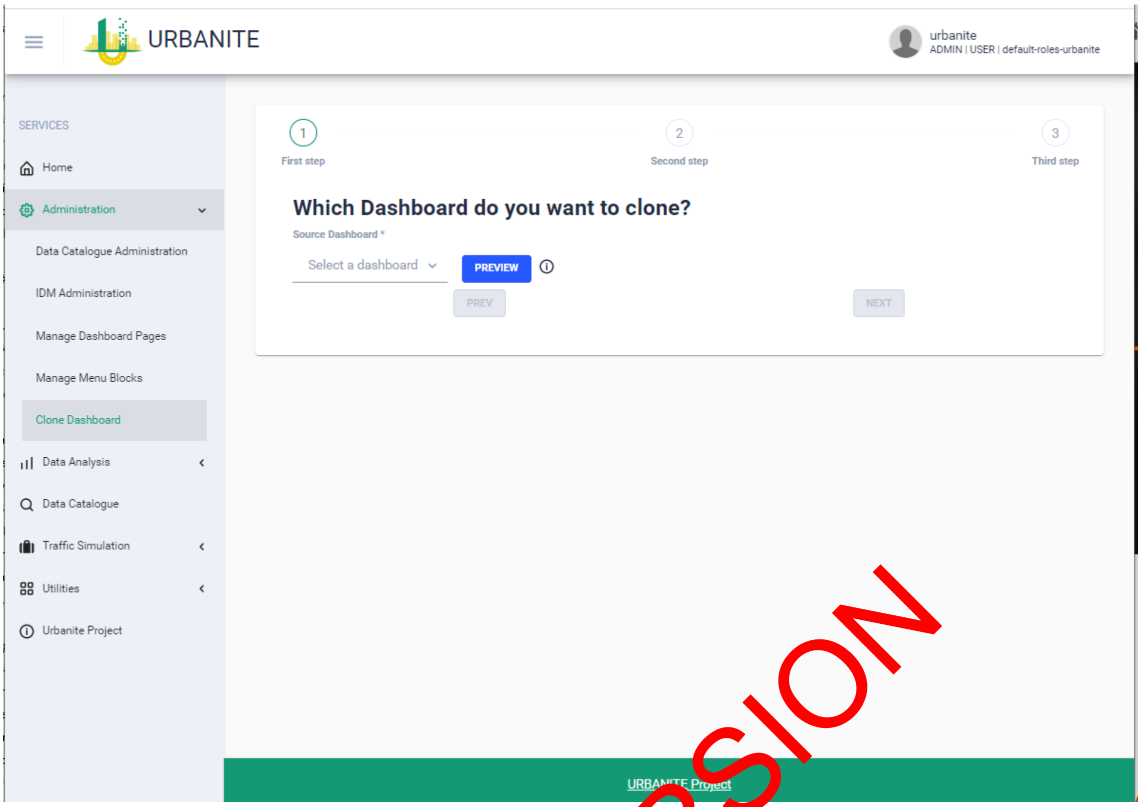
Figure 10.Administration: Manage Dashboard Pages.



Menu Blocks

Type	Code	Label	Actions
	Code	Label	
SHARED	MYITEN	MyIten	

Figure 11.Administration: Manage Menu Blocks.



URBANITE

urbanite
ADMIN | USER | default-roles-urbanite

SERVICES

- Home
- Administration
  - Data Catalogue Administration
  - IDM Administration
  - Manage Dashboard Pages
  - Manage Menu Blocks
  - Clone Dashboard
- Data Analysis
- Data Catalogue
- Traffic Simulation
- Utilities
- Urbanite Project

1 First step — 2 Second step — 3 Third step

Which Dashboard do you want to clone?

Source Dashboard *

Select a dashboard ⌄ PREVIEW ⓘ

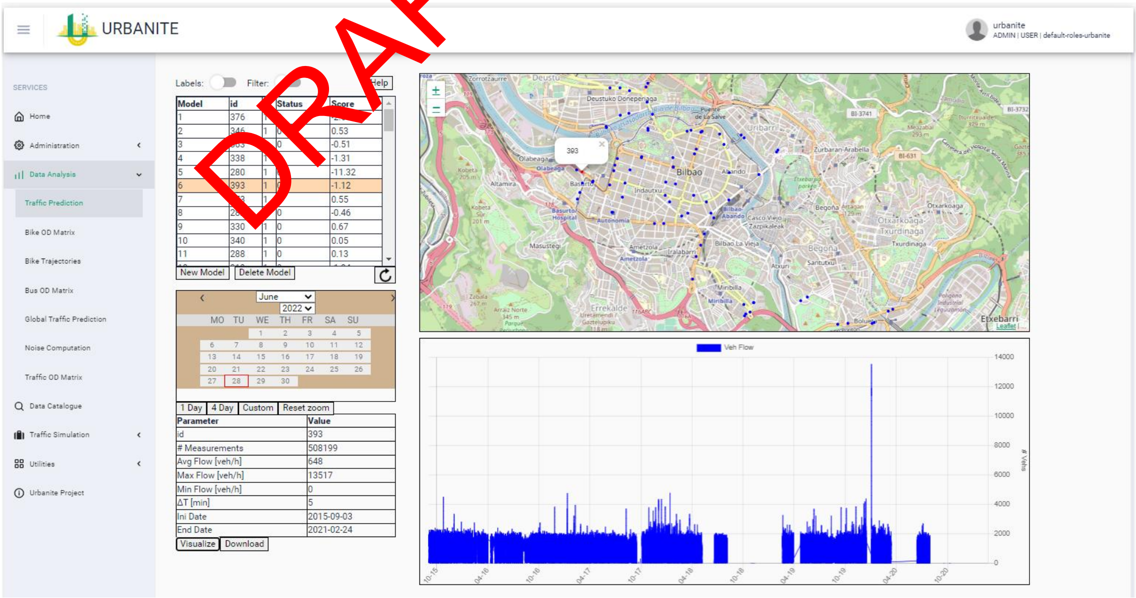
PREV NEXT

URBANITE Project

Figure 12.Administration: Clone dashboard.

- Data Analysis

Bilbao pilot provides all the modules developed for data analytics. All of them include a help button with information about how to use the specific analysis in order to obtain the desired results.



URBANITE

urbanite
ADMIN | USER | default-roles-urbanite

SERVICES

- Home
- Administration
- Data Analysis
  - Traffic Prediction
  - Bike OD Matrix
  - Bike Trajectories
  - Bus OD Matrix
  - Global Traffic Prediction
  - Noise Computation
  - Traffic OD Matrix
- Data Catalogue
- Traffic Simulation
- Utilities
- Urbanite Project

Labels: Filter: Help

Model	id		Status	Score
1	376	1	[illegible]	[illegible]
2	346	1	0	0.53
3	[illegible]	[illegible]	0	-0.51
4	338	1	[illegible]	-1.31
5	280	1	[illegible]	-11.32
6	393	1	[illegible]	-1.12
7	[illegible]	1	[illegible]	0.55
8	[illegible]	[illegible]	0	-0.46
9	330	1	0	0.67
10	340	1	0	0.05
11	288	1	0	0.13

New Model Delete Model

June 2022

MO	TU	WE	TH	FR	SA	SU
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

1 Day 4 Day Custom Reset zoom

Parameter	Value
id	393
# Measurements	508199
Avg Flow [veh/h]	648
Max Flow [veh/h]	13517
Min Flow [veh/h]	0
ΔT [min]	5
Ini Date	2015-09-03
End Date	2021-02-24

Visualize Download

Figure 13.Data Analysis: Traffic Prediction.

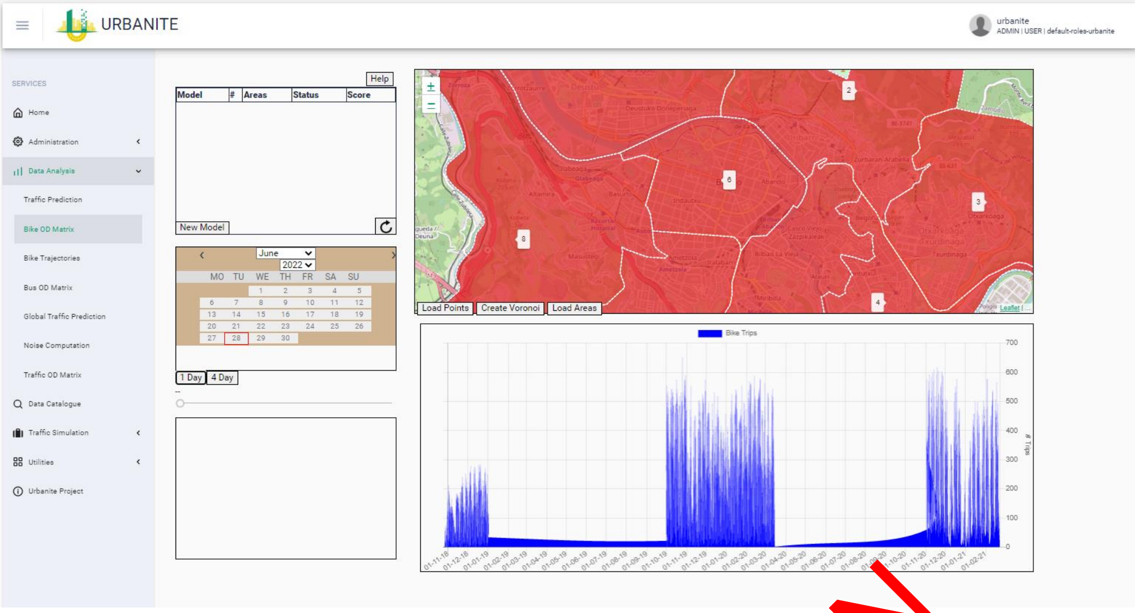


Figure 14.Data Analysis: Bike OD Matrix

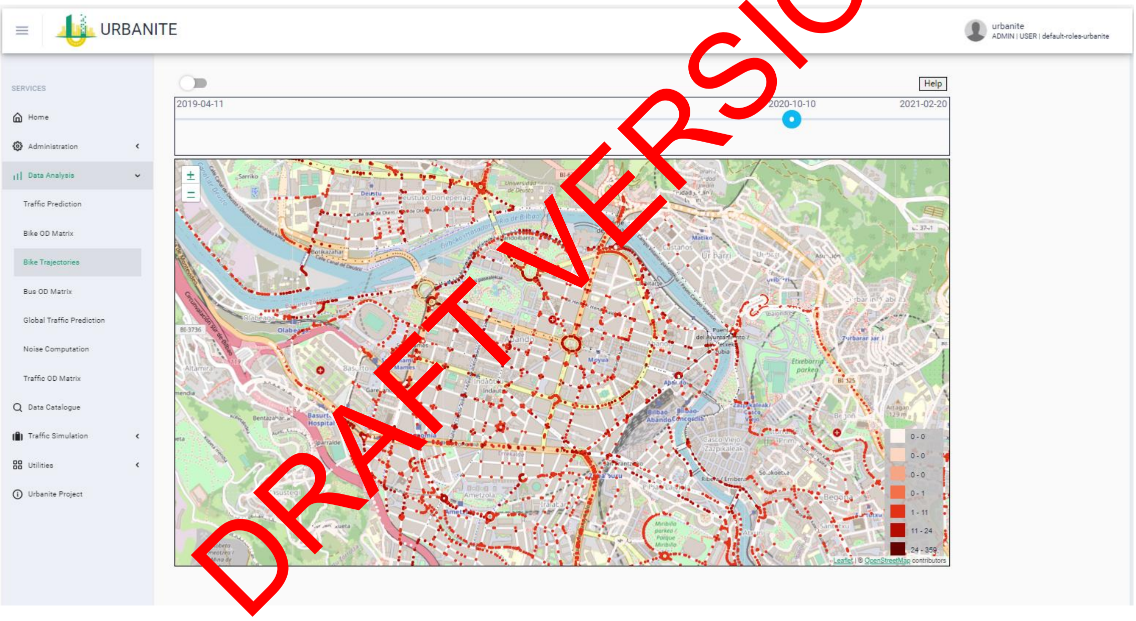
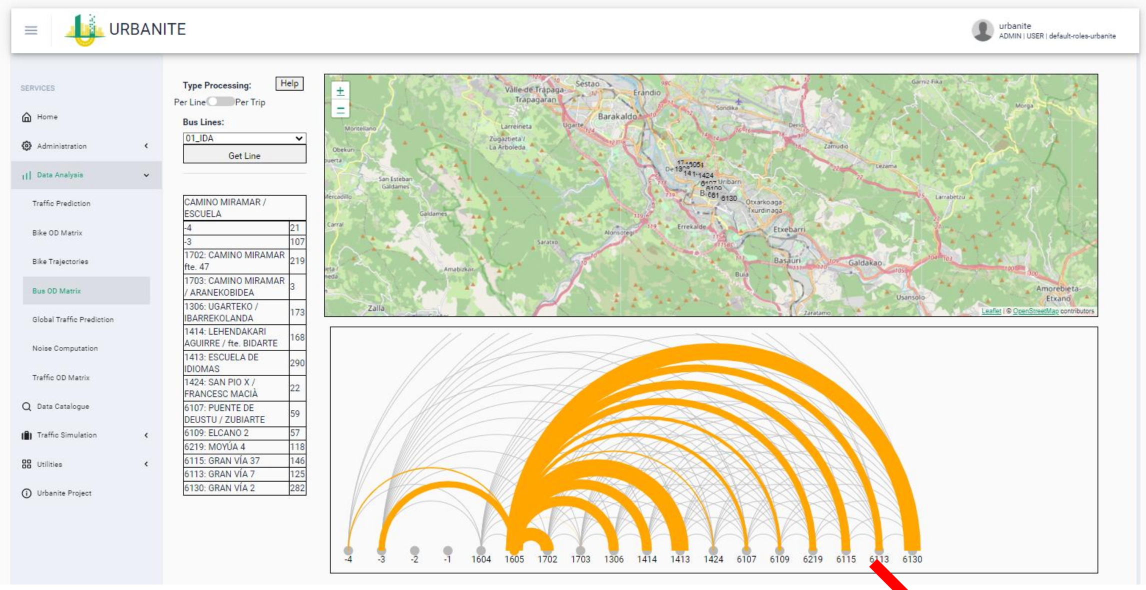


Figure 15.Data Analysis: Bike Trajectories

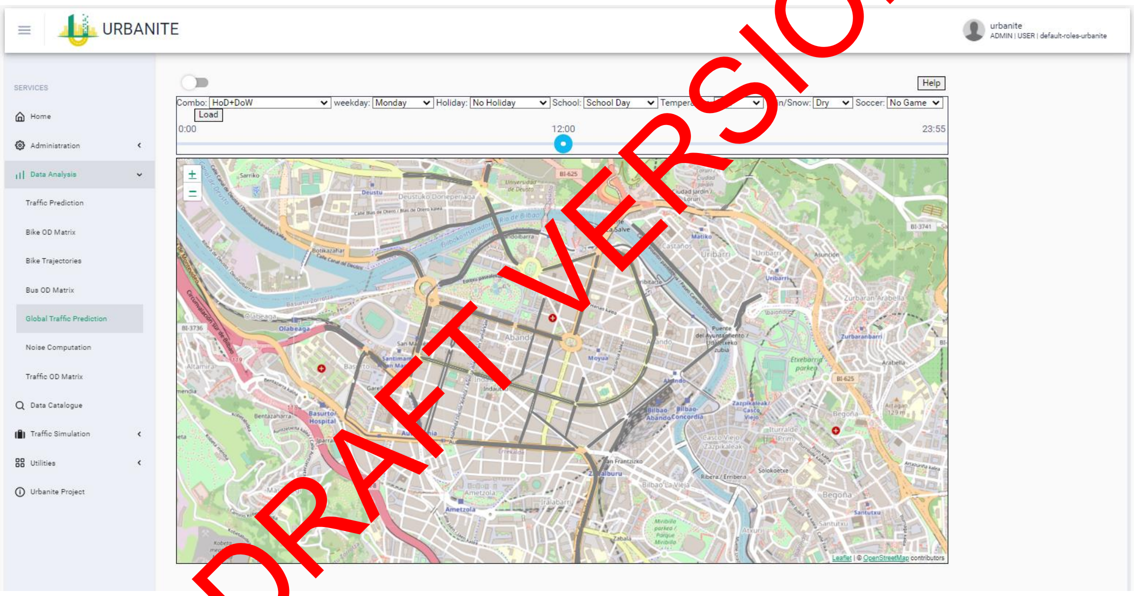


Type Processing: Per Line Per Trip

Bus Lines: 01_IDA

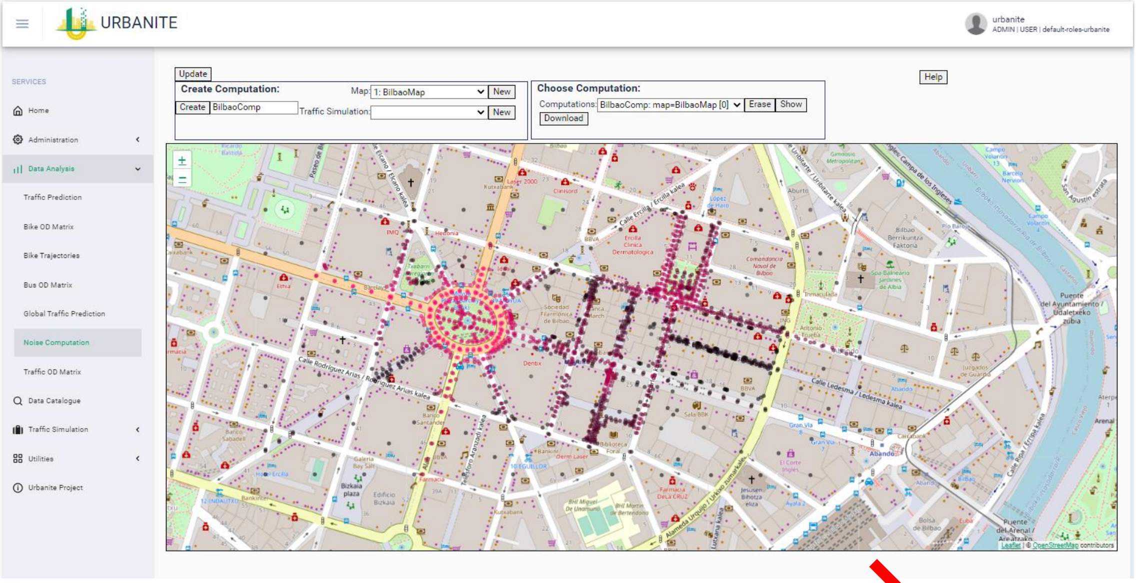
CAMINO MIRAMAR / ESCUELA	
-4	21
-3	107
1702: CAMINO MIRAMAR fte. 47	219
1703: CAMINO MIRAMAR / ARANEKOBIDEA	3
1306: UGARTEKO / IBARREKOLANDA	173
1414: LEHENDAKARI AGUIRRE / fte. BIDARTE	168
1413: ESCUELA DE IDIOMAS	290
1424: SAN PIO X / FRANCESC MACIÀ	22
6107: PUENTE DE DEUSTU / ZUBIARTE	59
6109: ELCANO 2	57
6219: MOYÚA 4	118
6115: GRAN VÍA 37	146
6113: GRAN VÍA 7	125
6130: GRAN VÍA 2	282

Figure 16.Data Analysis: Bus OD Matrix.



Combo: HoD+DoW weekday: Monday Holiday: No Holiday School: School Day Tempera… …in/Snow: Dry Soccer: No Game

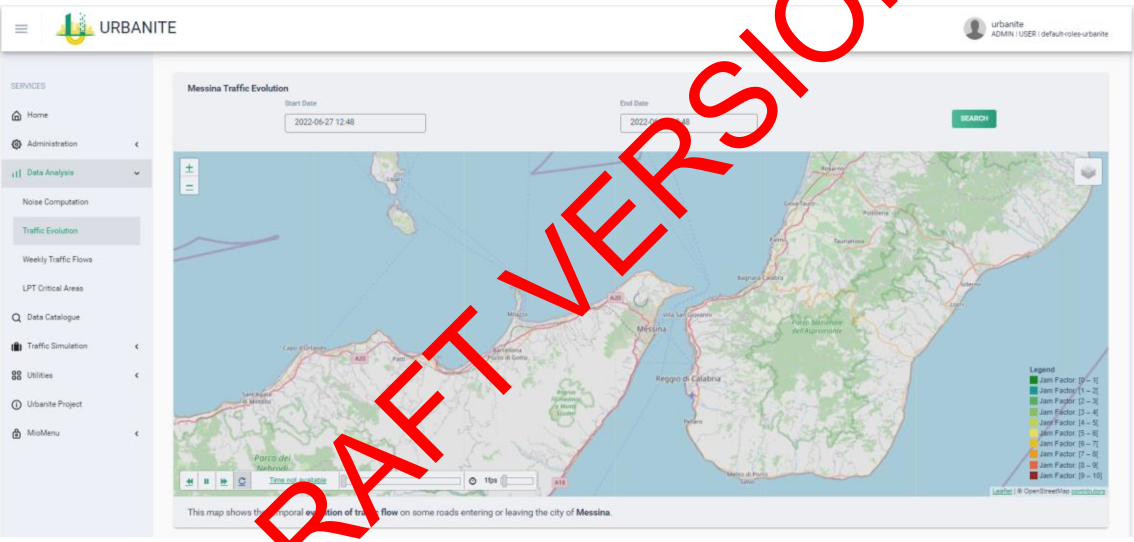
Figure 17.Data Analysis: Global Traffic Prediction.



Create Computation: Map: 1: BilbaoMap
BilbaoComp Traffic Simulation:

Choose Computation:
Computations: BilbaoComp: map=BilbaoMap [0]

Figure 18.Data Analysis: Noise Computation



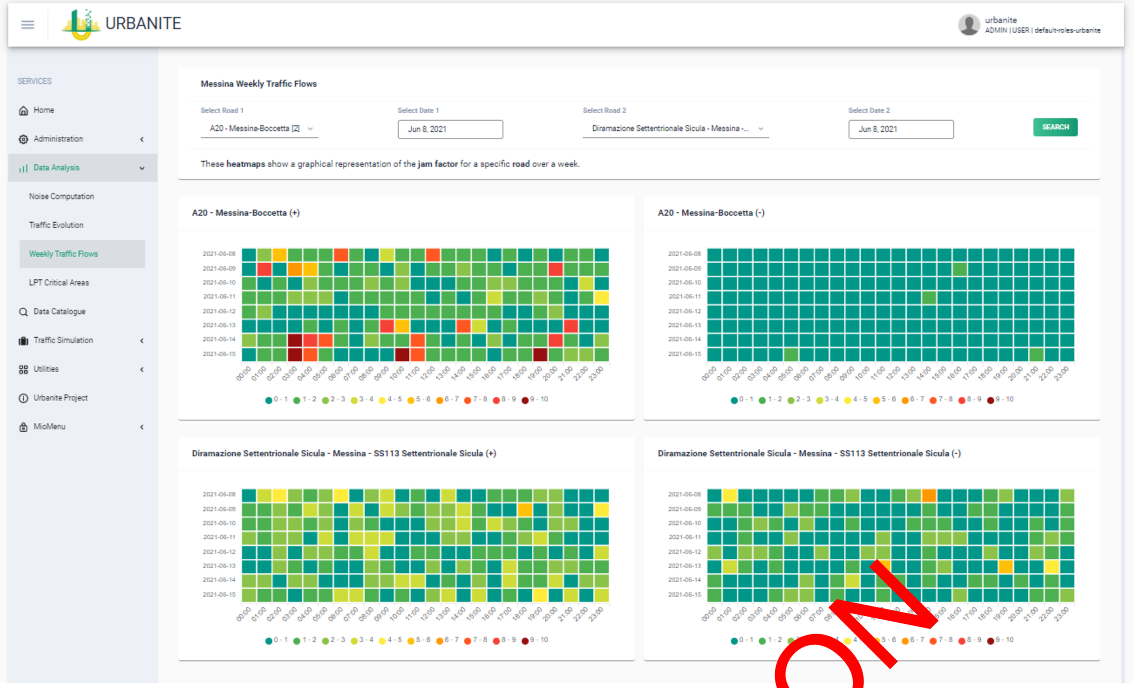
Messina Traffic Evolution

Start Date: 2022-06-27 12:48

End Date: 2022-0[illegible]48

This map shows the temporal evolution of traffic flow on some roads entering or leaving the city of Messina.

Figure 19.Data Analysis: Traffic Evolution

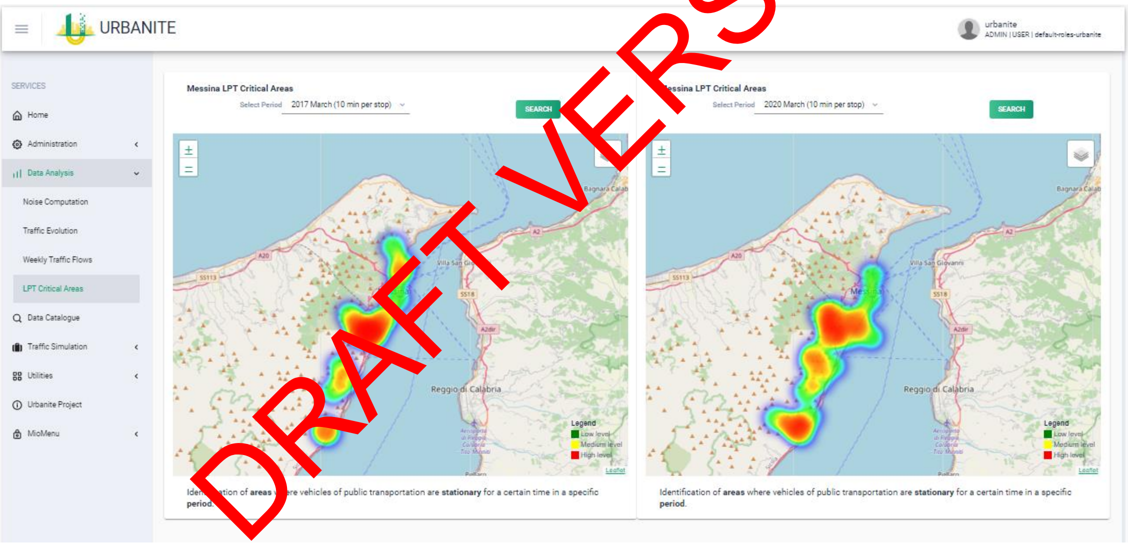


Messina Weekly Traffic Flows

Select Road 1: A20 - Messina-Boccetta [2]
Select Date 1: Jun 8, 2021
Select Road 2: Diramazione Settentrionale Sicula - Messina -...
Select Date 2: Jun 8, 2021

These **heatmaps** show a graphical representation of the **jam factor** for a specific **road** over a week.

Figure 20.Data Analysis: Weekly Traffic Flows



Messina LPT Critical Areas

Select Period: 2017 March (10 min per stop)

Identification of **areas** where vehicles of public transportation are **stationary** for a certain time in a specific **period**.

Messina LPT Critical Areas

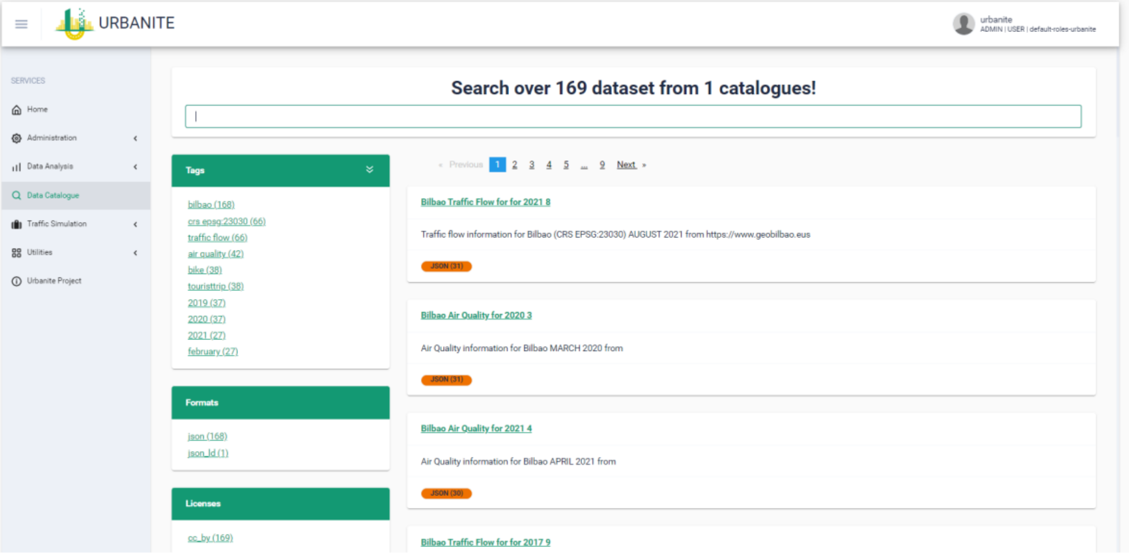
Select Period: 2020 March (10 min per stop)

Identification of **areas** where vehicles of public transportation are **stationary** for a certain time in a specific **period**.

Figure 21.Data Analysis: LPT Critical Areas

- Data catalogue

This option presents to the user the datasets available, and it allows to search among them selecting a predefined criterion.



Search over 169 dataset from 1 catalogues!

bilbao (168)
crs epsg:23030 (66)
traffic flow (66)
air quality (42)
bike (38)
touristtrip (38)
2019 (37)
2020 (37)
2021 (27)
february (27)

json (168)
json_ld (1)

cc_by (169)

Bilbao Traffic Flow for for 2021 8

Traffic flow information for Bilbao (CRS EPSG:23030) AUGUST 2021 from https://www.geobilbao.eus

JSON (31)

Bilbao Air Quality for 2020 3

Air Quality information for Bilbao MARCH 2020 from

JSON (31)

Bilbao Air Quality for 2021 4

Air Quality information for Bilbao APRIL 2021 from

JSON (30)

Bilbao Traffic Flow for for 2017 9

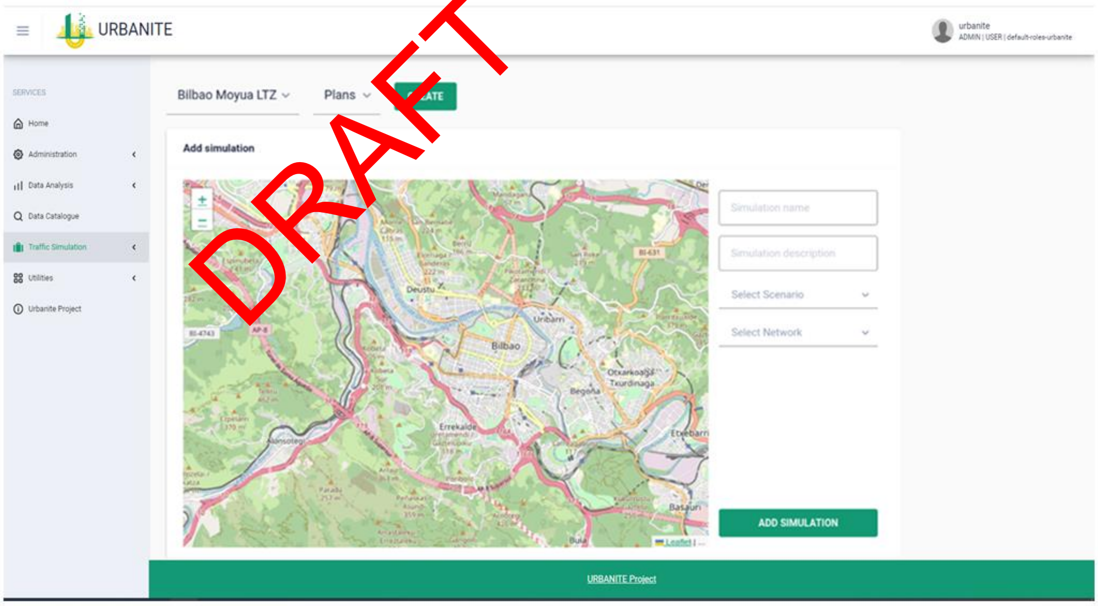
Figure 22.Data Catalogue

- Traffic Simulation

The Add simulation component allows the creation of a new simulation by entering name and description and selecting the appropriate scenario, network file and plans file.

When network is selected, it is visualized on the map. Differences between the map and the network should be highlighted.

Click on the Add simulation button creates the simulation.



Bilbao Moyua LTZ

Figure 23.Traffic Simulation: Create Simulation Page

Results:

The topmost part lists all simulations, their status as an icon, and buttons to select one or more simulations, to run them, run Decision Support System (calculate KPIs and perform decision analysis).

The map below shows the visualization of selected simulations' KPIs. Layers shown on top right allow for selection or simulation to visualize and the checkboxes below the map allow the selected of KPI to visualize.

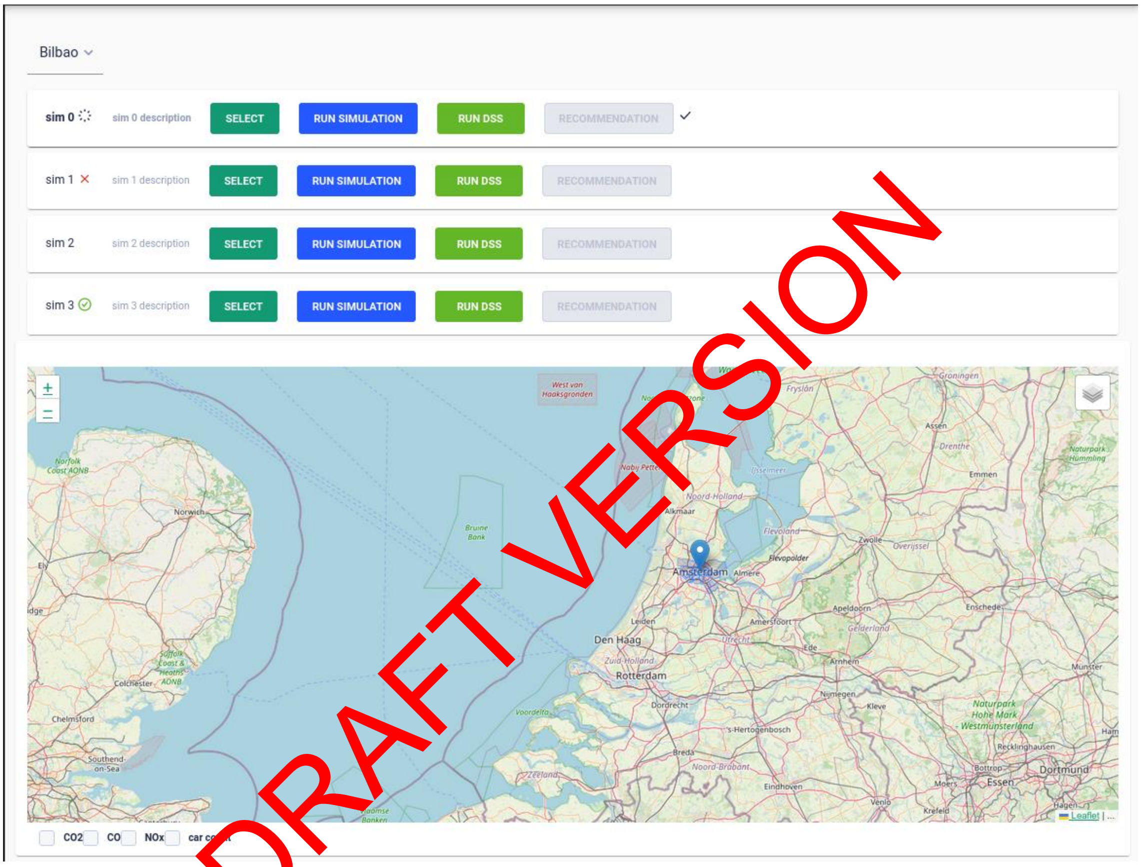
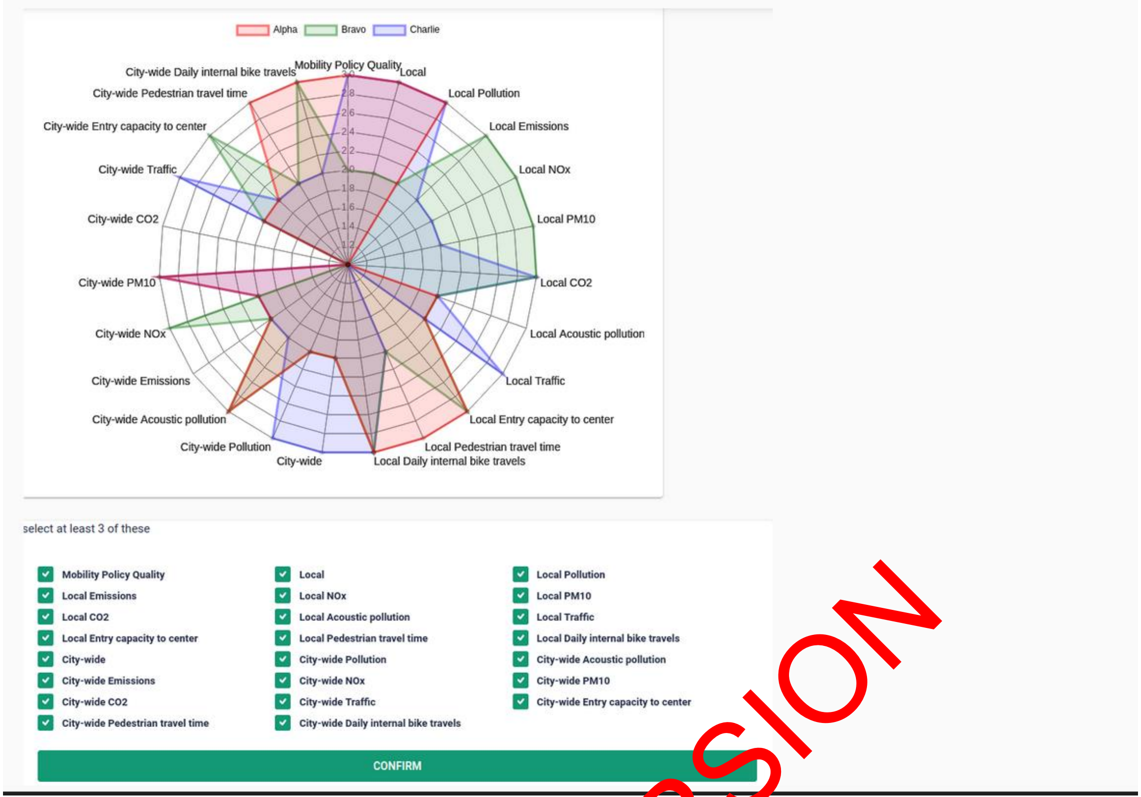


Figure 24.Traffic Simulation: Available simulations

Figure 25 shows the decision analysis results. Each selected simulation's KPI are shown in different color. Below, the KPIs and aggregated KPIs are listed, allowing the selection of specific KPIs to compare.



select at least 3 of these

☑ Mobility Policy Quality
☑ Local Emissions
☑ Local CO2
☑ Local Entry capacity to center
☑ City-wide
☑ City-wide Emissions
☑ City-wide CO2
☑ City-wide Pedestrian travel time

☑ Local
☑ Local NOx
☑ Local Acoustic pollution
☑ Local Pedestrian travel time
☑ City-wide Pollution
☑ City-wide NOx
☑ City-wide Traffic
☑ City-wide Daily internal bike travels

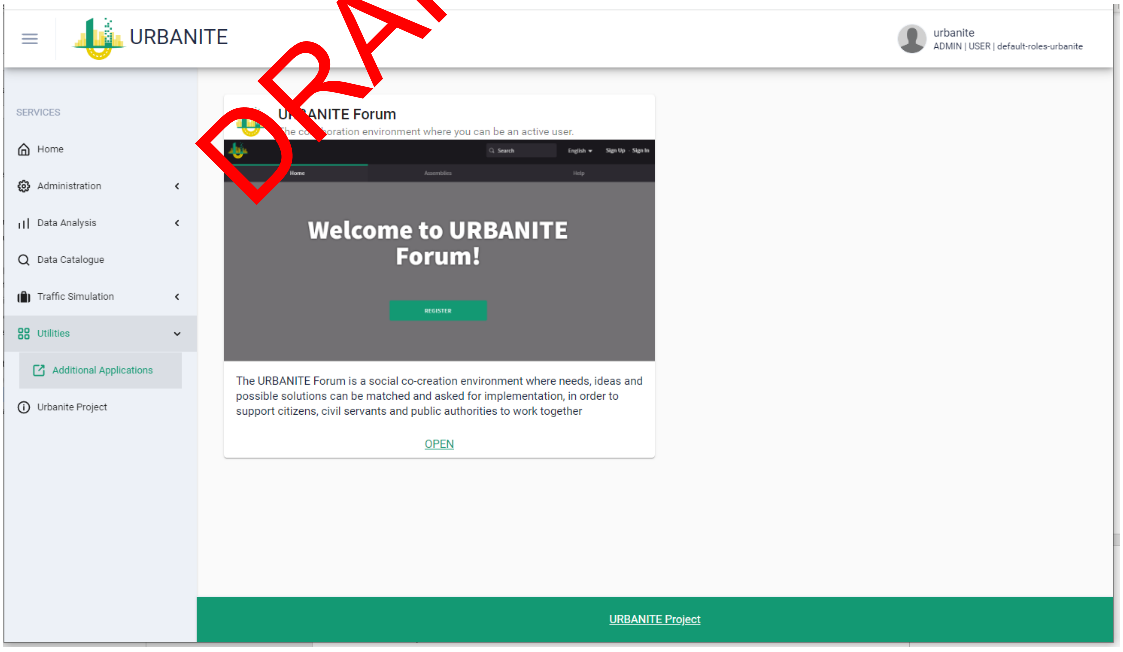
☑ Local Pollution
☑ Local PM10
☑ Local Traffic
☑ Local Daily internal bike travels
☑ City-wide Acoustic pollution
☑ City-wide PM10
☑ City-wide Entry capacity to center

CONFIRM

Figure 25.Traffic Simulation: Decision Analysis results

- Utilities.

The URBANITE Forum is included as an additional application. The URBANITE GUI allows to integrate external tools to be accessible to the users from the URBANITE GUI.



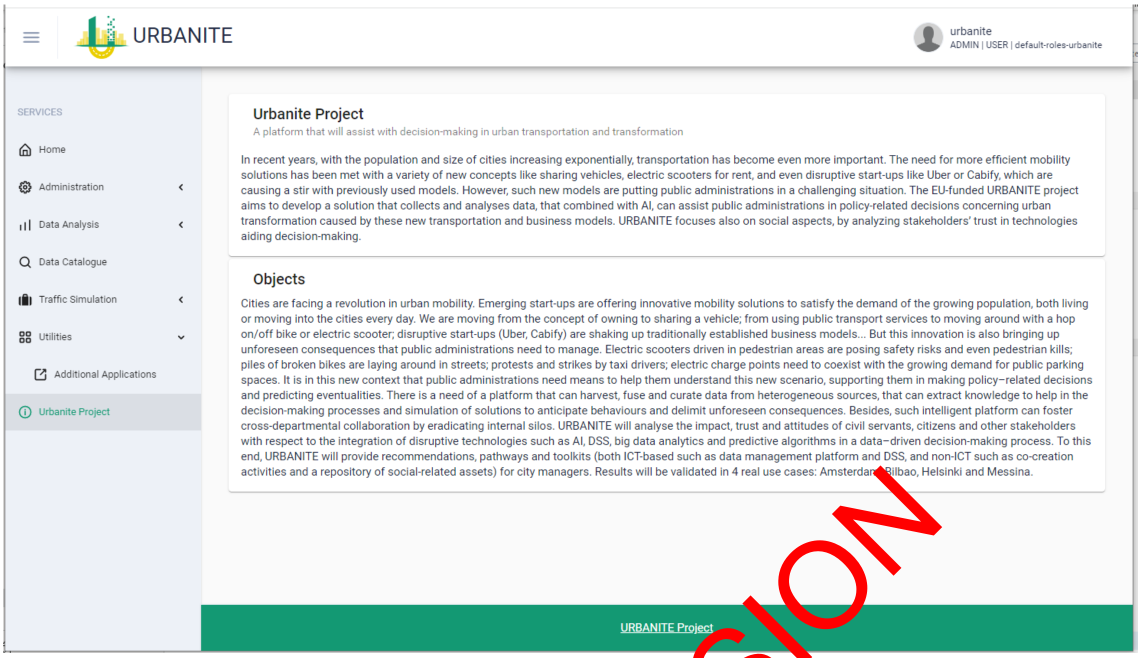
URBANITE Forum

The co-creation environment where you can be an active user.

The URBANITE Forum is a social co-creation environment where needs, ideas and possible solutions can be matched and asked for implementation, in order to support citizens, civil servants and public authorities to work together

Figure 26.Utilities: URBANITE Forum as Additional Application

- Urbanite Project with general information of the project and a link to the public page of it (https://urbanite-project.eu/)



Urbanite Project

A platform that will assist with decision-making in urban transportation and transformation

In recent years, with the population and size of cities increasing exponentially, transportation has become even more important. The need for more efficient mobility solutions has been met with a variety of new concepts like sharing vehicles, electric scooters for rent, and even disruptive start-ups like Uber or Cabify, which are causing a stir with previously used models. However, such new models are putting public administrations in a challenging situation. The EU-funded URBANITE project aims to develop a solution that collects and analyses data, that combined with AI, can assist public administrations in policy-related decisions concerning urban transformation caused by these new transportation and business models. URBANITE focuses also on social aspects, by analyzing stakeholders' trust in technologies aiding decision-making.

Objects

Cities are facing a revolution in urban mobility. Emerging start-ups are offering innovative mobility solutions to satisfy the demand of the growing population, both living or moving into the cities every day. We are moving from the concept of owning to sharing a vehicle; from using public transport services to moving around with a hop on/off bike or electric scooter; disruptive start-ups (Uber, Cabify) are shaking up traditionally established business models... But this innovation is also bringing up unforeseen consequences that public administrations need to manage. Electric scooters driven in pedestrian areas are posing safety risks and even pedestrian kills; piles of broken bikes are laying around in streets; protests and strikes by taxi drivers; electric charge points need to coexist with the growing demand for public parking spaces. It is in this new context that public administrations need means to help them understand this new scenario, supporting them in making policy–related decisions and predicting eventualities. There is a need of a platform that can harvest, fuse and curate data from heterogeneous sources, that can extract knowledge to help in the decision-making processes and simulation of solutions to anticipate behaviours and delimit unforeseen consequences. Besides, such intelligent platform can foster cross-departmental collaboration by eradicating internal silos. URBANITE will analyse the impact, trust and attitudes of civil servants, citizens and other stakeholders with respect to the integration of disruptive technologies such as AI, DSS, big data analytics and predictive algorithms in a data–driven decision-making process. To this end, URBANITE will provide recommendations, pathways and toolkits (both ICT-based such as data management platform and DSS, and non-ICT such as co-creation activities and a repository of social-related assets) for city managers. Results will be validated in 4 real use cases: Amsterdam, Bilbao, Helsinki and Messina.

Figure 27. URBANITE Project

The final release of the URBANITE Ecosystem, which will be described in the D5.9 deliverable, will include a more detailed manual and user guide according to the final features provided by the platform.

3.4 Licensing information

The license under which this prototype is delivered is not decided yet. It is a future work to take that decision depending on the licenses of the different components that will be part of the final URBANITE Ecosystem.

3.5 Download

The code is uploaded and available by now in the project GitLab repository:

https://git.code.tecnalia.com/urbanite/releases

The testable version of this M27 prototype can be checked accessing to the different deployed pilots, where a stable version of this prototype is available per each of them:

https://amsterdam.urbanite.esilab.org

https://bilbao.urbanite.esilab.org

https://helsinki.urbanite.esilab.org

https://messina.urbanite.esilab.org

These environments will not be immutable since they gather the versions of the components the technical partners develop and test in every moment of the project.

4 Conclusions

This document corresponds with the report accompanying the intermediate prototype of the URBANITE Ecosystem, which is the M27 release. It contains the description of the prototype from a functional and technical point of view, considering the not final status of the components that form the prototype. Some of the components are not integrated yet but they will be in the final version of the URBANITE Ecosystem.

This is the second version of the URBANITE Ecosystem due to M27. The next version will be reported as D5.9 deliverable and released in Month 33. The incremental approach followed along the project is continuously improving the functionalities provided and adding new ones if needed.

The description of the final URBANITE Ecosystem will describe as covered the majority of the requirements and a complete manual for making the platform more usable.

The license under the URBANITE Ecosystem will be offered, is still under study, because it is a decision to take as part of the tasks of WP7 and will be taken by the whole consortium considering the licences of the individual components that compose this integrated version.

5 References

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[11] URBANITE Consortium, «D3.7 Data Aggregation and Storage module implementation,» 2021.

[12] URBANITE Consortium, «D4.2 Implementation of Strategies and algorithms for data modelling and visualizations,» 2022.

[13] URBANITE Consortium, «D6.2 URBANITE Use cases implementation».