

**D6.2 Validation and Evaluation of the Optimized City and Mobility Planning Use Case**

**V2**

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# Introduction

## Objective of this document

This Deliverable 6.2 -Validation and Evaluation of the Optimized City and Mobility Planning Use Case v1 deals with the validation tests performed in the task 6.2, Spanish pilot (task 6.2.1). Version 1 of the deliverable is due to submit in M24 and will be followed by version 2 in M33.

In the use case on Optimized City and Mobility Planning, an advanced application will be built for providing planning services and mobility information both for citizens and for city authorities considering relevant information such as contamination or traffic conditions. All the information will be analyzed in real-time through dashboards.

The *Optimized City and Mobility Planning* will consider multi-modal mobility taking into account public and private transportation, awareness of energy usage, environmental conditions, pollution levels, travel costs and durations. The application will consider personalized preferences and constraints, this data will be used to optimize the route to be calculated.

As for the relation to other work in ESTABLISH project we have to emphasize that the task 6.2 reflects the work of all previous work packages (pilots’ specification, development and realization) and as for the validation processes the document D6.1 was created which provided the evaluation methodology in order to assess if all requirements were accomplished.

This document contains the initial objective validation and evaluation of the use case developed by Hi-Iberia y Prodevelop with the strengths and weaknesses of the current status of it. This information will be used to improve the final version of the pilot.

## Structure of this document

This deliverable is composed of five sections. This introduction is followed by sections with the tables of tests. The test tables were overtaken from D3.3 and methodology from D6.1. The test tables were added by test results and will be followed by section of validation assessment. The positive validation process assumes no critical failures within the tests. Evaluation, i.e. system works according to requirements, is described in the last chapter - Conclusion.

# Generic Applied methodology for evaluation

The methodology elaborated in D6.1 was adopted. This methodology has 4 steps:

* Step 1: selection of parameters to be evaluated
* Step 2: definition of the possible methods to be used to evaluate each property
* Step 3: Set de standards to collect the evidence
* Step 4: Reporting and decision making

The evaluation process focused at the recommended set of parameters both generic and use case (pilot) specific.

The generic ones are:

* Meeting general project objectives
* Meeting use case specific objectives
* System performance
* Privacy and security issues
* Feedback system performance
* System satisfaction

The specific ones recommended are:

* Self-awareness and self-adaptability
* Sensor system performance
* Visualization framework
* Management platform
* Big data management /processing
* Event processing
* Completeness of the use case
* Non-redundancy
* Operability
* Data sources utilization
* Storage, recording of the data
* Scope of the monitoring
* Monitoring applications
* Implementation
* Validation and integration within aimed domains
* Privacy and security
* Stakeholders’ Feedback

In the Table 1 of the deliverable D6.1 the details of what the parameters mean (including examples) were provided.

The deliverable D6.1 also recommended to make optional selection of parameters which are highly relevant for evaluation of the specific use case (pilot).

Table 1 Table of the relevant parameters within use case 1.

|  |  |
| --- | --- |
| Parameter | In use case  |
| How the system copes with Self-awareness and self-adaptability | 🗷 |
| Meeting objectives | 🗷 |
| Systems’ performance | 🗷 |
| Visualization framework | 🗷 |
| Management platform | 🗷 |
| Big data management | 🗷 |
| Event processing | 🗷 |
| Use case implementation | 🗷 |
| Redundancy percentage |  |
| Usability | 🗷 |
| Data sources utilization | 🗷 |
| Storage, recording of the data | 🗷 |
| Implementation | 🗷 |
| Validation and integration within aimed domains | 🗷 |
| Privacy and security  | 🗷 |
| Stakeholders’ feedback | 🗷 |
| IoT Interoperability |  |
| Reliability of simulations / predictions | 🗷 |
| Portability | 🗷 |

According to the chapter 2.2 of the deliverable D6.1 the evaluator

* chosen criteria to use for the evaluation based on the guidelines in Step 1,
* determined the evidence that will be collected for each chosen criterion,
* determined the sample that will be used, if appropriate,
* determined ways to collect the evidence and,
* set up a plan to collect the evidence,

.

In line with the chapter 2.3 of the deliverable D6.1 the evaluator

* informed the client of the scales that will be used to determine quality,

then the client

* developed the decision-making process to use based on the evaluated performance quality and
* set the standards that will be used in decision-making.

After the client has set the standards, the evaluator

* collected the evidence and
* documented the findings.

# Detailed methodology for the use case

The properties to be evaluated for the use case are described in this section.

## Self-awareness and self-adaptability

|  |
| --- |
| **Description** |
| How well the system is adapting to the environmental changings. Adaptability includes the introspection of the system operation and how well the system’s high-level goals are met and how to make the system meet the goals / make system reach the desired state |
| **Methods**  |
| Researcher’s rough evaluation of how much the adaptability of the system components has been realised and working properly. |
| **Accomplishment Scale** |
| Self- awareness and self-adaptability scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Meeting objectives

|  |
| --- |
| **Description** |
| How well it was possible to meet the technical objectives in the project. All the technical requirements specified for the use case will be evaluated |
| **Methods**  |
| Researcher’s rough evaluation of how much the technical requirements of the system components has been realised and working properly. |
| **Accomplishment Scale** |
| Meeting objectives :* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Systems’ performance

|  |
| --- |
| **Description** |
| How well system performs in terms of quality of service (QoS), battery life/power consumption, latency, network coverage, network range, deployment model (?), cost and security.The Response time to make some calculations/analysis is inside the acceptable time |
| **Methods**  |
| All the components of the systems will be measured to obtain the response time.An acceptable response time for a website will be less than 1 secondAn acceptable response time for a mobile application will be less than 1 secondAn acceptable response time to calculate the optimized route should be less than 5 seconds.An acceptable data set update/synchronization time should be less than the refresh time for each data set  |
| **Accomplishment Scale** |
| System’s Performance scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Visualization framework

|  |
| --- |
| **Description** |
| How well the visualisation framework (i.e. Dashboard) meets the end-users needs and how well it performs data search, interpretation, contrasting and comparing and includes at a glance views of key performance indicators (KPIs).There are different needs for different stakeholders and there is also different type of dashboards that can be used (strategic, analytic, operational, and informational). It has to be evaluated how well the visualisation framework serves each intended stakeholder.*Strategic dashboards*: visualises high-lever measures of performance, forecasts, might include static snapshots of data*Analytic dashboards*: include more context, comparison and history along with subtler performance evaluators*Operational dashboards*: monitoring activities and events that are constantly changing and might require attention and response at short notice*Informational dashboards*: System or user or operator information are included if they are not included at above dashboards.  |
| **Methods**  |
| Researcher’s rough evaluation of how much the Dashboards of the system components has been realised and working properly. |
| **Accomplishment Scale** |
| Visualization scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Management platform

|  |
| --- |
| **Description** |
| Management of system’s entities– operators, sensors, gateways, organizing logs, warnings, remote access possibilities, entering of data, user-friendliness, etc.) |
| **Methods**  |
| Researcher’s rough estimation of the platform’s costs / year / user vs target costs and estimation on the ease of making modifications to the system |
| **Accomplishment Scale** |
| Management scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Big data management

|  |
| --- |
| **Description** |
| How well the data acquisition, storing and processing was realised. Were there data losses, problems with data storing? Were there batch processing or real-time/stream-based processing? |
| **Methods**  |
| Researcher’s rough estimation on the big data management tools, their suitability and robustness |
| **Accomplishment Scale** |
| Big data Management scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

Satisfying: The use case is running using containers technologies. The system is scalable, and it is possible to create new container instances in case it is needed more resources. The storage system selected is elasticsearch, a No SQL-Database that is also scalable. The most critical resource is the disk space that has been emptied since the start of the project.

It should be interesting to include a resource manager component to monitor the resources of the system and send alerts if required.

## Event processing

|  |
| --- |
| **Description** |
| The evaluator has in mind a full processing chart, starting at event sources (which system part generated data) continuing over event processor towards event consumer and reactions to events. |
| **Methods**  |
| Researcher checks the important communication junctions.  |
| **Accomplishment Scale** |
| Event processing scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Use case implementation

|  |
| --- |
| **Description** |
| Evaluate the progress of all the components-subsystems to be developed and the integration between them Main components to be evaluated are:* Open data management
* Data fusion
* Traffic simulation platform
* Mobile application
* web application
* multimodal route planner
* dashboard

Integration evaluation:* use of open data information in all the developments
* integration of the components in the web
* integration of the component in the app
* representation of the results of the route planner into the dashboard
 |
| **Methods**  |
| Ask with all the partners involved in the development for the progress (%) of each component and the planification of the different developments.If it is possible (demo available), check the current development progress  |
| **Accomplishment Scale** |
| General % of accomplishment and the expected progress  |

## Redundancy percentage

|  |
| --- |
| **Description** |
| What is the percentage of the same parameters that come from multiple sources(except the cases when the redundancy is required). |
| **Methods**  |
| Researcher’s rough estimation on the percentage of the parameters collected that were measured from more than 2 sources |
| **Accomplishment Scale** |
| Redundancy scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Usability

|  |
| --- |
| **Description** |
| Does software operability follow good practice which tends to be simpler to operate and maintain, with a reduced cost of ownership, and almost certainly fewer operational problems. |
| **Methods**  |
| Researcher performs Usability and static code analysis for ensuring reliability, safety, security of software. |
| **Accomplishment Scale** |
| Usability scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Data sources utilization

|  |
| --- |
| **Description** |
| Are data sources used in optimal way? Do we have overloaded data sources? Do we have space for system optimization in this respect? |
| **Methods**  |
| Monitor data communication channels in process of system implementation. |
| **Accomplishment Scale** |
| Data source scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Storage, recording of the data

|  |
| --- |
| **Description** |
| What percentage of the stored data is useful and reliable? |
| **Methods**  |
| Researcher’s rough estimation of the good quality data percentage of / Amount of stored data / person |
| **Accomplishment Scale** |
| Storage source scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Implementation, Validation and integration within aimed domains

|  |
| --- |
| **Description** |
| Evaluate how the use case fits to the aimed domain in such details as: Do we have designed proper user communication interfaces? Do we have developed compatible system components? Do we have missed any standard? |
| **Methods**  |
| User interface is adapted to the device which client uses, e.g. mobile device, desktop, tablet. |
| **Accomplishment Scale** |
| Implementation and validation scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Privacy and security

|  |
| --- |
| **Description** |
| How secure is the system and how well privacy is guaranteed |
| **Methods**  |
| Researcher’s rough estimation of the security of the system and privacy of the data stored |
| **Accomplishment Scale** |
| Implementation and validation scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Stakeholders’ feedback

|  |
| --- |
| **Description** |
| How satisfied the participants were with the pilot as a whole |
| **Methods**  |
| How likely is it that you would recommend our company/product/service to a friend or colleague? |
| **Accomplishment Scale** |
| Implementation and validation scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## IoT Interoperability

|  |
| --- |
| **Description** |
| Ease of using other types of sensors and communication protocols, or the ease of using several iot platforms at the same time. |
| **Methods**  |
| System is operable even though the sensors communicate with the platform over the various protocols. |
| **Accomplishment Scale** |
| Implementation and validation scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Reliability of simulations / predictions

|  |
| --- |
| **Description** |
| Determine the quality of the simulations and predictions that the system performs. To do this, we would have to compare the predictions with what really happens. |
| **Methods**  |
| Compare the traffic simulation models, pollution predictions and event processors with the real data. These comparisons are not trivial because there is not a registry with all this information. |
| **Accomplishment Scale** |
| Reliability of simulations / prediction scale scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

## Portability

|  |
| --- |
| **Description** |
| Understanding portability, how easy it is to adapt and apply the pilot to other cities or other buildings. How coupled the software systems is developed? |
| **Methods**  |
| Evaluate which components are most dependent on the city chosen for the case of use and which are most easily adaptable. |
| **Accomplishment Scale** |
| Reliability of simulations / prediction scale scale:* Excellent
* Very good
* Satisfying
* Poor
* Very poor
 |

# Initial validation and evaluation of of the Optimized City and Mobility Planning Use Case (M24)

## Restrictions of the evaluation process

In the current state of the pilot, there are certain properties that cannot be evaluated because we do not have the final version and several components are not available.

Currently, the first versions of all the modules that make up the use case have been developed: A route planner, simulation and prediction platforms, Complex event processor and dashboards.

It is not available a web that agglutinates all the developments, nor the mobile application for the citizens.

For the final evaluation we will be able to evaluate all the properties and compare them with the results obtained for version 1.

## Evaluation Results

|  |  |  |  |
| --- | --- | --- | --- |
| ***Parameter*** | **UC1** | **Result** | **Description** |
| *Self-awareness and self-adaptability* |   | Poor | This property was not included in the initial non-functionality requirements of the use case, for that reason the use case has poor result for this property. Most of the components are not prepared to adapt itself in case that a problem happens.  |
| *Meeting objectives*  |  | Very good | Many of the technical requirements of the use case are fully or partially fulfilled with the current state of the components. It is expected that these requirements will be fully met by the final version of the use case application. |
| *Systems’ performance* |  | Very good |  The system is obtaining data from the Open data since 2017. Currently there are more than 10gb of information stored in the data base (old data has been removed periodically) The response time of the route planner is less than 5 seconds, and the response time of the current web site is less than 1 second. The dashboard takes more than 1 second to refresh because lots of calculations are made. The mobile app in not available |
| *Visualization framework* |  | Very good | The system provides two types of dashboards. The first one is for the town hall and contain different visualizations for strategic, analytic and operational uses. The users have control over the different visualizations and can create/update them. The second one is for citizens, it is an informational dashboard to consult the status and trends of some indicators and data sets |
| *Management platform* |  | Satisfying | The system has a device and user manager that allows you to configure the different devices and users to be available in the system. Moreover, this device manager contains an API, to allow third parties to access to the main functionalities though it. Some component does not use the device manager to update its behaviour taking into account the new available devices.For the next version, a CEP manager system will be included. This component will allow users to create dynamically new CEP rules at runtime. |
| *Big data management* |  | Satisfying | The use case is running using containers technologies. The system is scalable, and it is possible to create new container instances in case it is needed more resources. The storage system selected is elasticsearch, a No SQL-Database that is also scalable. The most critical resource is the disk space that has been emptied since the start of the project.It should be interesting to include a resource manager component to monitor the resources of the system and send alerts if required. |
| *Event processing* |  | Satisfying | The system provides access to the raised events though the dashboard. When the final app will be available, the user could receive customized notifications. |
| *Use case implementation (Completeness of use case)* |  | Accomplishment 70% | The initial versions of all components have been developed and are being improved. In a few months we will have the final versions of them and a mobile app to interact with them. |
| *Redundancy percentage (Non-redundancy)* |   |   | This property was not included in the initial non-functionality requirements of the use case, for that reason the use case has poor result for this property. The use case does not use sensor information directly, it uses data from open data sources and web services.  |
| *Usability*  |  | Very good |  The software components have been developed following best developing guidelines and with a scalable architecture. A static code analysis for java has been used to ensure the quality of the code. A documentation of the different components will be use useful. |
| *Data sources utilization* |  | Very good | The use case retrieves all its information though an API of the Open data of Valencia and webservices. Some improvements should be included if we want to obtain the data as soon as is available and only store the updated one |
| *Storage, recording of the data* |  | Very good |  Only the needed information is stored in the system. An initial study of the available data sets has carried out at the beginning of the project to select only the interesting ones.  |
| *ImplementationValidation and integration within aimed domains* |  | Satisfying | The current version of the web site is responsive, and it is adapted to the user device automatically. For the final review of the use case, the app will be evaluated |
| *Privacy and security*  |  | Satisfying | Most of the data used in the use case comes from the open data and it is public data accessible for everybody. There is some information about the user, this information is encrypted into the DB. In July 2018, the no-sql database was jacked because we were using the default configuration for elasticsearch. We have changed the configuration properties and installed some security plugins. |
| *Stakeholders’ feedback* |  | Very good | At the time of writing this document, interviews with stakeholders had not been completed. But from the available data, we can say that most users would be willing to use the system if the benefits obtained are really the ones we set as the objective of the use case. |
| *IoT Interoperability)* |  |   | This property does not affect us, because we are getting the information from the open data that makes us independent of this problem |
| *Reliability of simulations / predictions*  |  | Poor | All the components related with this property are under development and there is no comparison with what really happens. This property could be evaluated with the final version of the use case |
| *Portability*  |  | Satisfying |  The ETL component is totally dependent on the data sets stored in the open data, in this case we are loading data from C-Kan which is the most common open data platform. Each town hall has different data sets with different properties. The route planner depends on the means of transport available, but this information is configurable, and it is ease to migrate this solution to other cities. The other AI components (simulation, prediction, CEP) are also configurable and can be ported to other cities making minor changes |

# Second validation and evaluation of of the Optimized City and Mobility Planning Use Case (M33)

## Restrictions of the evaluation process

In the current state of the pilot, all the properties can be evaluated because the pilot is almost finished.

Currently, all the modules that make up the use case have been developed: A route planner, simulation and prediction platforms, Complex event processor and dashboards.

For the final evaluation we will be able to evaluate all the properties and compare them with the results obtained for version 1 and version 2 (the current one).

## Evaluation Results

|  |  |  |  |
| --- | --- | --- | --- |
| ***Parameter*** | **UC1** | **Result** | **Description** |
| *Self-awareness and self-adaptability* |   | Poor | This property was not included in the initial non-functionality requirements of the use case, for that reason the use case has poor result for this property. Most of the components are not prepared to adapt itself in case that a problem happens.  |
| *Meeting objectives*  |  | Very good | Most of the technical requirements of the use case are fully accomplished with the current state of the components. It is expected that these requirements will be fully met by the final version of the use case application. |
| *Systems’ performance* |  | Very good |  The system is obtaining data from the Open data since 2017. Currently there are more than 10gb of information stored in the data base (old data has been removed periodically) The response time of the route planner is less than 5 seconds, and the response time of the current web site is less than 1 second. The dashboard takes more than 1 second to refresh because lots of calculations are made. The CEP, processes the information almost in real time, and detects evens in less than 0,1 SecondA mobile App and a web application are available, these systems provide an integrated user interface to access to the different modules of the pilot. The response time of these system is almost the same of the response time of the components alone if you have a good Internet connection. There is a minor relay related with the communication between the app/web with the components. |
| *Visualization framework* |  | Very good | The Web application provides two types of dashboards. The first one is for the town hall and contain different visualizations for strategic, analytic and operational uses. The users have control over the different visualizations and can create/update them. The second one is for citizens, it is an informational dashboard to consult the status and trends of some indicators and data sets.The app provides an intuitive user interface to calculate the optimal route to go from one point to another inside the city area. |
| *Management platform* |  | Very good | The system has a device and user manager that allows you to configure the different devices and users to be available in the system. Moreover, this device manager contains an API, to allow third parties to access to the main functionalities though it. Some component does not use the device manager to update its behaviour taking into account the new available devices.In this second version, a CEP manager system has been included. This component allows users to create dynamically new CEP rules at runtime. |
| *Big data management* |  | Satisfying | The use case is running using containers technologies. The system is scalable, and it is possible to create new container instances in case it is needed more resources. The storage system selected is elasticsearch, a No SQL-Database that is also scalable. The most critical resource is the disk space that has been emptied several times since the beginning of the project.It should be interesting to include a resource manager component to monitor the resources of the system and send alerts if required.The advantage of using containers is that the solution can be moved to other servers of cloud solution with any issues.  |
| *Event processing* |  | Satisfying | The system provides access to the detected events though the dashboard. In the final version of the app, the user could receive customized notifications. |
| *Use case implementation (Completeness of use case)* |  | Accomplishment 90% | A new version of all the components of the pilot are available. Some of them are finished but other are under testing phase. For the final evaluation we will have the final components including the final versions of the mobile app to interact with them. |
| *Redundancy percentage (Non-redundancy)* |   |   | This property was not included in the initial non-functionality requirements of the use case, for that reason the use case has poor result for this property. The use case does not use sensor information directly, it uses data from open data sources and web services.  |
| *Usability*  |  | Very good |  The software components have been developed following best developing guidelines and with a scalable architecture. A static code analysis for java has been used to ensure the quality of the code. A documentation of the different components will be use useful. |
| *Data sources utilization* |  | Very good | The use case retrieves all its information though an API of the Open data of Valencia and webservices. Some improvements should be included if we want to obtain the data as soon as is available and only store the updated one |
| *Storage, recording of the data* |  | Satisfying |  Only the needed information is stored in the system. An initial study of the available data sets has carried out at the beginning of the project to select only the interesting ones. If we want to store the historical data obtained from the pilot, it will be needed to use a system with more resources. With the current system we have to empty the data base from time to time |
| *ImplementationValidation and integration within aimed domains* |  | Satisfying | The current version of the web site is responsive, and it is adapted to the user device automatically. The app has been developed following the standards and best guidelines to develop usable android app.  |
| *Privacy and security*  |  | Satisfying | Most of the data used in the use case comes from the open data and it is public data accessible for everybody. There is some information about the user, this information is encrypted into the DB. In July 2018, the no-sql database was jacked because we were using the default configuration for elasticsearch. We have changed the configuration properties and installed some security plugins.The data used for the mobile application is stored in a local SQL database saved in the device of each user |
| *Stakeholders’ feedback* |  | Satisfying | At the time of writing this document, the application and the web site have been used internally. During the development of the application the design and usability department has been involved, and provided feedback to improve the solution. For the final evaluation we will include comment and feedback from real citizens. |
| *IoT Interoperability)* |  |   | This property does not affect us, because we are getting the information from the open data that makes us independent of this problem |
| *Reliability of simulations / predictions*  |  | Medium | All the components related with this property are under test/adjustment phase and the comparison with what really happens is not satisfactory enough. The precision varies from 30-50%, for that reason we are improving the algorithms and evaluating the inclusion of new data . This property could be evaluated with the final version of the use case |
| *Portability*  |  | Medium | The ETL component is totally dependent on the data sets stored in the open data, in this case we are loading data from C-Kan which is the most common open data platform. Each town hall has different data sets with different properties. The route planner depends on the means of transport available, but this information is configurable, and it is ease to migrate this solution to other cities. The other AI components (simulation, prediction, CEP) although configurable, their portability depends on the data available by the municipality |

# Conclusion

The document provides a second validation and evaluation of the Optimized City Optimized City and Mobility Planning Use Case. This use case has been implemented within the Spanish pilot. Furthermore this document has helped to test if all defined requirements on the use cases (system functionalities) were implemented. Validation results will help to make final assessment of the system readiness to enter the market.

In this second evaluation all the component of the pilot including the app and the web site have been evaluated. This deliverable will be followed by 3rd version (v3), where the tests proposed for the system will be mostly repeated with the final version of the demonstrator.

From the business model point of view the evaluation results will support development of the proposed business models discussed at stakeholders’ meetings and workshops.

# References

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