ALMANAC

RELIABLE SMART SECURE
INTERNET OF THINGS FOR SMART CITIES

(FP7 609081)

D2.4.1 Updated Requirements Report 1

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2.2	Trine F. Sørensen (IN-JET)	2015-08-21	Lessons Learned reported by WP leaders in the project wiki have been added. Ready for internal review.
2.3	Trine F. Sørensen (IN-JET)	2015-08-31	WP7 Lessons Learned added.
2.4	Trine F. Sørensen (IN-JET)	2015-09-07	ISMB internal review comments incorporated
2.5	Trine F. Sørensen (IN-JET)	2015-09-14	TIL internal review comments incorporated. Requirements for citizen-centric application added. Appendix C added.
2.6	Marco Jahn (FIT)	2015-09-21	WP7 Lessons Learned analysed and edited.
2.7	Trine F. Sørensen (IN-JET)	2015-09-21	Final editing
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Maria Teresa Delgada (ISMB)	2015-09-03	Status of citizen-centric application requirement added. Approved with minor comments
Claudio Pastrone (ISMB)	2015-09-03	Approved with minor comments.
Roberto Gavazzi (TIL)	2015-09-11	Approved, some detailed explanation suggested.
Daniele Buosi (TIL)	2015-09-11	Approved with minor comments, typo correction.

Index:

1 Executive summary

This deliverable was first submitted in October 2014, however based on recommendations in the first year review report received in December 2014, the project decided that it would be useful to update D2.4.1. The result is this present document, representing version 2.8 of *D2.4.1 Updated Requirements Report 1*.

The purpose of this deliverable is to report the current status of the requirements re-engineering work in the waste and water application domains, and provide an initial overview of the process for the citizen-centric application domain.

The project has adopted an innovation driven, evolutionary requirement engineering, specification and design methodology. This deliverable presents the results from two of the tasks that will be undertaken in each iteration, namely i) Application requirements engineering from the scenarios, and ii) Lessons Learned and change analysis leading to requirements refinements.

Lessons Learned have been collected and documented during the first cycle. While some lessons learned have value for specific technical development activities, others have value for the project and its' methodology as a whole. Some of the lessons learned clearly reflect first year challenges in a project like this.

Waste

The user scenarios for the waste application first presented in *D2.1 Scenarios for Smart City Applications* have been made more specific based on the increased understanding of the domain and users' needs. As a result, 14 new use cases for the waste application have been developed at the end of the first iteration. Figure 1 below gives a visual overview of the actors involved in the new use cases for the waste application.

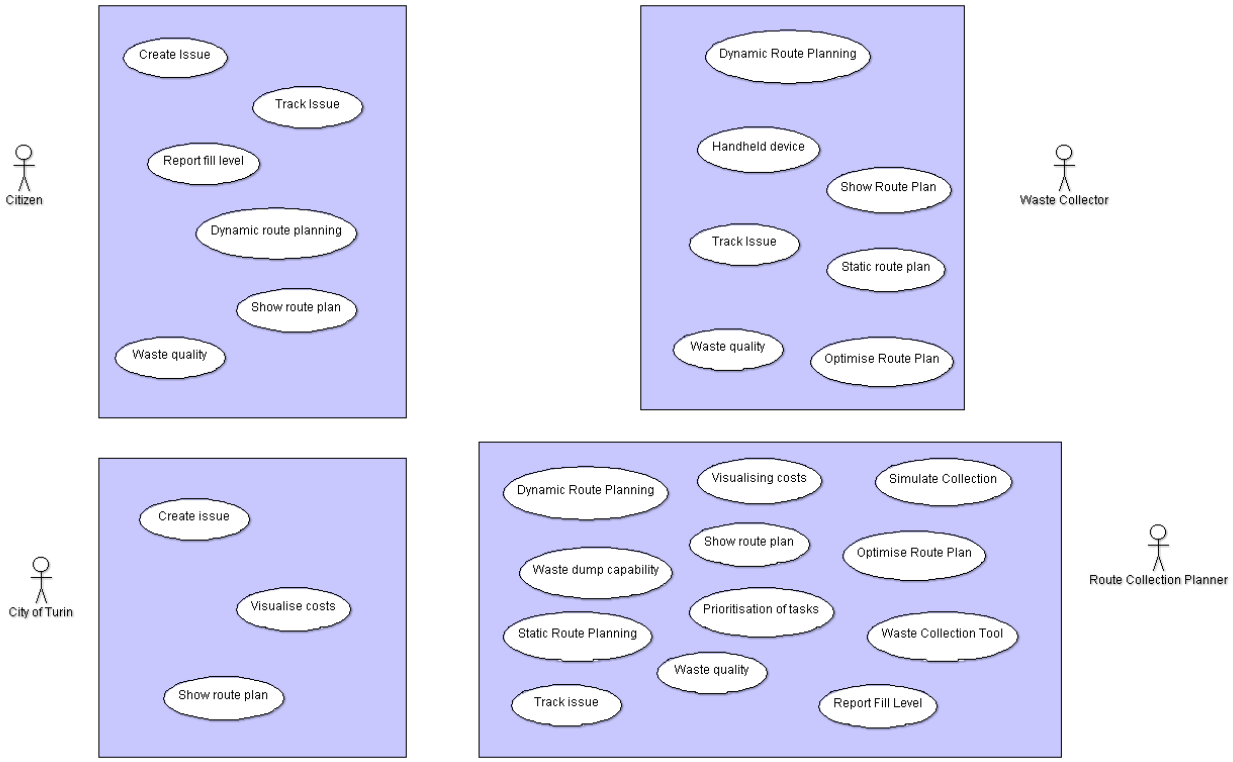

Figure 1: Overview of waste application use cases and involved actors

The new waste application use cases have generated an additional 33 new requirements. The current status of all the waste application requirements is presented in Chapter 5.

Water

The two user scenarios for the water application were first presented in *D2.1 Scenarios for Smart City Applications*. However, input from meetings with Turin municipality and SMAT made it clear that the main user need was to gain more insight into water consumption data. The two initial scenarios have therefore been replaced with two new user scenarios: Consumption Awareness and Consumption Aggregation. The work on the scenarios has resulted in several new use cases which involves various users (actors) with different user requirements. Figure 2 gives an overview of the use cases for water application from the perspective of the actors.

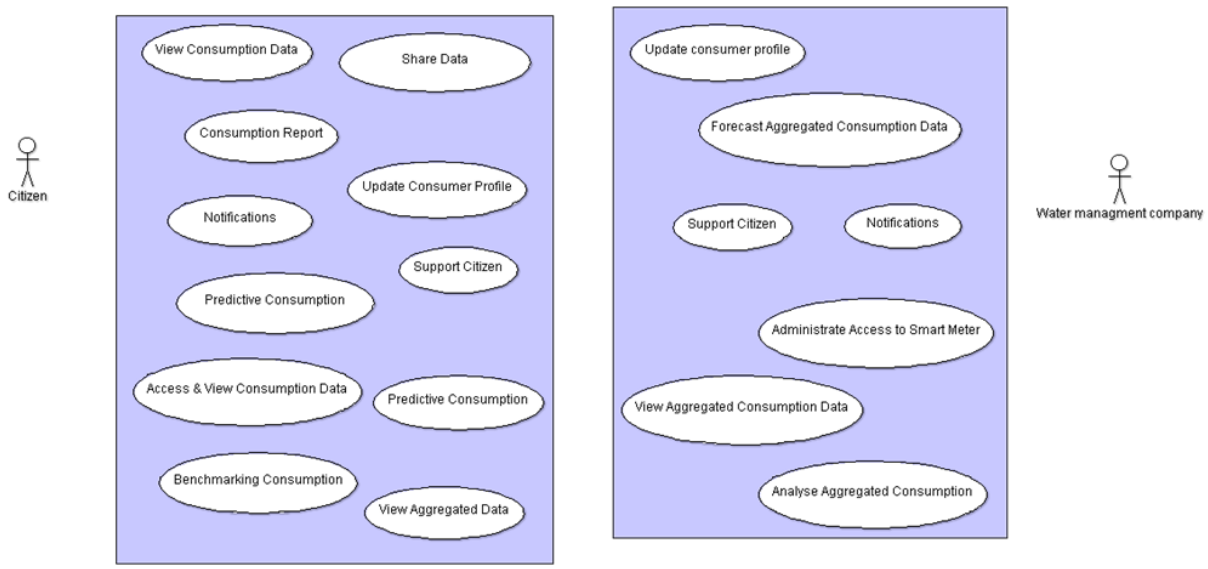

Figure 2: Overview of aster application use cases and involved actors

The new water application use cases have generated an additional 29 new requirements. The current status of the user requirements for the water application is presented in Chapter 6.

Citizen-centric

The initial application prototype for the citizen-centric application was ready in M24. It was based on a refined version of the initial user scenarios first presented in *D2.1 Scenarios for Smart City Applications*. The work on the three scenarios has resulted in 15 new use cases. Figure 3 below gives an overview of the use cases for the citizen-centric application from the perspective of the actors.

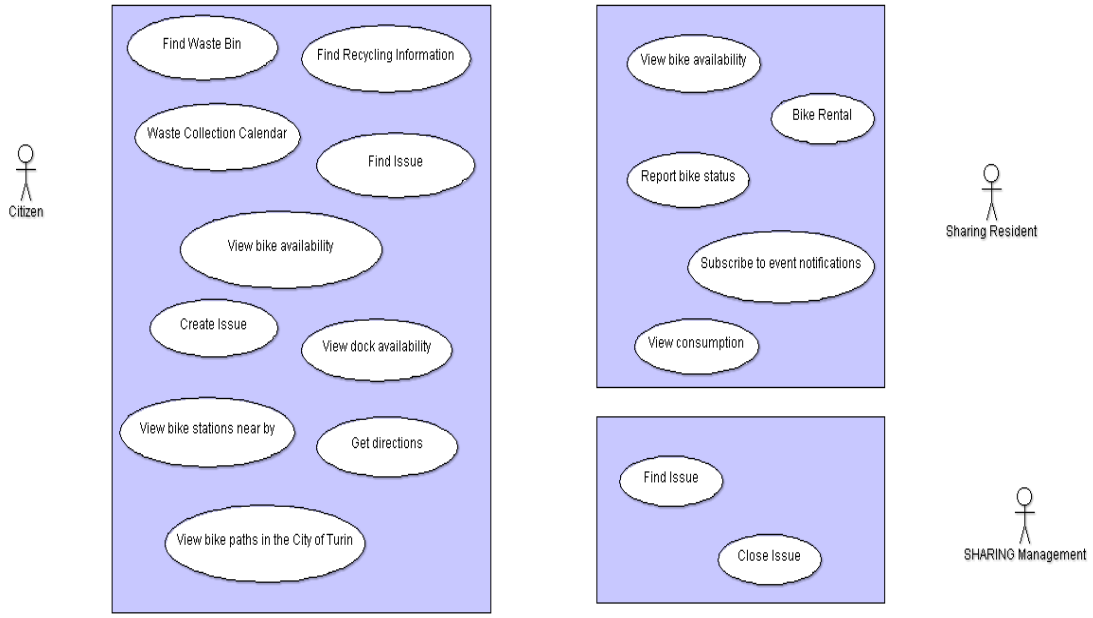

Figure 3: Overview of citizen-centric application use cases and involved actors

The new citizen-centric application use cases have resulted in the elicitation of nine new user requirements. The current status of the user requirements for the citizen-centric application is presented in Chapter 7.

The strong user-centric approach in the ALMANAC project has required a great deal of resources to ensure that the developed applications and the ALMANAC smart city platform respond accurately to end-users needs. The development work is well underway and significant progress on the requirements is expected in the forthcoming period.

2 Introduction

During Year 1, the project has worked on understanding the businesses ecosystem and developing a demonstration prototype that is not only business-relevant but that also clearly demonstrate the innovations in Smart City applications provided by the ALMANAC platform.

The use case specifications presented in *ID2.2 Initial Requirements Report* have since been further detailed due to several factors:

- The development work in Y1 was focused on architectural components and demonstrating them using feature relevant "showcases". As anticipated, it has not yet been relevant to approach external users with operational software.
- The functional gap between an IoT platform and actual business application is quite wide. A realistic business scenario requires considerable implementation not necessarily inside the scope of an IoT platform. Therefore, a number of iterations are needed for modelling of real-life scenarios and subsequent scoping of relevant components.
- The need for aligning application development and integration efforts was solved by developing showcases and organising Hackathon at IoT events.

The attempt to better understand the business processes and improve the application requirements gathering process has been a cooperative effort between project developers and end-users in which the following activities have been undertaken:

- Liaison with AMIAT[1] and SMAT[2] to understand the target environment combined with supporting meetings with Danish Water and Waste Utilities.
- A 1st version of Updated Application Scenarios, Use Cases and Requirements for Water and Waste applications were reported in a working document.
- Liaison between WP2 application requirements and WP8 application definitions including alignment of Use Cases and Scenarios.

2.1 Purpose, context and scope of this deliverable

This deliverable is a second version of *D2.4.1 Updated Requirements Report 1* (submitted in M14). It was decided to produce a second version in order to include the recommendations in the Technical Review Report received in M16, i.e. after *D2.4.1 Updated Requirements Report 1* had been submitted. The consortium decided that it would be most useful to complete this second version of D2.4.1 at the end of year 2, i.e. in M24, in order to also provide an end of year 2 status report on the user requirements for the three user applications for consideration in the second year review.[3] In other words, this current deliverable *D2.4.1 Updated Requirements Report 1_version 2.8* provides a M24 status of user requirements as well as a consideration of the recommendations from the first review report.

The main purpose of this deliverable is to report the current results of the requirements re-engineering work in the three application domains considered by ALMANAC.

As a result of the specification of user scenarios and use cases, including the development of new use cases during the first cycle of the project, a series of new requirements have subsequently been elicited for both the waste and the water applications. The initial application prototype for the citizen-centric application was ready in M24. The initial uses cases and requirements that have guided the development of the first citizen-centric application are presented in this deliverable.

Another purpose of this deliverable is to present the Lessons Learned that have been collected in all the Research and Technological Development (RTD) work packages during the first cycle of the project. Some Lessons Learned have already had a direct impact on project partners' approach to

[1] Waste Management Company in the City of Turin
[2] Waste Management Company in the City of Turin
[3] D2.4.2 Updated Requirements Report 2 was originally intended to give a status of requirements as of M26, showing the progress from M14 to M26. However, this deliverable is only subject to review in year 3.

the development work while some Lessons Learned will influence work yet to be undertaken during the next cycle of the project.

2.2 Content of the deliverable

Chapter Three provides an overview of the evolutionary requirement engineering methodology used in the project. The Lessons Learned collected in cycle one are presented in Chapter Four.

The results of the re-engineering work on user requirements for the waste application and the water application are presented in Chapters Five and Six. These chapters include a description of the elaborated user scenarios, use cases, and the status of the user requirements. The use cases and user requirements defined for the first prototype of the citizen-centric application are presented in Chapter Seven.

In the Appendices, full descriptions of the use cases, the scenario they relate to and the defined user requirements are presented. Moreover, the ALMANAC Innovations are described.

3 Methodology

The project has adopted an innovation driven, evolutionary requirement engineering, specification and design methodology, which complies with the following broad template for each iteration:

- Business driven development of scenarios in Smart Cities applications
- Application requirements engineering from the scenarios
- Architecture design specification and refinement
- Innovation driven technologies research to implement the architecture
- Prototype development, system integration and testing
- Deployment in real settings and evaluation of selected proof-of-concept applications
- Lessons Learned and change analysis leading to requirements refinements.

This deliverable covers two items of the template: i) Application requirements engineering from the scenarios and ii) Lessons Learned and change analysis leading to requirements refinements.

The evolutionary requirement engineering methodology has already been described in *ID2.2 Initial Requirements Report* but the following section will sum up the most important aspects of the two above items that are covered in this deliverable.

3.1 Application requirements engineering from scenarios

The methodology calls for stakeholder analysis and scenario thinking to form an initial set of Smart City end-user application requirements. These requirements would represent the needs and priorities of all actors and users, as well as the sound business proposition to ensure wider marketability and exploitation of the resulting solution.

In ALMANAC, the "User-Centric System" of the requirement engineering process is focused on understanding, formulating and scoping the users' reality, i.e., political governance, economical constraints, urban development and organisational needs. This work is based on field studies and interviews with city officials, subcontractors, utilities and employees in the field. User scenarios for the Waste, Water and Citizen-centric applications were formulated during the data collection process and reviewed with the stakeholders.

The user scenarios form the basis for the innovation driven platform architecture and functionalities in the "Development System" of the project. The scenarios drive the specifications used in the design and development of the platform and its subsequent instantiation in specific end-user applications for demonstrations. In collaboration with users, the technical use cases were defined based on the user scenarios for the applications in the three domains.

Based on an analysis of the user scenarios and their use cases the initial requirements are then elicited. From the initial set of requirements, the technical experts will specify the initial architectural specification which then drives the research and development work and system integration. The requirement process is based on the Volere requirements mastering process. The Volere process ensures that all the important aspects of requirements are carefully addressed and that the methods applied have proven their value in practical work.

Moreover, the Volere template ensures that the results are documented in a way that can be communicated efficiently to developers. A rationale and an appropriate classification have been assigned to requirements during several group discussions with the project team. Finally, quality checks have been performed with the aim of eliminating redundancy in clusters of equivalent statements and phrasing the essential meaning in one statement.

Requirements are stored in JIRA which is a web-based issue tracker that allows implementing and tracking a collaborative workflow. JIRA is also used as a tool for gathering and sharing requirements amongst developers.

In order to bridge the end-user's needs (real world) and the technology objectives of the project, the requirement process operates with two parallel sets of requirements: end-user application requirements and platform requirements, referred to as Innovations. Innovations have been defined

by the technical team based on the already collected end-user application requirements (recorded in JIRA Volere). They are developed in an agile fashion using feature-driven development and the JIRA Agile product. This deliverable focus on the results of the first iteration of the user requirements for the ALMANAC applications, and not on the Innovations. Details on the Innovations and the methodology used to drive their design are provided in Appendix D.

The ALMANAC scenarios, technical use cases, the Volere template and process, the JIRA tool, and the requirement workflow used in ALMANAC are all described in detail in *ID2.2 Initial Requirements Report* which also contains a list of the initial requirements.

3.2 Lessons Learned and Change Analysis

Lessons Learned are a principal component of a project culture committed to Knowledge Management. They help to support project goals in the RTD work of:

- Promoting recurrence of successful outcomes
- Precluding the recurrence of unsuccessful outcomes.

As part of the continuous improvement program adopted by the ALMANAC project a systematic and continuous collection, indexing and dissemination of lessons learned will be undertaken in WP2.

This section will establish criteria for the Lessons Learned process in ALMANAC and discuss how to turn Lessons Learned into Lessons Applied.

Lessons are learned during project RTD work, during testing and integration, as a part of the validation of project prototypes and during literature search and technology watch-reports. Lessons can thus be learned throughout the project work. As such, Lessons Learned constitute both individual and organisational knowledge and understanding gained by experience, either negative (missed targets, solutions that do not work as expected, wrong choice of technology) as well as positive (easier implementation than expected, faster response time, more interoperable devices than expected).

In order to implement a workable Lessons Learned process, we need first to define what we understand with the term "lesson". We use the following characteristics for a lesson:

- It must be significant in terms of the project progress and ability to meet its goal.
- It must be valid, i.e. the experience gained must be repeatable.
- It must be applicable to the ALMANAC project
- It may contain or address pertinent info
- It may provide information of interest.

Not all experiences will qualify as being Lessons Learned and it is important that reported Lessons Learned not merely restates existing information and existing experiences related to ALMANAC work.

The ALMANAC Lesson Learned process has 6 steps:

- Collection
- Verification
- Storage
- Dissemination
- Reuse
- Identification of improvement opportunity.

Collection

The collection process focuses on collecting Lessons Learned from many sources internal and external to the project. The collection is undertaken in practically all work packages in ALMANAC with special focus on the RTD work packages (WP3-WP7).

WP2 will collect Lessons Learned from the iterative requirements engineering process which can be reused to improve the performance and efficiency of future iterations. The RTD work undertaken in WP3-WP8 is expected to provide the largest amount of Lessons Learned by virtue of the many researchers participating in this work and the many small and large experiences gained individually and as teams. The challenge here is to identify and properly describe the Lessons Learned and filter them according to significance, validity, and applicability to the ALMANAC project.

The definition, development and evaluation of applications in WP8 will also provide a range of experiences that can be classified as Lessons Learned.

Finally, the supporting work undertaken in WP9 in the form of dissemination and exploitation activities may also contribute to Lessons Learned that, even if not having a direct impact on the technical development and requirement engineering work, can be used to redirect and optimise dissemination and exploitation activities.

Verification

Verifying the collected lessons according to established standards is the second step in the process. All Lessons Learned must be verified for correctness, significance, validity, and applicability. The verification will be performed by the Technical Manager and the relevant WP leaders. The Technical Manager will decide to add and remove Lessons Learned as necessary.

Some of the criteria that may be used for verification are:

- Relationship with the project flow
- Relevance to the project outcome
- Significance in terms of quality parameters such as robustness, ease of use, functionality
- Research aids used
- Systemic process issues
- Credibility or reputation of the originator.

Storage

In the first instance, the Lessons Learned is entered into a reserved area of the ALMANAC Wiki. The area has been created and is maintained by WP2. It contains a simple categorisation tagging for filtering purposes. For the sake of simplicity, a very simple template has been provided which is illustrated in Figure 4 below.

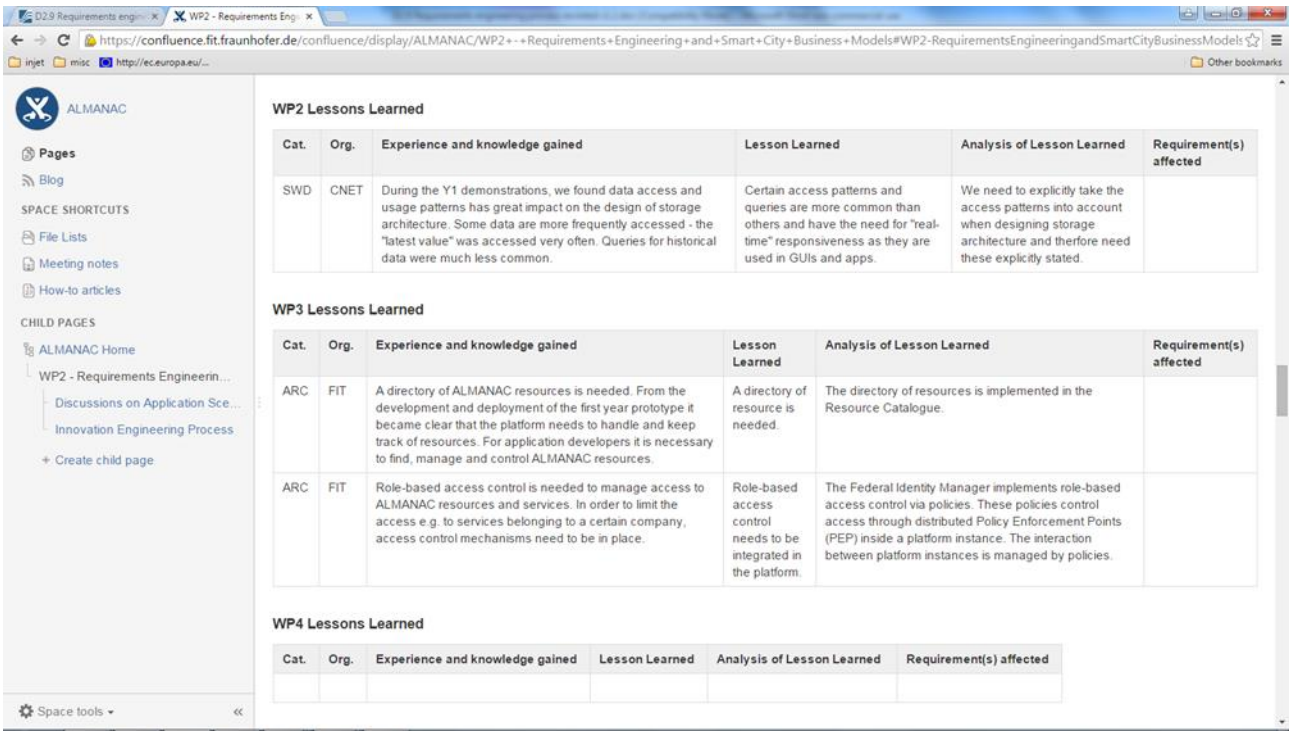

Figure 4: ALMANAC wiki for collection and storage of Lessons Learned

The Lessons Learned repository will act as an organisational memory for experiences acquired by project members during the cause of the project.

Dissemination

A very important part of the process is of course to inform project partners in the feedback cycle. All project partners are encouraged to continuously consult the Lessons Learned repository, not only with the purpose of reporting, but also to inform themselves of and gain from the Lessons Learned by other project partners.

Reuse

The ALMANAC project encourages and promotes lessons to be used by other than the submitter. The WP leaders have a responsibility to consult the Lessons Learned repository regularly and at least before any major decision affecting the scientific work and project outcome is to be made. The WP leaders are obliged to take part of the engineering process of requirements, which is based on a timely assessment of the reported Lessons Learned.

Identification of improvement opportunities

The last step in the process is the identification of incremental and innovative improvements and additions to the initial set of requirement specifications for the project. From the Lessons Learned, relevant new and/or updated requirements may thus be extracted and the requirement repository in JIRA (JIRA Volere and JIRA Agile) updated as necessary. The Lessons Learned and any resulting change requests are also documented in the requirements report at the end of the iterative cycle (here D2.4.1 and D2.4.2).

4 Lessons Learned Year 1

During development work, each WP Leader is responsible for collecting and analyse their Lessons Learned, and reporting these in the project wiki. The Lessons Learned that have been collected during the first year of the research and development work are presented here.

The following codes for categorisation are used:

- RTD: Research oriented
- PRO: Process oriented
- SWD: Software development experience
- ARC: Architecture oriented
- NET: Network oriented
- SEC: Security oriented
- TST: Testing result
- INT: Integration experience
- VAL: Validation experience.

4.1 WP2 Lessons Learned

Cat.	Org.	Experience and knowledge gained	Lesson Learned	Analysis of Lesson Learned
SWD	CNET	During the Y1 demonstrations, we found that data access and usage patterns have great impact on the design of storage architecture. Some data are more frequently accessed - the "latest value" was accessed very often. Queries for historical data were much less common.	Certain access patterns and queries are more common than others and have the need for "real-time" responsiveness as they are used in GUIs and apps.	We need to explicitly take the access patterns into account when designing storage architecture and therefore need these explicitly stated.

No requirements have been affected.

4.2 WP3 Lessons Learned

Cat.	Org.	Experience and knowledge gained	Lesson Learned	Analysis of Lesson Learned
ARC	FIT	A directory of ALMANAC resources is needed. From the development and deployment of the first year prototype it became clear that the platform needs to	A directory of resource is needed.	The directory of resources is implemented in the Resource Catalogue.

Cat.	Org.	Experience and knowledge gained	Lesson Learned	Analysis of Lesson Learned
		handle and keep track of resources. For application developers it is necessary to find, manage and control ALMANAC resources.		
ARC	FIT	Role-based access control is needed to manage access to ALMANAC resources and services. In order to limit the access e.g. to services belonging to a certain company, access control mechanisms need to be in place.	Role-based access control needs to be integrated in the platform.	The Federal Identity Manager implements role-based access control via policies. These policies control access through distributed Policy Enforcement Points (PEP) inside a platform instance. The interaction between platform instances is managed by policies.

No requirements have been affected.

4.3 WP4 Lessons Learned

Cat.	Org.	Experience and knowledge gained	Lesson Learned	Analysis of Lesson Learned
SWD, INT	TIL	The Smart devices to be connected to the Almanac SCP available from manufacturer are not following a standard. Usually they have proprietary SW interfaces. In order to collect data from many different sources SW adapters have to be developed. The SW adapters are then sending the data to the ETSI M2M Platform using ETSI standard interface and the ETSI M2M platform is providing a unique Cloud AP to all the apps and to the other modules of the Almanac Smart City Platform. In this way all the sensors/smart devices appear to apps developers as having a unique and standard	An adapter Layer is needed	The adapted Layer has been developed and integrated as a capability of the ETSI M2M Platform R1

Cat.	Org.	Experience and knowledge gained	Lesson Learned	Analysis of Lesson Learned
		interface.		
RTD	TIL	Capillary networks will have more than one reference frequency and protocol. At least three frequencies bands will be used: 169 MHZ, 868 MHZ, 2.4 GHZ. The choice of the frequency to be used depends on the applications to be developed and the market (standard de facto) and on standardization bodies (both at European and at regional level). This is going to increase the cost of deploying capillary networks reducing the possible economy of scale.	To increase pressure on standardization bodies to reduce the frequencies to be used for capillary networks (one frequency would be the optimal).	In Almanac all the three most important frequencies for capillary networks (169 MHZ, 868 MHZ and 2.4 GHZ) have been deployed and integrated in the Almanac SCP in such a way that the data from smart devices are available in SCP independently from the frequencies of transmission of the smart devices. So the feasibility has been proved.

No requirements have been affected.

4.4 WP5 Lessons Learned

No Lessons Learned have been collected in WP5.

4.5 WP6 Lessons Learned

Cat.	Org.	Experience and knowledge gained	Lesson Learned	Analysis of Lesson Learned
ARC	FIT	Event Manager based on SOAP/HTTP generates too much overhead and is not capable of dealing with large amounts of devices and events	SOAP-based Event Manager is not feasible for ALMANAC.	SOAP-based Event Manager was replaced by an MQTT broker which is based on TCP and significantly reduces the overhead.
SWD	FIT, CNET	During bursts with high frequency of received events, the time required to store values was longer than the time between	Bursts of data must be handled.	A queue between MQTT client and storage was introduced. In a non-demo deployment, the data insertion mechanism may have be scaled out by adding (real or virtual) hardware using load balancing clusters. These

Cat.	Org.	Experience and knowledge gained	Lesson Learned	Analysis of Lesson Learned
		messages received from MQTT.		may be provisioned in the cloud. We will also use the distributed design with ALAMANC PI:s to limit the amount of data going to one storage node. By practical measures like filtering the data streams (downsampling, compressing, storing only specified data), the amount of data may also be reduced.
SWD	FIT, CNET	The amount of data (indexes in memory) grew too large for the hardware the single instance MongoDB was running on.	When we store everything, the storage will eventually be "full" for any hardware specification.	There are different possibilities to tackle this problem: In the general case, without any specific functional requirements on data access, we scale out by adding an additional cluster node (buy more hardware or cloud resources). This will have to be provisioned by the business entity setting up the ALAMANAC PI and have defined mechanisms for how to detect that the storage is full and scale out. The PI will also have to have defined "graceful degradation" mechanisms when the specified hardware / cloud storage limit is reached. Also, by analysing storage requirements and data usage patterns, we could devise additional partitioning mechanisms, e.g. we could partition by time, so that old values are located at another storage that requires longer access time but is cheaper. The PI manager should also be able to define what is stored and with the granularity of observations. Compression mechanisms like RLE may be employed. The DFM will be able to handle much of this. Old data that is not needed may be rolled-up, archived or deleted. (We provide our own (sort of) partitioning mechanism already, as data is distributed per platform.) We may need to define (or find) a Data Management Language

Cat.	Org.	Experience and knowledge gained	Lesson Learned	Analysis of Lesson Learned
				to describe these mechanisms.
SWD	CNET	Query throughput is very much affected by storage volume in a single instance.	Data access patterns need to be analysed to design storage.	The most frequently requested data; the “current value” cache will be physically separate from the long-term storage of historical values. "Heavy" queries against large volumes of data should not affect the "small" queries used by GUIs and apps which require high responsiveness. Foreseen access patterns should be analysed to design partitioning of data.

No requirements have been affected.

4.6 WP7 Lessons Learned

Cat.	Org.	Experience and knowledge gained	Lesson Learned	Analysis of Lesson Learned
INT	FIT/CNET	.NET integration into Jenkins CI Server is not feasible	.NET continuous integration needs to be tackled outside Jenkins Server.	For .NET components unit tests are performed locally within the IDE. Remote integration tests are integrated with the other components through Rest Assured Framework. Publication is done via MSI Installers.
INT	FIT/ALL	Development should be accompanied by regular updates and knowledge exchange between the developers.	Weekly developer conference calls are suitable when applying SCRUM to international research projects.	A developer conference call per week is the most suitable timeframe. Daily stand up meetings are not feasible for distributed development teams in projects like ALMANAC.
INT	FIT/ALL	The development process should be driven by iterations with reasonable goals.	SCRUM-like development sprints are suitable to organize and drive the SW-development.	Creation of user stories and tasks supported by tools (JIRA Agile) is very useful to keep the SW-development on track, transparent and traceable. Regular sprints (timeframe about 2-4 weeks) allow for focussed development.

No requirements have been affected.

4.7 WP8 Lessons Learned

Cat.	Org.	Experience and knowledge gained	Lesson Learned	Analysis of Lesson Learned
SWD	ALEX	It is important to have a running instance of the platform available 24x7x365.	Without this development stalls and time is wasted	Multiple platform instances should be deployed, for example one for platform component development, one for application development, and at least one for demonstrations and demos.
SWD	ALEX	Thorough documentation of platform components is vital	Document components	. It takes a lot of time to experiment and randomly test platform components from the application development side. Misunderstandings could be eliminated by partners providing code examples to document their components.
SWD	ALEX	Stability of components must be high.	Stability is important.	Exceptions and other crashes by platform components are very expensive. In fact, most of the development time spent in WP8 was spent testing components.
SWD	ALEX	High level of responsiveness from platform developers is needed.	Communication is important.	When errors are detected, it is sometimes difficult to resolve the issue because each partner says it is a problem in another partner's component. Perhaps we can have a QA department or something?

No requirements have been affected.

5 Updated Requirements M24: Waste Application

This section describes the first year's re-engineering of the initial user scenarios, application user requirements and use cases and the continuous feedback from end-users and the evolution of the understanding of the business environment and the possible contributions by ALMANAC to solve the city's challenges.

In the last years, the City of Turin has promoted innovative policies in the field of waste management, which are in line with EU and national frameworks. This enabled the city to play a pivotal role at national level with special regard to waste selected collection. The Waste Application is the most elaborated prototype application of year 1.

5.1 Updated user scenarios

The user scenarios for the waste application first presented in *D2.1 Scenarios for Smart City Applications* have been made more specific based on the increased understanding of the domain and users' needs:

- Waste optimisation
  Optimisation of waste handling according to priority, recycling cost and location of waste dump

- Collection optimisation
  Optimisation of route planning according to priorities and geography. Support for exception and collection optimisation. Quality of waste support for exception and collection optimisation

- Issue management
  Waste issues can be reported. The status of reported issues can be fed back to the citizens. When issues are resolved they can be reported to the system by the collection vehicle operators. Handling of priority issues

- Waste quality
  The quality level of the collected waste is reported by the collection vehicle operators who guide the citizen end users on waste sorting quality. It is possible to establish a penalty/reward system for the citizens

- Waste level reporting
  Several of the bins are equipped with fill level sensors. The fill level is automatically reported to the ALMANAC system. Waste level issues can also be manually reported to the ALMANAC system by the citizens.

The five scenarios can be interlinked in various ways; the waste application developed will thus cover a range of functionalities (use cases and user requirements) across the different waste scenarios.

5.2 Updated and New Use Cases

The work on the scenarios has resulted in 14 new use cases that have been developed at the end of the first iteration. For each of the five scenarios the new use cases are:

- Waste Optimisation
  - Waste Dumps Capability
  - Visualising the costs

- Collection Optimisation
  - Dynamic Route Planning
  - Simulate Collection
  - Show Route Plan
  - Optimise Route Plan
  - Static Route Planning
  - Waste Collection Tool
- Issue management
  - Prioritisation of Tasks
  - Handheld Device for Use in the Vehicle
  - Track Issue
  - Create Issue
- Waste quality
  - Register and Feedback Waste Quality
- Waste Level Reporting
  - Report Fill Level.

Four types of end-users have been identified for the waste use cases and they may be involved in several use cases albeit with different unique requirements and roles. The identified end-users in the use cases are:

- Waste collector (AMIAT)
- Waste collection planner (AMIAT)
- The city of Turin
- Citizens in Turin.

Figure 5 below gives an overview of the actors involved in new use cases for the waste application.[4]

[4] While reminiscent of a UML diagram, Figure 5 is solely intended to give an overview of which use cases are relevant for which actor. UML diagrams are available in e.g. *D8.4 Application Definition – Waste Management*.

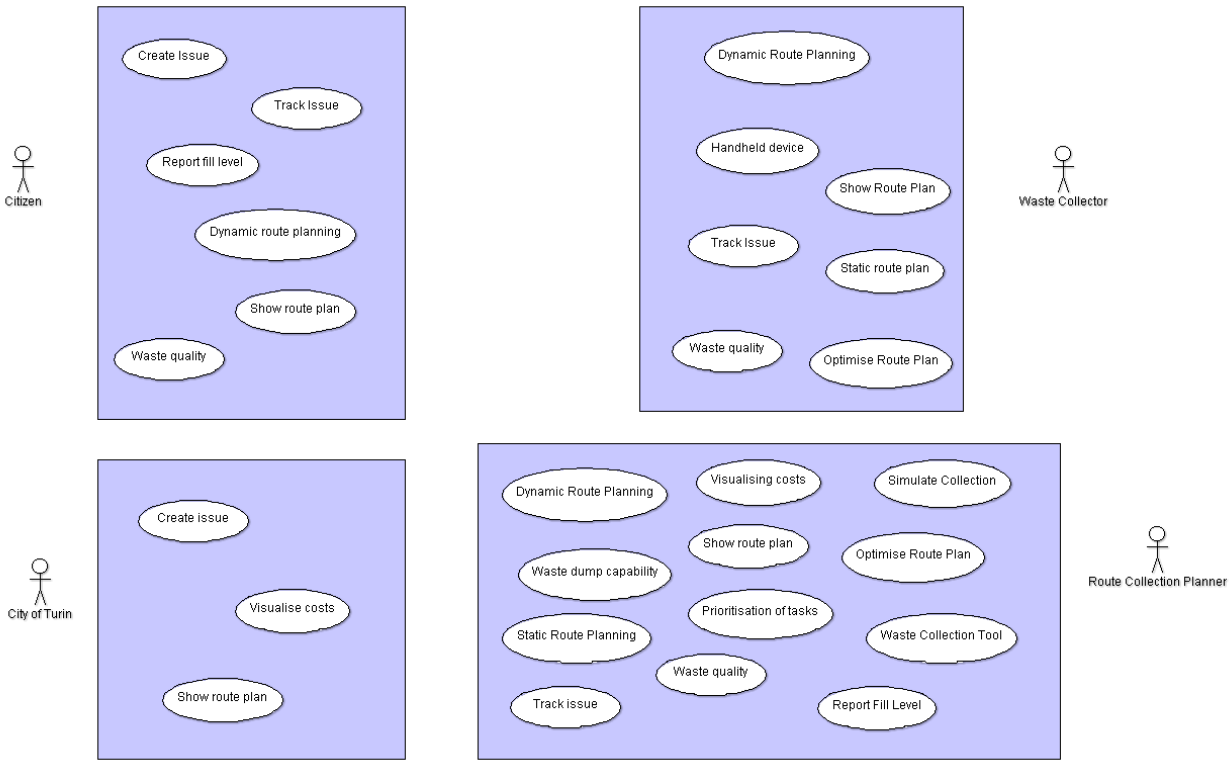

Figure 5: Overview of updated waste application use cases

The new use cases have generated a series of new requirements, some of which could be applied to more than one use case; different users will have different requirements even though they are actors in the same use case. A full description of the waste use cases, the scenario they relate to and the user requirements that have been elicited from the use cases is available in Appendix A.

5.3 Updated User Requirements

This section presents the status of the waste application requirements as of M24. While the initial requirements drove the development work of the first year waste application, the elaboration of user scenarios and use cases led to the elicitation and formulation of additional requirements which have been feed into the development work of the second cycle (year 2). In the process, all requirements were processed along the Volere requirements workflow and their status consequently updated.

5.3.1 Initial Requirements

The initial requirements drove the development work of Year 1 prototype for the ALMANAC waste application. The table below gives an overview of the current status in M24 of the initial requirements:

Key	Summary	Status M24
ALMANAC-21	ALMANAC shall be able to integrate fill level sensors of waste bins	Implemented.
ALMANAC-23	It should be possible to group resources	Implemented
ALMANAC-24	Users can view status of their waste bins in ALMANAC system	Implemented
ALMANAC-28	Public waste bins can be viewed on an electronic map	Implemented
ALMANAC-45	Display aggregated data and historical data	Implemented.

ALMANAC-18	Issues have to be assigned according to role and status (e.g. location)	Part of Specification
ALMANAC-16	Citizens should be able to report abandoned waste issues	Quality Check Passed
ALMANAC-17	Waste issues should be collected and presented through the ALMANAC platform	Quality Check Passed
ALMANAC-19	All relevant stakeholders should be notified about state updates of issues	Quality Check Passed
ALMANAC-20	Priority or importance of issues can be edited manually	Quality Check Passed
ALMANAC-22	Devices should be able to automatically create issues based on defined rules	Quality Check Passed
ALMANAC-25	Citizens should be able to request extraordinary waste collection	Quality Check Passed
ALMANAC-26	Route planning happens according to current waste situation (e.g. fill level, issue track list, etc.)	Quality Check Passed
ALMANAC-29	Feedback on waste quality is reported to owners	Quality Check Passed

5.3.2 New Requirements

33 new Requirements have been derived from the new waste application use cases. The table below presents an overview of the initial requirement status M24:

Key	Summary	Status M24
ALMANAC-176	Geographical Map overlays - fill capacity of bins	Implemented
ALMANAC-177	Geographical Map overlays - fill level information	Implemented
ALMANAC-153	Geographical Map overlays	Part of Specification
ALMANAC-154	Generate a static route for each waste collection vehicle and show it on a map	Part of Specification
ALMANAC-156	Issues automatically raised	Part of Specification
ALMANAC-157	Route plan optimization	Part of Specification
ALMANAC-159	Public App for waste issues	Part of Specification
ALMANAC-160	Inform the waste issue creator of collection	Part of Specification
ALMANAC-161	The handheld device- used by the professionals in the vehicle - must be able to report back to the ALMANAC, when the waste has been picked up at the issue point	Part of Specification
ALMANAC-162	Prioritization of issues	Part of Specification
ALMANAC-166	Fill level sensors	Part of Specification
ALMANAC-174	Just in Time adjustment of Route	Part of Specification
ALMANAC-178	Geographical Map overlays - routes	Part of Specification

ALMANAC-179	Geographical Map overlays - vehicle information	Part of Specification
ALMANAC-181	Geographical Map overlays - vehicles not in operation	Part of Specification
ALMANAC-146	Calculate the cost of a collection route	Quality Check Passed
ALMANAC-147	Inputs for Cost analysis - Waste dump Characteristics	Quality Check Passed
ALMANAC-148	Input for Cost analysis - Routes	Quality Check Passed
ALMANAC-149	Inputs for Cost analysis - Collecting wide spread waste	Quality Check Passed
ALMANAC-150	Inputs for Cost analysis - obstacles to collection	Quality Check Passed
ALMANAC-151	Select waste dump	Quality Check Passed
ALMANAC-152	Waste dump Attributes	Quality Check Passed
ALMANAC-155	Use the following information for route planning	Quality Check Passed
ALMANAC-163	Quality registration on handheld device	Quality Check Passed
ALMANAC-164	Feed back to the users	Quality Check Passed
ALMANAC-165	Penalty/award system	Quality Check Passed
ALMANAC-170	Quality reports for single citizens are summarizable	Quality Check Passed
ALMANAC-171	Waste collection quality report	Quality Check Passed
ALMANAC-173	Frequency and priority on routes	Quality Check Passed
ALMANAC-158	Public web page	Open
ALMANAC-167	Public App for waste reporting	Open
ALMANAC-168	Fill level sensors, sampling technique	Open
ALMANAC-172	Fill level sensors, signal transmission	Open

5.3.3 Changed or Deleted Requirements

4 requirements have been rejected as either duplicates or out of scope:

Key	Summary	Status M24
ALMANAC-27	Situation can adapt based on near real-time changes and events (e.g. new issues)	Rejected (duplicate)
ALMANAC-169	Fill level sensors, power supply	Rejected (Out of Scope)
ALMANAC-175	Single Bin information Geographical Map overlays	Rejected (Duplicate)

ALMANAC-180	Geographical Map overlays - vehicle positions	Rejected (Duplicate)

6 Updated Requirements M24: Water Application

The vision of the Water Management Smart metering IoT application system is to enable online and instant access to relevant parts of the consumption of water resources at individual, organisational and societal level. The aim is to combine the measurement technology with relevant connections to a water utility business running a simple automated consumption-related billing of water usage.

6.1 Updated User Scenarios

The two user scenarios for the water application were first presented in *D2.1 Scenarios for Smart City Applications*. However, input from meetings with Turin municipality and SMAT made it clear that the main user need was to gain more insight into water consumption data. The two initial scenarios have therefore been replaced with two new user scenarios:

- Consumption Awareness
  The scenario covers both consumption awareness and consumption measurement. Citizens and private households can get information of their own water consumption from locally installed meters, and thereby develop more sustainable usage patterns. The setting is a combined smart meter / citizen application product that can access, characterize and compare the citizens' water consumption to averages.

- Consumption Aggregation
  The professional user, offering the smart metering solution to the consumption attentive customer, has to aggregate and access multiple customers' data in an anonymized fashion in order to compute consumption statistics and perform result evaluations.

As in the case of the waste application, the water application can be developed to meet the user requirements across the two scenarios and their use cases.

The water irrigation scenario that was presented in *D2.1 Scenarios for Smart City Applications* was elaborated and new use cases defined in the first version of this deliverable (v1.0 issued October 2014). However, as development work progressed, it became clear that the irrigation scenario was both out of scope for the project and not an accurate reflection of end-users' real need. It was therefore decided to withdraw this scenario and its corresponding use cases and requirements.

6.2 Updated and New Use Cases

The work on the water scenarios has resulted in several new use cases which involve various users (actors) with different user requirements. The use cases for the two water scenarios are:

- Consumption Awareness
  - Consumption Report
  - Share Data
  - Access and View Consumption Data
  - Update Consumer Profile
  - Notifications
  - Benchmarking Consumption
  - Predictive Consumption
  - Administrate Access to Smart Meter
  - Support Citizen
- Consumption Aggregation
  - View Aggregated Consumption Data

- Forecast Aggregated Consumption
- Analyse Aggregated Consumption.

Two types of end-users have been identified for the water use cases and they may be involved in several use cases albeit with different unique requirements and roles. The identified end-users in the use cases are:

- Water management company (employees)
- Citizens (private households).

Figure 6 below gives an overview of the use cases for water from the perspective of the actors using the water application in the two scenarios:[5]

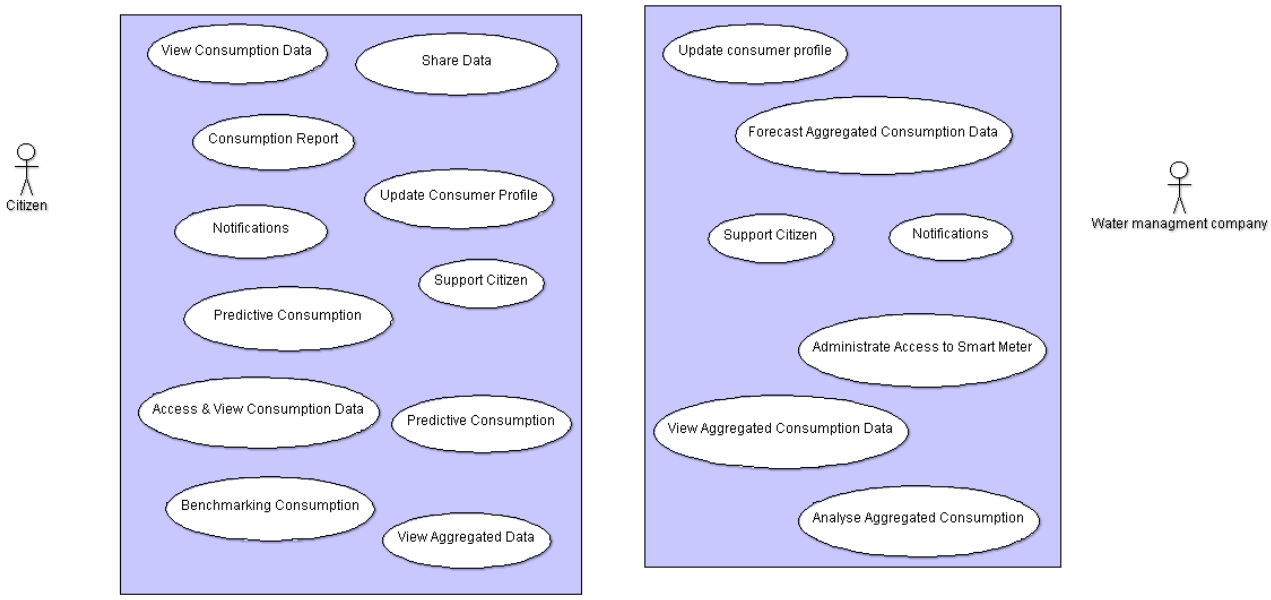

Figure 6: Overview of updated water application use cases

As in the case of the waste use cases, the new use cases for the water application have generated a series of new requirements, some of which could be applied to more than one use case; different users will have different requirements even though they are actors in the same use case. A full description of the water use cases, the scenario they relate to and the user requirements that have been elicited from the use cases is available in Appendix B.

6.3 Updated User Requirements

This section presents the status of the water application requirements as of M24. While the initial requirements drove the development work of the first year water application, the elaboration of user scenarios and use cases led to the elicitation and formulation of additional requirements which would feed into the development work of the second cycle (year 2). In the process, all requirements were processed along the Volere requirements workflow and their status consequently updated.

6.3.1 Initial Requirements

The initial requirements drove the development work of Year 1 prototype for the ALMANAC water application. The table below shows the status of the initial requirements in M24:

[5] While reminiscent of a UML diagram, Figure 6 is solely intended to give an overview of which use cases are relevant for which actor. UML diagrams are available in e.g. *D8.2 Application Definition – Water Management*.

Key	Summary	Status
ALMANAC-34	Supported platform	Implemented
ALMANAC-35	ALMANAC sensor integration	Implemented
ALMANAC-45	Display aggregated data or historical data	Implemented
ALMANAC-31	Consumption comparison	Quality Check Passed
ALMANAC-32	Social interaction	Quality Check Passed
ALMANAC-33	Application intrusion	Quality Check Passed
ALMANAC-37	News / Updates section	Quality Check Passed
ALMANAC-39	Data privacy on personal data	Quality Check Passed
ALMANAC-40	User authorisation	Quality Check Passed
ALMANAC-41	Competitive data	Quality Check Passed
ALMANAC-42	Inter city competitions	Quality Check Passed
ALMANAC-43	Water consumption heatmap	Quality Check Passed
ALMANAC-44	Create real world comparisons	Quality Check Passed
ALMANAC-46	The system must be expandable to other devices	Open

6.3.2 New Requirements

29 new requirements have been derived from the updated and new waste application use cases. Their current status M24 is:

Key	Summary	Status
ALMANAC-99	It must be possible for the citizen water app to connect to the user's social network profile	Quality Check Passed
ALMANAC-100	A user group must be created on a social network for "Turin Smart City Water App Users"	Quality Check Passed
ALMANAC-101	The Water application must generate a "I Use Turin Water App" post to the social network profile of the user	Quality Check Passed
ALMANAC-102	The Water application app can generate consumption statistics to post to the users' social network	Quality Check Passed
ALMANAC-103	The Water application should have a button for sharing data (in anonymized form)	Quality Check Passed
ALMANAC-104	It should be possible for the user to access the social network group and view own and other's messages	Quality Check Passed

ALMANAC-105	The user's profile data shall be a part of the users' statistics used for anonymization	Quality Check Passed
ALMANAC-115	Discontinue and disconnect a citizen's meters from the citizen data area	Quality Check Passed
ALMANAC-116	Disconnect a citizen and create a new citizen application instance to an existing household with instruments	Quality Check Passed
ALMANAC-119	Users can edit parameters for predictive consumption calculator	Quality Check Passed
ALMANAC-115	Discontinue and disconnect a citizen's meters from the citizen data area	Quality Check passed
ALMANAC-116	Disconnect a citizen and create a new citizen application instance to an existing household with instruments	Quality Check passed
ALMANAC-111	Double check metering measurement	Quality Check passed
ALMANAC-113	Assess the function of the single instrument	Quality Check passed
ALMANAC-123	The application must have a functionality to extend and forecast the water consumption	Quality Check passed
ALMANAC-120	Define a customer group	Quality Check passed
ALMANAC-121	Define and access Citizen Group for Analytics	Quality Check passed
ALMANAC-122	Access values based on groups	Quality Check passed
ALMANAC-186	Request consumption report	Open
ALMANAC-187	Generate consumption report at fixed intervals	Open
ALMANAC-188	Setting access rights	Open
ALMANAC-189	Defining time period for access rights	Open
ALMANAC -190	Access to public buildings' water consumption data	Open
ALMANAC-191	View own water consumption data	Open
ALMANAC-192	View publicly available water consumption data	Open
ALMANAC-193	View other's water consumption data	Open
ALMANAC-194	Update user information	Open
ALMANAC-195	Setting Benchmark	Open
ALMANAC-196	Viewing benchmark analysis	Open

6.3.3 Changed or Deleted Requirements

9 requirements have been rejected as out of scope or withdrawn:

Key	Summary	Status
ALMANAC-4	Smart city resources shall be identified uniquely in the Abstraction Framework	Rejected (withdrawn)
ALMANAC-30	A number of sensors must be combined to form a 'household'	Rejected (Out of Scope)
ALMANAC-36	ALMANAC actuator integration	Rejected (withdrawn)
ALMANAC-38	Multiuser system	Rejected (withdrawn)
ALMANAC-108	The user should be able to set a name for the single meter.	Rejected (Out of Scope)
ALMANAC-109	The Water application must be able to set the sampling rate of the smart meters (default 20 secs).	Rejected (Out of Scope)
ALMANAC-112	Access and calculate transmission success rate over the last 24 hrs	Rejected (Out of Scope)
ALMANAC-114	Access the Consumer´s Water app from the professional's Water app	Rejected (Out of Scope)
ALMANAC-118	Citizens should be able to grant read-only access to professionals to their data, and revoke it again	Rejected (withdrawn)

7 Initial Requirements M24: Citizen-centric Application

The Citizen-centric Application is intended to showcase the capabilities and help to demonstrate the ability of the ALMANAC platform to provide access to open data and enable high-level semantic interoperability with the other applications developed within the project. As the initial prototype application was only ready (and due) in M24, the elicited user requirements are yet to be processed along the workflow in JIRA. This work will be carried out in M25-M26, and results presented in the forthcoming *D2.4.2 Updated Requirements Report 2* (M26).

7.1 User Scenarios

The user scenarios for the citizen-centric application first presented in *D2.1 Scenarios for Smart City Applications* have been made more specific based on the increased understanding of the domain and users' needs. Three scenarios have been identified and defined:

- Recycling support:
  Increasing the quality of recycled waste while providing citizens support through the waste recycling process by making relevant recycling information clear and easily accessible.

- Issue reporting
  Enabling citizens to report problems both at building and at a city level, while providing feedback on the issues status to the citizens. More sustainable behaviours are promoted by integrating user consumption data.

- Bike SHARING
  Integration of different bike sharing services and other relevant open data from the city of Turin to improve the efficiency of these type of services.

These three scenarios can be interlinked in various ways; therefore, the citizen-centric application developed will cover a range of functionalities (use cases and user requirements) across the different scenarios.

A more detailed description of these scenarios can be found in the application definition deliverable *D8.6 Application Definition: Citizen-Centric application*.

7.2 Use cases

The work on the scenarios has resulted in 15 new use cases that have been developed during the first two years of the ALMANAC project; some of these use case can be extended into sub-use cases. For each of the three scenarios the use cases are:

- Recycling Support:
  - Find Waste Bin
    - View Waste Bin Map
  - Find Recycling Information
    - Manual Input (product name)
    - Scan Barcode
    - Browse Guide
    - Edit Recycling Information
  - Waste Collection Calendar
    - Managing reminders
- Issue reporting
  - Create Issue

    - Find Issue
        - Update Issue
        - Close Issue
    - View Consumption
- Bike SHARING
    - View bike stations near by
    - View bike Availability
    - View dock availability
    - View bike paths in the City of Turin
    - Get directions (preferring bike paths)
    - View bike availability (SHARING)
    - Bike Rental (SHARING)
    - Report bike status (SHARING)
    - Subscribe to event notifications (SHARING)

Three types of end-users have been identified for the citizen-centric use cases and they may be involved in several use cases albeit with different unique requirements and roles. The identified end-users in the use cases are:

- Citizens (in City of Turin).
- SHARING Residents
- SHARING Management.

Figure 7 below presents an overview of the new use cases for citizen-centric from the perspective of the actors using the application in the three scenarios:

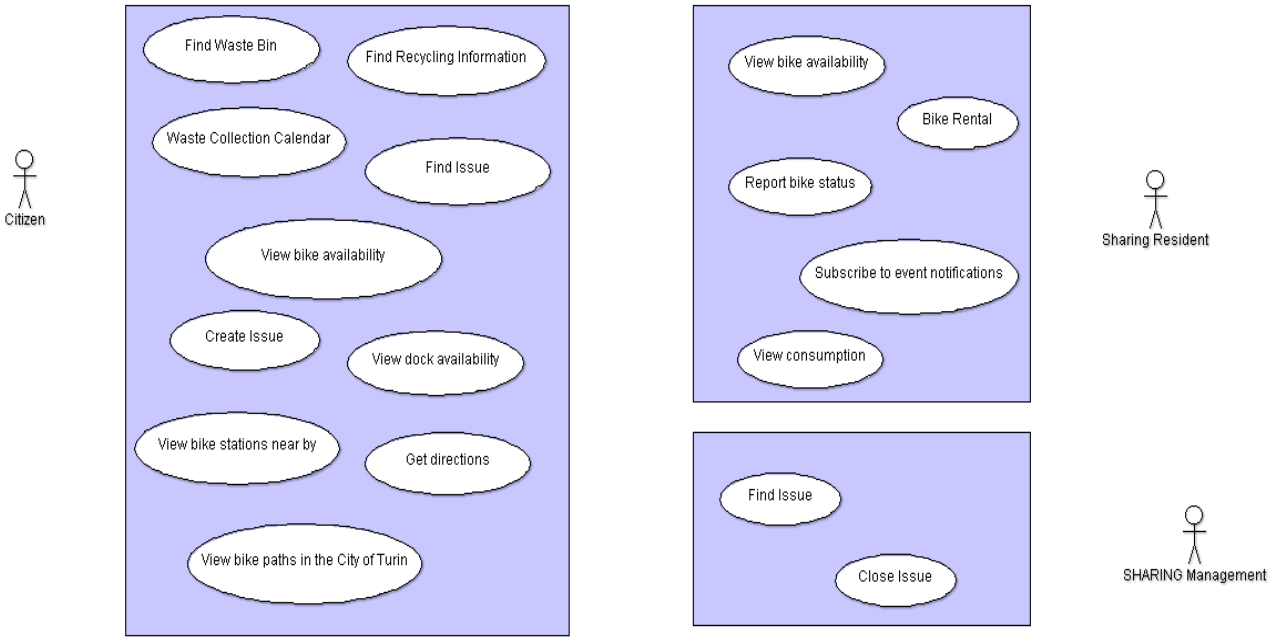

Figure 7: Overview of citizen-centric application use cases

A full description of the citizen-centric use cases, the scenario they relate to and the user requirements that have been elicited from the use cases is available in Appendix C.

7.3 New Requirements

Nine new requirements were created as a result of the development of the first prototype application at M24.

Key	Summary	Status
ALMANAC-184	Enable users to consult the waste collection calendar	Open
ALMANAC-185	Enable users to set waste collection notifications	Open
ALMANAC-197	Provide an interactive support Recycling guide	Open
ALMANAC-198	Enable users to find a waste bin based on their location	Open
ALMANAC-199	Allow users to visualize the properties of a specific waste-bin	Open
ALMANAC-200	Enable users to obtain recycling information associated to a specific material	Open
ALMANAC-201	Enable users to obtain recycling information associated to a Barcode	Open
ALMANAC-202	Enable users to provide feedback regarding the recycling information provided in the Recycling Guide	Open
ALMANAC-203	Enable user to obtain recycling information associated to a specific object	Open

7.4 Changed or Deleted User requirements

As work progressed on understanding the needs of the citizen-centric application domain, the scenarios first presented in *D2.1 Scenarios for Smart City Applications* have also evolved. The methodology and the activities related to the definition of the citizen-centric application are documented in *D8.6 Application Definition – Citizen-centric Application.* As a result, the scenario from which the initial user requirements documented in *ID2.2 Initial Requirements Report* were elicited is no longer relevant; the initial user requirements have therefore been rejected as "withdrawn".

Key	Summary	Status
ALMANAC-54	The citizen must be able to access sensors and attach information and measurement data to projects or ideas	Rejected (withdrawn)
ALMANAC-55	The municipal user must be able to announce topics or information to users and/or groups	Rejected (withdrawn)
ALMANAC-56	The municipal user must be able to invite for ideas	Rejected (withdrawn)
ALMANAC-57	The system must implement means of communication between users	Rejected (withdrawn)
ALMANAC-58	Implement workspaces for users and user groups	Rejected (withdrawn)
ALMANAC-59	The citizen must be able to create a group of users	Rejected (withdrawn)
ALMANAC-60	The system must implement rules for deletion of groups	Rejected (withdrawn)

ALMANAC-61	Provide a template repository for collection or project elements	Rejected (withdrawn)
ALMANAC-62	The citizen must be able to create an idea	Rejected (withdrawn)
ALMANAC-63	Implement profile for individual users and groups	Rejected (withdrawn)
ALMANAC-64	The citizen must be able to create a personal profile	Rejected (withdrawn)
ALMANAC-65	The citizens must be able to cooperatively develop a policy	Rejected (withdrawn)
ALMANAC-66	The citizen must be able to overview own or group's projects in process	Rejected (withdrawn)
ALMANAC-67	Instantiate a collection element and associate it to a workspace	Rejected (withdrawn)
ALMANAC-68	Provide means of storing information in relation to own profiles or groups	Rejected (withdrawn)
ALMANAC-69	The Citizen must be able to connect to a group	Rejected (withdrawn)
ALMANAC-70	The Citizen must be able to leave a group	Rejected (withdrawn)
ALMANAC-71	The Citizen must be able to vote for and rate ideas	Rejected (withdrawn)
ALMANAC-72	The municipal users (and other user types) shall be recognizable in the system with a special iconic representation	Rejected (withdrawn)
ALMANAC-73	The system must notify the group members of the changing of state of a group project	Rejected (withdrawn)
ALMANAC-74	The Citizen must be able to share an idea with his group(s)	Rejected (withdrawn)
ALMANAC-75	The Citizen must be able to create, view and manipulate projects	Rejected (withdrawn)
ALMANAC-76	The citizens must be able to communicate personally or via groups using a bulletin board / dashboard / wall	Rejected (withdrawn)
ALMANAC-77	Implement a visualisation of collection templates with data elements	Rejected (withdrawn)
ALMANAC-78	Provide a project structure for collaborative work	Rejected (withdrawn)

8 Conclusion

The strong user-centric focus in the ALMANAC project has required a great deal of resources to ensure that the developed applications and the ALMANAC smart city platform respond accurately to end-users needs. The work on the ALMANAC Applications for the three chosen domains has progressed as planned and a definition of the applications has been reached and a series of new end user requirements have been elicited. The requirement engineering work continues as development work progresses and an updated status will be presented in the forthcoming *D2.4.1 Updated Requirements Report 2* in M26.

9 Appendix A: New Waste Application Scenarios, Use Case and Requirements

The following abbreviations are used:

- [S] = Scenario
- [UC] = Use Case
- [R] = Requirement

9.1 [S] Waste Optimization (AI-203)

Context	Waste Application
Description	To optimise the waste handling process: 1. Analysis and prioritisation of measures with the greatest cost saving potential 2. Cost of recycling. The cost varies depending of what is to be recycled and how well it is sorted 3. The characteristics and capability of the waste dumps. The capacity, sorting capability, level of recycling, etc. Based upon the characteristics of the waste dump the most suitable waste dump can be selected for a particular waste handling task 4. Increased amount of waste and type of waste that can be recycled 5. Systems for Increased sorting level (quality) of all the bins - sorting as close as possible to the waste producer 6. Reduction of the widespread abandonment of waste next to the bins 7. Reduction of the widespread abandonment of waste in peripheral/industrial/riverbank areas 8. Procedure for handling parked cars obstructing the path of vehicles servicing the bins.

9.1.1 [UC] Waste dump capability (AI-205)

Context	Waste Optimization
Description	The waste dumps are described with their ability to handle the waste: 1. Capacity. The amount of waste it can handle 2. Types. the different types of waste, it can handle 3. Sorting level in. The level of sorting of the received waste, it can handle 4. Sorting level out. The level of sorting of the waste, when the waste has been handled 5. The cost of handling the waste, based upon the type of waste received

[R] Waste dump Attributes (ALMANAC-152)

Context	Waste Optimization / Waste dump capability

Description	The waste dumps capability should be described with their ability to handle the waste: • Capacity. The amount of waste it can handle • Types. the different types of waste, it can handle • Sorting level in. The level of sorting of the received waste, it can handle • Sorting level out. The level of sorting of the waste, when the waste has been handled • The cost for handling the waste, based upon the type of waste received
Rationale	None
Fit criterion	Several waste dumps are selectable with all of the parameters described
Status	Open

9.1.2 [UC] Visualising the Cost (AI-204)

Context	Waste Optimization
Description	The cost varies depending of what is to be recycled. By visualising the cost of recycling and prioritising the areas where the economical benefits are greatest, it is possible to increase the efficiency and thereby reduce the cost.

[R] Calculate the cost of a collection route (ALMANAC-146)

Context	Waste Optimization / Visualising the Cost
Description	The cost of executing a specific collection route should be computable (cost analysis)
Rationale	This feature is important for the route planner actor
Fit criterion	Fit Criterion The cost analysis should be accessible from the route plan, by 1 click
Status	Open

[R] Inputs for Cost analysis - Waste dump Characteristics (ALMANAC-147)

Context	Waste Optimization / Visualising the Cost
Description	Input to the cost analysis: The Cost of utilizing a specific waste dump should include the following parameters: • Total capacity • Which type of waste can be sorted and to what level of quality • Special capability • Sorting capacity (amount of type) / hour • Cost, based upon the type of waste received. • The percentage of the received waste, that can be reused
Rationale	Inputs for possible optimization of routes
Fit criterion	The cost analysis should be calculated to a level where at least 80% of the parameters are used. The parameters are not necessary based upon actual figures, but need to be present for the calculation.

Status	Open

[R] Input for Cost analysis - Routes (ALMANAC-148)

Context	Waste Optimization / Visualising the Cost
Description	The cost of a particular route can be calculated based upon: • The salary for each of the employed participating in the collecting • The total vehicle expenses for the particular route
Rationale	Inputs for cost analysis of routes
Fit criterion	The cost analysis should be calculated to a level where at least one of the parameters are used. The parameters are not necessary based upon actual figures, but need to be present for the calculation
Status	Open

[R] Inputs for Cost analysis - Collecting wide spread waste (ALMANAC-149)

Context	Waste Optimization / Visualising the Cost
Description	Input to the cost analysis: The cost for collecting abandoned and misplaced waste (e.g. next to the bin/peripheral): • The amount of waste collected • The salary for each of the employed participating in the specific collecting • The extra time spent for this collecting • The delivery cost for this at the waste dump • The vehicle expenses for the particular route
Rationale	Inputs for cost analysis of routes
Fit criterion	The cost analysis should be calculated to a level where at least 80% of the parameters are used. The parameters are not necessary based upon actual figures, but need to be present for the calculation
Status	Open

[R] Inputs for Cost analysis - obstacles to collection (ALMANAC-150)

Context	Waste Optimization / Visualising the Cost
Description	Input to the cost analysis: Cars obstructing the waste collection: • The extra time used • The cost of a new waste collection route
Rationale	Inputs for cost analysis of routes
Fit criterion	The cost analysis should be calculated based upon the parameter. The parameter is not necessary based upon actual figures, but need to be present for the calculation
Status	Open

9.2 [S] Collection Optimization (AI-206)

Context	Waste Application

Description	The planning for the fleet of waste collection vehicles is complicated, and many elements have to be coordinated. The primary goal for a planning tool is to establish a total overview of the situation, and to make the planning of the collection easy, effective and useful. The tool for collection optimisation could be based on a GIS system, where the actual planned routes for all the waste collection vehicles are shown. The planning of the route for the individual waste collection vehicles is performed by collecting information on the capacity of the waste collection vehicles, the current waste level on the route, the roads availability, the geography, the dump end points, and historical data based on previously recorded waste collection. If a public event is planned, the need for extra bin capacity must be estimated to anticipate this in the route planning. The bins with automatic reporting of fill level, the street bins and the UEIs are all displayed on the GIS map, and optionally on lists. Information on each individual bin and UEI can be displayed direcctly from the map. The information comprises at least ID, type, size/capacity and attached sensors. For each bin and UEI the actual fill level – where relevant – can be displayed. Dynamically, the current position of all the available waste collection vehicles is displayed on the map and updated regularly. The vehicles are olso objects with attached information - type, capacity, etc. On the screen the status of the waste collection vehicles not currently available can be shown. The route planning tool must be able to handle both static and dynamic information reported from the bin areas. The tool must be able to handle any waste issue, whether it is reported from sensor-equipped waste bins, a bin on the street or from an UEI. The outcome is an updated route for the vehicle operators. The goal of the dynamic updates is "Just in Time" collection. The efficiency must be high, and the planning tool might also handle a situation, where bins are not sufficiently full, and therefore to be excluded from collection. If a street bin is not accessible, i.e., if a parked car is blocking the access to a bin, the vehicle operators can report this issue to the ALMANAC issue database, and a new schedule for picking up this particular bin is prepared. This is reported from the handheld devices to the ALMANAC issue database. Optimisation of the route is possible in several loops. The optimisation algorithm can work with different parameters, e.g., optimising for speed, quality, economy, etc. The route planning tool must be able to prioritise areas or routes of greater importance, or op. The route planning tool automatically updates the routes, when new information indicates that re-planning is necessary. The route planning tool must be able to update the route planning system to ensure optimal ""Just-in-Time"" routes. The route plans will be published on a web page, allowing the public to see the routes and find out when their bins are scheduled to be emptied. The routes are often restricted information, as they are used by the collectors for competing on collection contracts. Therefore, the solution must be configuable with respect to which stakeholders can access what.

9.2.1 [UC] Dynamic Route Planning (AI-221)

Context	Collection Optimization
Description	The route planning tool must be able to dynamically handle information reported from the bin areas. The tool must be able to handle any waste issue, whether it is reported from sensor-equipped waste bins, a bin on the street or from an UEI. The tool then attaches the issue to a relevant route for the vehicle operators. If a street bin is not accessible, i.e., if a parked car is blocking the access to the bin, the vehicle operators can report this issue to the ALMANAC issue database. This is reported by the vehicle operators with the handheld devices, and a new schedule for handling this particular bin is prepared.

[R] Route planning happens according to current waste situation (e.g. fill level, issue track list, ...) (ALMANAC-26)

Context	Collection Optimization / Dynamic Route Planning
Description	
Rationale	ALMANAC should be able to correlate all smart city information into reasonable decisions.
Fit criterion	It is possible to define situations or states based on resource states. These rules are then used to identify state changes where these states are queryable.
Status	Open

[R] Situation can adapt based on near real-time changes and events (e.g. new issues) (ALMANAC-27)

Context	Collection Optimization / Dynamic Route Planning
Description	
Rationale	A just reported abandoned waste issue can be collected immediately by a waste truck going through the street.
Fit criterion	After emitting an event an effected state can correctly adapt within 1 minute.
Status	Open

[R] Public waste bins can be viewed on an electronic map (ALMANAC-28)

Context	Collection Optimization / Dynamic Route Planning
Description	
Rationale	As a citizen I want to know the nearest waste bin to my location.
Fit criterion	50% of waste bins appear on a map application
Status	Open

[R] Issues automatically raised (ALMANAC-156)

Context	Collection Optimization / Dynamic Route Planning

Description	The route planning tool must be able to handle dynamically information reported from the areas: • If a sensor-equipped waste bin report the bin as full. • A waste issue is reported from a public mobile device app • A report from the vehicle operator that a specific bin cannot be emptied It should be possible to define the level "full" as 60, 70, 80, 100% The route planning tool updates automatically or on request the route based upon both the static and dynamic input
Rationale	None
Fit criterion	The route will be calculated and displayed based upon both the static route and the dynamic input information. At least one of the dynamic information can be handled.
Status	Open

9.2.2 [UC] Simulate collection (AI-211)

Context	Collection Optimization
Description	This use case defines a simulation scheme for the Waste scenarios. The functionality and data can be used either as project demonstrations, or even in run time as a collection planner's tool. Define a GIS map of a city area Define a set of the relevant • Vehicle positions/garages • Bin types • A sample set of routes, with vehicle IDs, vehicle speed and collection times • Waste dumps with the relevant main parameters • Generate fill level signals for simulation of filling of waste bins. Add or multiply a seed-based randomisation factor as necessary. Implement a simulation engine capable of ticking time and a tick routine updating time and populating the routes with resources and states.

No requirements specified

9.2.3 [UC] Show Route plan (AI-210)

Context	Collection Optimization
Description	The route plans are visualized, and the relevant actors are able to see the routes and citizens can see when their bins are scheduled to be emptied.

[R] Users can view status of their waste bins in ALMANAC system (ALMANAC-24)

Context	Collection Optimization / Show Route plan
Description	
Rationale	To increase user engagement all relevant information should be visible four citizens.

Fit criterion	Through a portal users should see - after providing their credentials - information related to them.
Status	Open

[R] Public waste bins can be viewed on an electronic map (ALMANAC-28)

Context	Collection Optimization / Show Route plan
Description	
Rationale	As a citizen I want to know the nearest waste bin to my location.
Fit criterion	50% of waste bins appear on a map application
Status	Open

[R] Public web page (ALMANAC-158)

Context	Collection Optimization / Show Route plan
Description	A public web page must be established. On the web page the "just-in-time" routes can be displayed, and detailed information about the routes can also be displayed. The design must be defined in more details.
Rationale	None
Fit criterion	The web page is public accessible.
Status	Open

[R] Single Bin information Geographical Map overlays (ALMANAC-175)

Context	Collection Optimization / Show Route plan
Description	The GIS system must be able to display the location of each bin with level detector, the condo areas bin and the UEIs.
Rationale	For operation of the UI
Fit criterion	The items are visible on the map or listable from the map with a single click
Status	Rejected

[R] Geographical Map overlays - routes (ALMANAC-178)

Context	Collection Optimization / Show Route plan
Description	The real time GIS system overview must be able to display information on the routes for each waste collection vehicle
Rationale	For operation of the UI
Fit criterion	The items are visible on the map or listable from the map with a single click

Status	Open

[R] Geographical Map overlays - vehicle information (ALMANAC-179)

Context	Collection Optimization / Show Route plan
Description	The real time GIS system overview must be able to display information on the waste capacity and other relevant information on the vehicles
Rationale	For operation of the UI
Fit criterion	The items are visible on the map or listable from the map with a single click
Status	Open

9.2.4 [UC] Optimize Route Plan (AI-209)

Context	Collection Optimization
Description	Optimisation of the route is possible in several loops. The optimisation algorithm can work with different parameters, e.g., optimising for speed, quality, economy, etc. The planning must be able to prioritise areas or routes of greater importance. The route planning tool automatically updates the routes, when new information indicates that re-planning is necessary. The route planning tool must be able to update the waste collection route system and update it with the new route – whenever necessary – in order to control and maintain optimal "Just-in-Time" routes. Some of the route plans could be published on web page and involved tools, and the public would be able to see the routes and when theirs bins are scheduled to be emptied.

[R] Route plan optimization (ALMANAC-157)

Context	Collection Optimization / Optimize Route Plan
Description	The route planning tool must be able to optimize the route in several loops. A set of parameters can be selected in order to choose what to optimize for: 1 Speed of the work. Defines how fast the route can be handled 2 The type and amount of waste collected 3 The Capacity of the vehicle type in mind 4 Quality. All waste is picked up, also widespread abandonment of waste next to the bins 5 Economy. The shortest and most optimal route - seen from a economic perspective
Rationale	None
Fit criterion	The route planning tool can optimize for at least one of the parameters. The calculation must be upon the priority parameter and an event can trigger the calculation

Status	Open

[R] Frequency and priority on routes (ALMANAC-173)

Context	Collection Optimization / Optimize Route Plan
Description	Each area and routes must have a collection frequency and a priority parameter. The priority parameter can be set to Low, Medium or High.
Rationale	It is important to be able to prioritize and plan for collection of the routes or areas.
Fit criterion	The parameters are accessible and viewable
Status	Open

[R] Just in Time adjustment of Route (ALMANAC-174)

Context	Collection Optimization / Optimize Route Plan
Description	In case of an event affecting a route, the planning tool is automatically activated and a new route is scheduled. The waste collection route instance is automatically updated with the new route. In case of extraordinary issues, it is important that the planned route is left unchanged
Rationale	In case of unplanned waste issues, routes under execution must be changeable on-the-fly
Fit criterion	The executed route is changed in real time
Status	Open

9.2.5 [UC] Static Route Planning (AI-208)

Context	Collection Optimization
Description	The planning of the route for each individual waste collection vehicle is performed by collecting information on the capacity of the vehicle, the current waste level on the route, the availability of the road, the geography, the selected dump end point, and historical data based upon the waste level from the same previously week day/date/month. These data give information on how big the needed capacity has been from a historical perspective. Statistical data from previous periods can also be fed into the planning system. If an public event is scheduled, information on how big a need for extra bin capacity must be estimated in order to take care of this in the route planning. The goal for the planning of the waste collection is that it has to be done "Just in Time". The efficiency must be high, and the planning tool must also be able to handle a situation where bins are not sufficiently full, and therefore not worthwhile to empty.

[R] Select waste dump (ALMANAC-151)

Context	Collection Optimization / Static Route Planning
Description	It should be possible to choose a waste dump as end point of a collection route
Rationale	This feature is important for the route planner - but we need a set of data for how is being done presently
Fit criterion	Several waste dumps are selectable
Status	Open

[R] Generate a static route for each waste collection vehicle and show it on a map. (ALMANAC-154)

Context	Collection Optimization / Static Route Planning
Description	The collection route must be shown on a street map
Rationale	None
Fit criterion	The route is shown on a street map
Status	Open

[R] Use the following information for route planning (ALMANAC-155)

Context	Collection Optimization / Static Route Planning
Description	The planning tool must be able to handle the following information: • The capacity of the waste collection vehicles • The current waste level on the route • The roads availability (possible roadwork) • The geography of the route • The selected dump end point • Historical data based upon the waste level from the same previously week day/date/month • Statistical data from previous periods • Planned public events • Handle bins not sufficiently full and therefore not worthwhile to empty
Rationale	None
Fit criterion	The route must be displayed on the GIS mapping system All the database records must be present on the screen and displayed either as totes or scrollable records. The static route plan can be calculated based upon at least 5/9 information parameters
Status	Open

9.2.6 [UC] Waste Collection Tool (AI-207)

Context	Collection Optimization
Description	The tool for collection optimisation is based upon a GIS system, where the actual planned routes for all the waste collection vehicles are shown. All the different types of waste bins and the UEIs are displayed

	on the GIS map and optionally in lists. Information on each individual bin and UEI can be displayed on the map and optionally in lists. The information covers the size/capacity and other relevant information. For each bin and UEI the actual current degree of filling - where possible - can be displayed. All the available waste collection vehicles are all displayed on the GIS map. The waste capacity and other relevant information on the vehicles can be shown on the GIS map. On the screen the status of the waste collection vehicles - not currently available - can be shown.

[R] Geographical Map overlays (ALMANAC-153)

Context	Collection Optimization / Waste Collection Tool
Description	The GIS system must be able to display the Bins, the UEIs and the collection vehicles with informative icons on the GIS system.
Rationale	For operation of the UI
Fit criterion	The items are visible on the map or listable from the map with a single click
Status	Open

[R] Single Bin information Geographical Map overlays (ALMANAC-175)

Context	Collection Optimization / Waste Collection Tool
Description	The GIS system must be able to display the location of each bin with level detector, the condo areas bin and the UEIs.
Rationale	For operation of the UI
Fit criterion	The items are visible on the map or listable from the map with a single click
Status	Rejected

[R] Geographical Map overlays - fill capacity of bins (ALMANAC-176)

Context	Collection Optimization / Waste Collection Tool
Description	The real time GIS system overview must be able to display information on the capacity/size etc. on each individual bin and UEIs
Rationale	For operation of the UI
Fit criterion	The items are visible on the map or listable from the map with a single click
Status	Open

[R] Geographical Map overlays - fill level information (ALMANAC-177)

Context	Collection Optimization / Waste Collection Tool
Description	The real time GIS system overview must be able to display the current filling level for each bin and UEI
Rationale	For operation of the UI
Fit criterion	The items are visible on the map or listable from the map with a single click
Status	Open

[R] Geographical Map overlays - routes (ALMANAC-178)

Context	Collection Optimization / Waste Collection Tool
Description	The real time GIS system overview must be able to display information on the routes for each waste collection vehicle
Rationale	For operation of the UI
Fit criterion	The items are visible on the map or listable from the map with a single click
Status	Open

[R] Geographical Map overlays - vehicle information (ALMANAC-179)

Context	Collection Optimization / Waste Collection Tool
Description	The real time GIS system overview must be able to display information on the waste capacity and other relevant information on the vehicles
Rationale	For operation of the UI
Fit criterion	The items are visible on the map or listable from the map with a single click
Status	Open

[R] Geographical Map overlays - vehicle positions (ALMANAC-180)

Context	Collection Optimization / Waste Collection Tool
Description	The real time GIS system overview must be able to display the current position of all the vehicles.
Rationale	For operation of the UI
Fit criterion	The items are visible on the map or listable from the map with a single click
Status	Open

[R] Geographical Map overlays - vehicles not in operation (ALMANAC-181)

Context	Collection Optimization / Waste Collection Tool
Description	The real time GIS system overview must be able to display the status of the waste collection vehicles not in current operation.
Rationale	For operation of the UI
Fit criterion	The items are visible on the map or listable from the map with a single click
Status	Open

9.3 [S] Issue Management (AI-212)

Context	Waste Application
Description	A Turin family is out for an afternoon stroll. On a street corner they see a big pile of debris from a building construction site. They think it may have fallen off the back of a vehicle. The pile is disturbing the traffic. They take a photograph of the pile with a mobile phone. Now they bring up the ALMANAC-compatible mobile device app. The app automatically creates a new waste issue in the ALMANAC application and uploads the newly taken photograph to the ALMANAC platform issue tracker. They opt for SMS notification to receive feedback when the issue has been handled. The issue is transmitted to the ALMANAC platform as is entered into the platform's collection optimisation planner and transmitted to the nearest waste handling vehicle. At this point, the user gets a Text message saying that the issue is being handled, perhaps including estimated time of completion. The vehicle operators follow the continuously updated issue plan in their waste collecting routine. Their handheld devices report back to the server database when the waste has been picked up at the issue point. Once the situation has been resolved, the user is notified by a Text message. Variation I: Another citizen passes the same pile of debris in the junction and photographs it 10 minutes after the issue has been reported. When uploading, the app tells him that he is in the vicinity of an unhandled waste issue and shows him the reported picture. He quickly realises that the issue is already dealt with, decides to add his photo, which is of better quality than the original one. He then subscribes to SMS notifications, as the family who defined the issue just did. He then presses on with his other business. Variation II: Someone in the business flow sees the issue and rates it "severe". A more effective handling plan is assigned and an separate vehicle is sent specifically to handle the issue.

9.3.1 [UC] Prioritisation of tasks (AI-216)

Context	Issue Management
Description	Someone in the business flow sees the issue and changes the importance of the issue to "severe". A more effective handling

	plan is assigned and a separate vehicle is sent specifically to handle the issue.

[R] Prioritization of issues (ALMANAC-162)

Context	Issue Management / Prioritisation of tasks
Description	The priority of a reported issue can be changed by the operator of the ALMANAC issue database. The importance can be reported as "Minor", "Major", "Severe" or "Critical"
Rationale	Escpecially for critical events this might be good. Might also be add-on at an early state and as such in need for other things working first
Fit criterion	The importance can be reported as "Minor", "Major", "Severe" or "Critical"
Status	Open

9.3.2 [UC] Handheld device for use in the vehicle (AI-215)

Context	Issue Management
Description	The waste collectors report back with their handheld devices to the ALMANAC issue database when the waste has been picked up at the issue point. When the issue has been resolved, the user is automatically notified.

[R] The handheld device- used by the professionals in the vehicle - must be able to report back to the ALMANAC, when the waste has been picked up at the issue point. (ALMANAC-161)

Context	Issue Management / Handheld device for use in the vehicle
Description	The report must included the issue Id number, that identifies the issue, the bin Id and the position of the bin.
Rationale	For user feedback (connects to text message)
Fit criterion	The handheld device for use in the vehicle must be able to communicate simple messages with the ALMANAC system.
Status	Open

9.3.3 [UC] Track Issue (AI-214)

Context	Issue Management
Description	The user of the mobile device app can select to be notified by a Text message when the issue has been resolved.

[R] Issues have to be assigned according to role and status (e.g. location) (ALMANAC-18)

Context	Issue Management / Track Issue
Description	
Rationale	The large number of collected issues has to be assigned to responsibles. This ensures the all issues get handled and solved.

Fit criterion	The issue automatically gets assigned to the right recipient.
Status	Open

[R] All relevant stakeholders should be notified about state updates of issues (ALMANAC-19)

Context	Issue Management / Track Issue
Description	
Rationale	People who have to act on issues need to know about changes in their state. Also reporting citizens might be interested in the progress of their reported issue.
Fit criterion	Required stakeholders get notification messages about issue state changes.
Status	Open

[R] Inform the waste issue creator of collection (ALMANAC-160)

Context	Issue Management / Track Issue
Description	The ALMANAC system should be able to send a Text message to the mobile device with information of the status of the reported issue. The TEXT MESSAGE must contain information on where the issue has been, and when the issue has been solved. When the reported issue is received the ALMANAC system must also send a TEXT MESSAGE to the mobile device to confirm the receipt of the message.
Rationale	Basic for issue entry - new functionality for civil users
Fit criterion	The ALMANAC system should be able to send Text messages to the mobile devices with receipt and description of the issue has been resolved.
Status	Open

[R] The handheld device- used by the professionals in the vehicle - must be able to report back to the ALMANAC, when the waste has been picked up at the issue point. (ALMANAC-161)

Context	Issue Management / Track Issue
Description	The report must included the issue Id number, that identifies the issue, the bin Id and the position of the bin.
Rationale	For user feedback (connects to text message)
Fit criterion	The handheld device for use in the vehicle must be able to communicate simple messages with the ALMANAC system.
Status	Open

9.3.4 [UC] Create Issue (AI-213)

Context	Issue Management
Description	Any issue of abandoned waste in the street can be reported via a freely available app. The app takes a picture of the issue, describes it, and sends it to the ALMANAC system. Where fill level sensors are not installed on waste bins shared by

	a group of families, waste level issues can be generated and reported to the ALMANAC system by the families, using a mobile device. In case of an extraordinary waste issue, this can also be generated and reported to the ALMANAC system, using the same system. The application can read the id of the waste bin and the fill level of the bin can be reported. The issue is automatically transmitted with information of the location (GPS from the mobile device).

[R] The ALMANAC system shall report to the municipality waste abandoned on the side of bins (ALMANAC-2)

Context	Issue Management / Create Issue
Description	The ALMANAC system shall report to the municipality waste abandoned on the side of bins. (fit criterion is arbitrary- to be discussed with end-users) (who is the customer ?)
Rationale	Abandoned waste is damaging for the city image.
Fit criterion	Abandoned waste is signaled by the system within 24 hours, in 90% of the cases.
Status	Open

[R] Citizens should be able to report abandoned waste issues (ALMANAC-16)

Context	Issue Management / Create Issue
Description	
Rationale	The ALMANAC Project has as aim to enable a higher engagement of users into the waste management process. Such an application will also create a uniform and standardized way of reporting issues.
Fit criterion	An App with which users can take a picture and report the location of waste.
Status	Open

[R] Waste issues should be collected and presented through the ALMANAC platform (ALMANAC-17)

Context	Issue Management / Create Issue
Description	
Rationale	ALMANAC has to provide a standardized way to deal with user complaints or reported issues. For this these have to be collected into a database.
Fit criterion	A view is necessary to list and filter issues according to type and state.
Status	Open

[R] Priority or importance of issues can be edited manually (ALMANAC-20)

Context	Issue Management / Create Issue
Description	
Rationale	Based on expertise a professional may rate a issue more important than others.
Fit criterion	Attributes of issues can be edited manually through the whole process.
Status	Open

[R] Devices should be able to automatically create issues based on defined rules (ALMANAC-22)

Context	Issue Management / Create Issue
Description	
Rationale	Waste bins should automatically create issues if critical fill level has been reached.
Fit criterion	After defining a set of rules the virtual entity should emit events if the criterion are met.
Status	Open

[R] It should be possible to group resources (ALMANAC-23)

Context	Issue Management / Create Issue
Description	
Rationale	For example if multiple waste bins have a high fill level they should all together emit one fused event.
Fit criterion	Dependencies between virtual devices are definable.
Status	Open

[R] Citizens should be able to request extraordinary waste collection (ALMANAC-25)

Context	Issue Management / Create Issue
Description	
Rationale	If users foresee unusual waste production they should be able to report this in advance. This avoids frustration and keeps the city cleaner.
Fit criterion	Through an App users can generate issues also not related to abandoned waste.
Status	Open

[R] Situation can adapt based on near real-time changes and events (e.g. new issues) (ALMANAC-27)

Context	Issue Management / Create Issue
Description	
Rationale	A just reported abandoned waste issue can be collected immediately by a waste truck going through the street.

Fit criterion	After emitting an event an effected state can correctly adapt within 1 minute.
Status	Open

[R] Public App for waste issues (ALMANAC-159)

Context	Issue Management / Create Issue
Description	A mobile device app must be able to take a picture of a waste issue, and transmit it to the ALMANAC system together with the GPS co-ordinates, a description of the issue and the phone number.
Rationale	Basic for issue entry - new functionality for civil users
Fit criterion	The picture can be transmitted to the ALMANAC system together with the GPS position, the description and the phone number of the sender
Status	Open

[R] Public App for waste reporting (ALMANAC-167)

Context	Issue Management / Create Issue
Description	Any waste level issue can be reported to the ALMANAC system using a mobile Android phone or a tablet. The user must report the Id of the waste bin together with the estimated fill level. The report could also be a waste level issue request to the system. The application can read the id of the waste bin and the level of the bin can be reported.
Rationale	To be evaluated
Fit criterion	The app can read the id of the bin, the fill level can be transmitted to ALMANAC
Status	Open

9.4 [S] Waste quality Inspection (AI-217)

Context	Waste Application
Description	The collector operator inspects the quality of the waste in the single bin in order to be able to guide the end user citizens and speak to / educate them on waste sorting issues. This routine is supported by using the sensors and the issue management system to enter a waste quality indicator on a handheld device, which automatically records information of the individual bin and owner and automatically returns information to the citizen on the waste quality. Hereby the citizen is encouraged to engage in better sorting, and he can see the result of his own work in the form of a "smiley"-type indicator. A penalty and/or a reward system may be established to further entice the citizen to improve the quality of his sorting. For the UEIs and the "stradales" the collector operator inspects the quality of the waste in the container and reports the waste quality. The reporting is carried out in the same way as with the bin.

9.4.1 [UC] Register and feedback Waste Quality (AI-218)

Context	Waste quality Inspection
Description	The collector operator visually inspects the quality of the waste in the single bin and reports the quality level to the ALMANAC system. This routine is supported by using sensors identifying the citizen owning the bin, and the issue management system to enter a waste quality indicator. This is carried out with a handheld device. The handheld device must also be able to read the id of the UEI bins and the "stradale" bins for reporting of the quality.

[R] Feedback on waste quality is reported to owners (ALMANAC-29)

Context	Waste quality Inspection / Register and feedback Waste Quality
Description	
Rationale	To increase citizen engagement and improve behavior citizens should see their produced waste quality and its effects.
Fit criterion	Information about waste of a person gets properly assigned and aggregated. This aggregation is used as feedback for example in form of a smiley.
Status	Open

[R] Quality registration on handheld device (ALMANAC-163)

Context	Waste quality Inspection / Register and feedback Waste Quality
Description	The collector should be able leave out a collection and report a waste quality issue or report to the issue management system by use of a handheld device. The waste quality indicator is defined as: Very poor, Poor, Acceptable, Fine, Very fine, and relate to sorting, overfilling or misuse (waste beside bin or in improper bags). The handheld functionality / device must identify the bin, by the sensor, a barcode or a passive NFC tag.
Rationale	It is important for the collectors to be able to report cases of non-emptying due to misuse, an be able to leave waste uncollected as "penalty" to citizens.
Fit criterion	The waste quality can be reported to ALMANAC by use of a handheld. The id on the bin and on the UEIs, and the "stradale". can be read by the handheld.
Status	Open

[R] Feed back to the users (ALMANAC-164)

Context	Waste quality Inspection / Register and feedback Waste Quality
Description	The reported quality of the citizens sorting is reported as a "smiley"-type indicator. The reported quality and the guideline and recommendations are reported to the ALMANAC system by the collector operator by using a handheld device. The report can be seen by the operator and send to the citizens.
Rationale	Important to the use case
Fit criterion	The report can be created, and send to the citizen. It is possible to see the report in the ALMANAC system

Status	Open

[R] Penalty/award system (ALMANAC-165)

Context	Waste quality Inspection / Register and feedback Waste Quality
Description	A penalty and/or an award system for the citizen should be established, based upon the results of quality of the citizen's sorting. For example, 1st bad quality report has no penalizing effect / collection fee in return, 2nd quality report a low penalty or a warning, 3rd report a fine / no reduction in fee.
Rationale	High level- How do we design this?
Fit criterion	The penalty/award system is established, and can analyze the quality reports on single citizen level
Status	Open

[R] Quality reports for single citizens are summarizable (ALMANAC-170)

Context	Waste quality Inspection / Register and feedback Waste Quality
Description	All the quality reports from each citizen are summarized to a report. Based upon the summarized report the operator can choose to give the citizen a penalty/award.
Rationale	It is important that the system does not not create "automatic penalties", and that any correction of a citizens payment should be documentable.
Fit criterion	The summarized reports from each citizen can be displayed.
Status	Open

[R] Waste collection quality report (ALMANAC-171)

Context	Waste quality Inspection / Register and feedback Waste Quality
Description	The system can generate a summary report based upon all the available waste quality reports generated from inspection of single citizen bins, and in aggregated form on route/waste fraction/area level for the waste process optimization.
Rationale	It is important to be able to monitor the quality of the collection systems, and of the monetary correction systems (penalty/award system). Therefore waste quality inspections must be available for statistics.
Fit criterion	The system can generate a summary report based upon all the reports
Status	Open

9.5 [S] Waste Level Reporting (AI-219)

Context	Waste Application
Description	The waste bins in a Turin residential area are equipped with fill level sensors, activating input to automatic issue generation in the ALMANAC system. The issue generator works from grouping the

	waste bins and generating a waste issue from the group, for example when the fill level exceeds 80%. For waste bins in the street, the issues can be still be generated by individuals, but also with a group profile. Using their mobile phone, residents can report an issue if, e.g., they have just generated an extraordinary waste issue as a result of a communal garden workday, or if a resident moves in or out. In the ALMANAC system the end user can check when their waste bins are scheduled for collection, and they can generate issues to get an extraordinary collection.

9.5.1 [UC] Report Fill Level (AI-220)

Context	Waste Level Reporting
Description	Some of the bins are equipped with fill level sensors. The sensors measure the fill level, which is automatically reported to the ALMANAC system.

[R] ALMANAC shall be able to integrate fill level sensors of waste bins (ALMANAC-21)

Context	Waste Level Reporting / Report Fill Level
Description	
Rationale	In order to automatically capture waste bins' fill levels it has to be monitored via sensors. These sensors must be integrated into the platform and communicate through it.
Fit criterion	Sensor devices need to be consumable over the ALMANAC platform
Status	Open

[R] Fill level sensors (ALMANAC-166)

Context	Waste Level Reporting / Report Fill Level
Description	The fill level sensor on the waste bin must be able to measure the fill level in relevant units to the collection task at hand. The measurement strategy must be thought together with the type of instrument, the sampling technique and transmission technology Please specify the value scale adopted (continuous, empty/full, or the like)
Rationale	It is important for scalability reasons to report the correct measurement values, units and scales in the correct intervals
Fit criterion	The fill level can be measured by a sensor, and transmitted to the ALMANAC system.
Status	Open

[R] Public App for waste reporting (ALMANAC-167)

Context	Waste Level Reporting / Report Fill Level
Description	Any waste level issue can be reported to the ALMANAC system using

	a mobile Android phone or a tablet. The user must report the Id of the waste bin together with the estimated fill level. The report could also be a waste level issue request to the system. The application can read the id of the waste bin and the level of the bin can be reported.
Rationale	To be evaluated
Fit criterion	The app can read the id of the bin, the fill level can be transmitted to ALMANAC
Status	Open

[R] Fill level sensors, sampling technique (ALMANAC-168)

Context	Waste Level Reporting / Report Fill Level
Description	The fill level signal must be sampled at a rate or an event relevant to the collection task at hand. Specify the method adopted
Rationale	As there are many bins, it is important for scalability that only the necessary measurements are transmitted.
Fit criterion	The fill level can be measured by a sensor, and transmitted to the ALMANAC system.
Status	Open

[R] Fill level sensors, power supply (ALMANAC-169)

Context	Waste Level Reporting / Report Fill Level
Description	The fill level sensor must be battery operated, optionally connected to a power line. (please specify)
Rationale	It is important for to have realistic maintenance strategy to the problem in hand,as there are many bin sensors
Fit criterion	The fill level can be measured by a sensor, and transmitted to the ALMANAC system.
Status	Open

[R] Fill level sensors, signal transmission (ALMANAC-172)

Context	Waste Level Reporting / Report Fill Level
Description	The transmission from the fill level sensor to ALMANAC must be NFC, wireless / M2M, optionally wired/M2M. (please specify)
Rationale	The transmission method is an important design parameter, and must fit with both the collection problem at hand, as well as the required equipment interfaces (eg vehicles and bin IDs).
Fit	The fill level can be measured by a sensor, and transmitted to the ALMANAC system.

criterion	
Status	Open

10 Appendix B: New Water Application Scenarios, Use Case and Requirements

The following abbreviations are used:

- [S] = Scenario
- [UC] = Use Case
- [R] = Requirement

10.1 [S] Consumption Awareness (AI-176)

Context	Water Application
Description	A water consumption application designed for measuring, reporting and automatic billing of water consumption. The scenario relies on the installation of smart metering in civil homes and covers live measurement of consumption data, Data sharing and comparison between users, checking of installations, automatic billing, and communication between utility and citizen on quality and function of installation as well as communication of news items and leakage notification.

10.1.1 [UC] Consumption Report (AI-202)

Context	Consumption Awareness
Description	The event manager is responsible for sending consumption reports to consumers. If a consumer wants a report every month, the event manager fetches the consumption figures for that specific consumer from the platform, and sends the report to the consumer The consumer wishes not to manually track consumption through the application, but have a report sent with consumption figures every once in a while. The user opens the water management application, and can choose a between different types of reports and how often they should be sent. Once the user has saved the settings, the system will manage sending reports to the consumer.

[R] Request consumption report (ALMANAC-186)

Context	Consumption Awareness
Description	A consumption report can be generated for a desired time period by the consumer using the application
Rationale	To enable easy monitoring and consumption awareness
Fit criterion	100% fulfilled
Status	Open

[R] Generate consumption report at fixed intervals (ALMANAC-187)

Context	Consumption Awareness
Description	A consumption report can be generated and sent automatically to the consumer at desired intervals
Rationale	To enable easy monitoring and consumption awareness
Fit criterion	100% fulfilled
Status	Open

10.1.2 [UC] Share Data (AI-197)

Scenario	Consumption Awareness
Description	The consumer user wishes to share data with other consumers on social networks which can be used to e.g. participate in challenges to reduce water consumption. The consumer can also choose to share data with other specific consumers, e.g. friends, family, neighbours etc. The consumer can choose to give access for a specified period of time or until further notice or indefinitely. Access settings can easily be changed. The utility employee wishes to make consumption data of a public building available. The utility employee opens the water management application and finds the smart meter associated with the building. The smart meter is then marked so it will be visible when citizens look for smart meters in the water management application.

[R] It must be possible to setup competitions with friends through the app (ALMANAC-41)

Use Case	Share Data
Description	A user and his / her neighbour might agree to compete on water consumption. For example, who can reduce their consumption the most in one week. Others should also be notified if a challenge is completed. The City of Turin could for example decide to implement a competition where the household that saves most water in a month is granted a holiday in Denmark.
Rationale	For generating behaviour motivation by gaming/competitions.
Fit criterion	Competition system must be implemented.
Status	Quality Check Passed

[R] It must be possible for the citizen water app to connect to the user's social network profile. (ALMANAC-99)

Use Case	Share Data
Description	The social network could be Facebook, twitter or the like
Rationale	To be able to share consumption data with others, and mutually discuss and learn sustainable behaviour

Fit criterion	It is possible for the citizen water app to connect to the user's Facebook profile. The Facebook is not required to frame in the application
Status	Quality Check Passed

[R] A user group must be created on a social network for "Turin Smart City Water App Users" (ALMANAC-100)

Use Case	Share Data
Description	The social network could be Facebook, twitter or the like
Rationale	To be able to share consumption data with others, and mutually discuss and learn sustainable behaviour
Fit criterion	A user group must be created on Facebooks for "Turin Smart City Water App Users"
Status	Quality Check Passed

[R] The Water application must generate a "I Use Turin Water App" post to the social network profile of the user. (ALMANAC-101)

Use Case	Share Data
Description	The social network could be Facebook, twitter or the like
Rationale	To be able to share consumption data with others, and mutually discuss and learn sustainable behaviour
Fit criterion	A tick mark is present and working for generating the Facebook message
Status	Quality Check Passed

[R] The Water application app can generate consumption statistics to post to the users' social network. (ALMANAC-102)

Use Case	Share Data
Description	The social network could be Facebook, twitter or the like
Rationale	To be able to share consumption data with others, and mutually discuss and learn sustainable behaviour
Fit criterion	The data is transferred and present on a Facebook wall
Status	Quality Check Passed

[R] The Water application should have a button for sharing data (in anonymized form) (ALMANAC-103)

Use Case	Share Data
Description	The anonymized data will be accessible to other users. The anonymized form is replacing the User ID with a generic one
Rationale	To be able to share consumption data with others, and mutually discuss and learn sustainable behaviour
Fit criterion	The consumption data are available in the platform, in anonymized form.

Status	Quality Check Passed

[R] It should be possible for the user to access the social network group and view own and other's messages (ALMANAC-104)

Use Case	Share Data
Description	By access means that the application should provide a quick link, a button or the like to bring the users' social network profile to the foreground and vice versa
Rationale	To be able to share consumption data with others, and mutually discuss and learn sustainable behaviour
Fit criterion	A means of connecting from users app to the social network is available, with few clicks
Status	Quality Check Passed

[R] The user's profile data shall be a part of the users' statistics used for anonymization (ALMANAC-105)

Use Case	Data
Description	Anonymization must be defined
Rationale	To be able to share consumption data with others, and mutually discuss and learn sustainable behaviour
Fit criterion	The social network group should show factsheet statistics
Status	Quality Check Passed

[R] Setting access rights (ALMANAC-188)

Use Case	Share Data
Description	End-users can give others access rights to their own water consumption data via the application
Rationale	End-user can define access rights
Fit criterion	Different access rights can be defined
Status	Open

[R] Defining time period for access rights (ALMANAC-189)

Use Case	Share Data
Description	End-users can define different time periods when setting access rights to others
Rationale	End-user should be able to control when and for how long others have access to their water consumption data
Fit criterion	Different time periods for access to water consumption data can be defined
Status	Open

[R] Access to public buildings' water consumption data (ALMANAC -190)

Use Case	Share Data
Description	Water consumption data for selected public buildings can be shared with citizens via the app.
Rationale	Create awareness and citizens engagement and promote water sustainable behaviour
Fit criterion	Water consumption data for public buildings can be made publicly available.
Status	Open

10.1.3 [UC] Access and view consumption data (AI-196)

Scenario	Consumption Awareness
Description	The consumer wishes to view the consumption of his/her own smart meter. The consumer starts the water management application, and is presented with a graphical overview of consumption. The user can select different periods of interest, and varying granularity. The citizen wishes to view the publicly available data. The citizen user starts the water management application, and is presented with a graphical overview of consumption. The user can select different periods of interest, and varying granularity. The citizen end-user wishes to view the consumption of a friend. The consumer starts the water management application, and is presented with a graphical overview of consumption. The user can select different periods of interest, and varying granularity. If the consumer has access to smart meters data of friends he can choose to view their data. End-user can choose to view data from any publicly available smart meters as well.

[R] View own water consumption data (ALMANAC-191)

Use Case	Access and view consumption data
Description	End-user can access and view own water consumption data using the application. Data can be displayed visually in a graph and for the chosen periods of time and with varying granularity.
Rationale	End-user must be able to view own water consumption data. Basic feature of the application
Fit criterion	Water consumption data is displayed on the application
Status	Open

[R] View publicly available water consumption data (ALMANAC-192)

Use Case	Access and view consumption data
Description	End-user can choose to view water consumption data for available public buildings. He can choose which public buildings he wishes to see the data for, for which periods and how detailed. Data can be presented as a graph.

Rationale	End-user should be able to access publicly available water consumption data.
Fit criterion	Publicly available data can be displayed via the app.
Status	Open

[R] View other's water consumption data (ALMANAC-193)

Use Case	Access and view consumption data
Description	End-user to access and view the water consumption data of others he has been given access to. Data can be presented as a graph.
Rationale	When given access, data must be visible. Enables sharing of data.
Fit criterion	Other's water consumption data can be viewed
Status	Open

10.1.4 [UC] Update consumer profile (AI-191)

Scenario	Consumption Awareness
Description	The consumer or the utility employee wishes to change some of the information regarding the consumer. If for example the consumer had registered an email address with the platform and wishes to change this, then the consumer or the utility employee open the water management application and change the values

[R] Update user information (ALMANAC-194)

Use Case	Update Consumer Profile
Description	The end-user can update personal information e.g. email or phone number using the app.
Rationale	It must be possible to update the user profile and information as necessary
Fit criterion	Personal user data can be updated via the application
Status	Open

[R] Discontinue and disconnect a citizen's meters from the citizen data area. (ALMANAC-115)

Use Case	Update Consumer Profile
Description	The professional shall be able to discontinue and disconnect a citizen's instruments from the citizen data area. A secure flow should be designed for this.
Rationale	If the citizen moves to another home
Fit criterion	It is possible to disconnect a citizen from the meters

Status	Quality Check Passed

[R] Disconnect a citizen and create a new citizen application instance to an existing household with instruments (ALMANAC-116)

Use Case	Update Consumer Profile
Description	The professional shall be able to disconnect a citizen and create a new citizen application instance to an existing household with instruments
Rationale	If the citizen moves to another home
Fit criterion	Re-connect a set of instruments to a new user
Status	Quality Check Passed

10.1.5 [UC] Notifications (AI-190)

Scenario	Consumption Awareness
Description	The event manager sends a notification to the consumers' water management application. The consumer opens the water management application, and can view the new notification alongside all previously sent notifications. Notifications could be information from the water management company regarding maintenance work or alerts that the benchmarked consumption has nearly been reached, etc. The water management company or city of Turin can issue relevant posts and news. A major catastrophe has occurred, and it is vital for the utility to inform citizens of impending danger. The utility employee opens the water management application to create a short warning message, location of the catastrophe and information about when to send out the message and for how long it is expected to be relevant. The event manager detects that a catastrophe has been registered, and must push this to citizens in the affected area. The event manager finds all consumers that are registered to a smart meter in the area of effect, and pushes the notification to them. If a citizen has chosen to allow ALMANAC to follow their location, a notification is also pushed to those citizens located in the area of effect.

[R] Consumption notifications (ALMANAC-33)

Use Case	Notifications
Description	The Consumption awareness app can push a notification to the user about the past days water consumption, if the user wants. The user can configure frequency of notifications. The application must show one or two lines of text on the users 'lock screen', with interesting facts about the water consumption since last notification.
Rationale	The application must be seen as ever present. Each day, the user must be involved in

	his/her water consumption.
Fit criterion	Notifications on water consumption are received according to the settings for frequency.
Status	Quality Check Passed

[R] The application must be able to display messages to the user (ALMANAC-37)

Use Case	Notifications
Description	Messages could come from the City of Turin, or the water board. They could include messages like 'Maintenance on the xx/xx 20XX - expect low water pressure', or 'Water quality alert'.
Rationale	To underpin user awareness it is important that service messages can be delivered
Fit criterion	Implementation of message service in the application.
Status	Quality Check Passed

10.1.6 [UC] Benchmarking Consumption (AI-188)

Scenario	Consumption Awareness
Description	The consumer wishes to benchmark own consumption, against similar households, using the water management application. The application takes the users benchmarking attributes, and queries the ALMANAC SCP. The platform calculates a simple score, and this is displayed by the water management application. A consumer wishes to change the parameters that are used to benchmark consumption. E.g. if a family member has left the household, and is no longer consuming water on the premises. The user starts the water management application, and can for example edit household size, m^3 of living space etc. No personal data must be revealed about the benchmarking attributes of households or of their specific consumption. Only a simple benchmark, like a score from A to F is revealed, or an anonymization must be performed

[R] Setting Benchmark (ALMANAC-195)

Use Case	Benchmarking Consumption
Description	The user wishes to set a benchmark value for desired water consumption to increase monitoring and to compare consumption with other households. Benchmark parameters are defined.
Rationale	Benchmarking will allow for comparisons and stronger monitoring of water consumption
Fit criterion	Benchmark value can be set
Status	Open

[R] Viewing benchmark analysis (ALMANAC-196)

Use Case	Setting Benchmark
Description	The user wishes generate a comparison between other households and request a benchmark analysis. A score is generated. No private data is revealed.
Rationale	Comparing with other similar households' water consumption will give the user a better idea of whether own water consumption is relatively low or high. Increases awareness.
Fit criterion	Benchmark analysis and comparison is generated
Status	Open

10.1.7 [UC] Predictive Consumption (AI-187)

Scenario	Consumption Awareness
Description	The consumer wishes to enhance the knowledge of own consumption. He opens the Predictive Consumption Calculator sheet and enters stationary data of consumption. The system follows the measurement values on line and estimates (comparable normalized consumption "standard" estimate, indications on consumer usage (high/low/medium or the like), forecast on bill size, price of a time period, ... etc) Postcondition: The vales are stored, and used when benchmarking water consumption against other households registered with the platform Actors: Citizen

[R] Users can edit parameters for predictive consumption calculator (ALMANAC-119)

Use case	Predictive Consumption
Description	The Predictive Consumption Calculator should include the following parameter: Freq of baths Freq of hand washes Freq of clothes washes Freq of dish washes Freq of of toilet flushes / hand washes) Freq of Cleaning of Kitchen Freq of Cleaning of Rest room / bath Freq of Cleaning of Floors (m^2) Freq of Cleaning of Other
Rationale	The consumption estimation based on usage parameters could enable estimation of usage to better detail than just one inlet flow.
Fit criterion	The frequencies must be present in editable form
Status	Quality Check Passed

10.1.8 [UC] Administrate access to smart meter (AI-178)

Scenario	Consumption Awareness

Description	A utility employee needs to manage who has access to a specific smart meter. The utility employee starts the water management application, and finds the smart meter by searching through the registered smart meters in the platform. If a new consumer must have access to a smart meter, the employee grants access. If a registered consumer moves, or otherwise looses the rights to view data form a smart meter, the utility employee removes the access to data.

[R] Data privacy on personal data (ALMANAC-39)

Use case	Administrate access to smart meter
Description	Only authorised clients may see data from a specific sensor, or household
Rationale	A (user) verification process must be implemented to ensure only people who share the same household can access sensor data.
Fit criterion	Unauthorised access to sensor data is not possible.
Status	Quality Check passed

[R] Dis-connect/connect users to smart meter (ALMANAC-40)

Use case	Administrate access to smart meter
Description	It must be possible to revoke a specific users access to a household of sensors, without effecting other users
Rationale	When users move out of a household, the meters and their data must be disconnected to be attached to "next inhabitant"
Fit criterion	Revoke process implemented. The user cannot connect.
Status	Quality Check passed

[R] Discontinue and disconnect a citizen's meters from the citizen data area. (ALMANAC-115)

Use case	Administrate access to smart meter
Description	The professional shall be able to discontinue and disconnect a citizen's instruments from the citizen data area. A secure flow should be designed for this.
Rationale	If the citizen moves to another home
Fit criterion	It is possible to disconnect a citizen from the meters
Status	Quality Check passed

[R] Disconnect a citizen and create a new citizen application instance to an existing household with instruments (ALMANAC-116)

Use case	Administrate access to smart meter
Description	The professional shall be able to disconnect a citizen and create a new citizen application instance to an existing household with

	instruments
Rationale	If the citizen moves to another home
Fit criterion	Re-connect a set of instruments to a new user
Status	Quality Check passed

10.1.9 [UC] Support Citizen (AI-181)

Scenario	Consumption Awareness
Description	The operator should be able to support the citizen in configuration, maintenance and advice. In this use case, this is done by accessing and viewing the data generated, while communicating with the citizen by other means (phone, skype, mail or the like), and helping with consultancy, operational help, explanations, etc. The Utility Employee's Consumption Awareness application can have an instance on a tablet computer, with the ability to, with permission, log into a citizen's data, or a central web-based application, where the citizen data is accessed from a consumer overview screen. The Utility Employee accesses the following functionalities The professional user accesses the following functionalities and data, to be able to assist the citizen: Associate specific instrument to citizen app, Replace or maintain instrument Accessing users' data Fact sheets Consumption calculators Cumulated /aggregated billing Actors: Utility Employee, Citizen

[R] Double check metering measurement (ALMANAC-111)

Use case	Support Citizen
Description	The system must include a function to double check metering measurement, by comparing measurement values between central outlet and aggregated outlet measurements, over the last hour – Raise an exception if mismatch.
Rationale	To help the user make sure that the smart meter works
Fit criterion	Demonstrate at least two flow metres in series measuring the same flow, and demonstrate an exception being set in the citizen UI
Status	Quality Check passed

[R] Assess the function of the single instrument (ALMANAC-113)

Use case	Support Citizen
Description	The system must be able to access the function of the single instrument, with accessing data less than 20 secs old, or pinging the actual instrument (if the instrument can do so)
Rationale	To help the user make sure that the smart meter works

Fit criterion	The system receives data form the single instrument, less than 20 secs old. A "ping " button can be set aside the instrument on the instrument list, press - send, release, received
Status	Implemented

10.2 [S] Consumption Aggregation (AI-200)

Context	Water Application
Description	This scenario is a part of the Water application, and generates statistical data using detailed and anonymized consumption measurement data from a group of consumers. The aggregate consumption data are used in-house and to publicize for Water App Consumers

10.2.1 [UC] View Aggregated Data (AI-201)

Context	Consumption Aggregation
Description	The Consumer or the utility employee wants to view the aggregated consumption data over a group of related consumers Pre:: The data must already be made publicly available Actors: Consumer

[R] Statistics should also be presented in alternative real-world terms (ALMANAC-44)

Use case	View Aggregation Consumption Data
Description	All water related numbers and statistics should also be presented in alternative real-world terms. For example, instead of 'City uses 42,323 m3 water per day', it should be presented as 'City uses water equivalent to 3,212 Olympic swimming pools per day' or 'The electricity used to purify water is equal to that of 50,000 households', or 'There are currently 10 million m³ water stored in the water towers, which is equal to what is available for the people of Ethiopia in a whole year'
Rationale	Presenting numbers in other than technical terms may be more meaningful and thought provoking to many consumers
Fit criterion	Statistics are representable using relatable real-world terms
Status	Quality Check Passed

10.2.2 [UC] Forecast Aggregated Consumption (AI-199)

Scenario	Consumption Aggregation
Description	The Utility Employee wants to generate predictive statistical data for consumption of water between consumers. Given the consumption in a customer group, what is the estimated water usage for the next period? Post: A statistical consumption estimate is generated Actor: Utility Employee

[R] The application must have a functionality to extend and forecast the water consumption (ALMANAC-123)

Use case	Forecast Aggregated Consumption
Description	The comparison can be based on citizen groups, users with certain characteristics (e.g. with similar number of inhabitants), or for all members
Rationale	For the user to be able to compare own consumption with standards, and learn sustainable consumption
Fit criterion	A set of standard consumption data are available and can be displayed togetheer with users' present consumption over same period
Status	Quality Check Passed

10.2.3 [UC] Analyse Aggregated Consumption (AI-198)

Scenario	Consumption Aggregation
Description	The Utility Employee wants to generate statistical data for consumption of water between consumers. Steps are: a Define a customer group. b) Access Citizen Group for Analytics, c) Compute and Access values based on groups; Pre: A sufficient number of Consumers are running the Water Application Post: A statistical data set is generated Actors: Utility Employee

[R] Define a customer group (ALMANAC-120)

Use case	Analyse Aggregated Consumption
Description	1 based on geographical area There could be other schemes as well, e.g. facebook group members) 2 based on no of family members
Rationale	Basis for computations on consumpation averages
Fit criterion	Input geographical positions, show the number of homes given the positions. Show number of homes with 2 family members
Status	Quality Check Passed

[R] Define and access Citizen Group for Analytics (ALMANAC-121)

Use case	Analyse Aggregated Consumption
Description	1 No. of inhabitants in area (anonymized statistics) 2 Historical data
Rationale	Basis for computations on consumption averages
Fit criterion	After input of geo positions, the number of inhabitants in the area is shown. Average consumption data are shown for the total group.

Status	Quality Check Passed

[R] Access values based on groups (ALMANAC-122)

Use case	Analyse Aggregated Consumption
Description	1 Fact sheets statistics 2 Anonymized Cumulated /aggregated billing statistics 3 Consumption calculators' statistics
Rationale	Basis for computations on consumption averages
Fit criterion	All of the data in 1 and 2 are available (3 is minor)
Status	Quality Check Passed

11 APPENDIX C: Citizen-centric Scenarios, use cases and requirements

11.1 [S] Recycling Support (AI-354)

Context	Citizen-centric
Description	This scenario aims to increase the quality of recycled waste while providing citizens support through the waste recycling process. It is often unclear how citizens should recycle composite and mixed materials which could lead to frustration and poor recycling habits. The recycling support tool aims to arm people with the knowledge they need to recycle, by making relevant information clear and easily accessible. Some of the features the recycling tool must be able to provide are: • Waste collection calendar indicating which type of waste is collected during each day of the week • Interactive recycling guide, with relevant information on "how to" and "what goes where" • Waste bin locator, based on the user location, type of waste and fill-levels (if available) of the bins in the area. Users should also be able to set reminders and configure the application to get notifications periodically.

11.1.1 [UC] Find Waste Bin (AI-357)

Scenario	Recycling Support
Description	A citizen needs to find the nearest waste bin around him. The recycling tool provides the bins' positions based on the citizen's location, together with additional information regarding the waste type associated to each bin. The citizen would also like to calculate the shortest path to the bin.

[R] Enable users to find a waste bin based on their location (ALMANAC-198)

Use case	Find Waste Bin
Description	
Rationale	Users should be able to locate a particular type of waste bin around them based on their location.
Fit criterion	User is able to find a specific type of waste bin in an area near him.
Status	Open

[R] Enable users to visualise the properties of a specific waste bin (ALMANAC-199)

Use case	Find Waste Bin
Description	
Rationale	Users should be able to consult the waste type, fill-level and temperature of a particular waste bin, whenever this information is available.

Fit criterion	When users click on a particular waste bin, is able to visualize the associated waste type, temperature and fill-level (if available).
Status	Open

11.1.1 [UC] View Waste Bin Map (AI-360)

Scenario	Recycling Support
Description	The user opens the waste bin map to search visually for the nearest bin by browsing through the map, even when location services (GPS) are not enabled (data connection is needed in both cases)

11.1.2 [UC] Find Recycling Information (AI-358)

Scenario	Recycling Support
Description	A citizen needs to find information on how to recycle certain packaging. The citizen is able to search for the needed information using different input methods: ▪ typing the name of a product/object ▪ scanning the product barcode ▪ browsing the recycling guide.

[R] Provide an interactive support Recycling Guide (ALMANAC-197)

Use case	Find Recycling Information
Description	
Rationale	The system must offer relevant recycling information through an interactive Recycling Support Guide, providing relevant recycling information in a clear and easily accessible way.
Fit criterion	Users should be able to browse through the guide to find recycling information associated to a particular type of waste or object.
Status	Open

[R] Enable users to obtain recycling information associated to a specific material (ALMANAC-200)

Use case	Find Recycling Information
Description	
Rationale	The user should be able to get recycling information, by typing or browsing for a specific material (e.g. glass, plastic)
Fit criterion	A user gets information on how to recycle a specific material after typing its name or browsing the recycling guide.
Status	Open

[R] Enable users to obtain recycling information associated to a Barcode (ALMANAC-201)

Use case	Find Recycling Information

Description	
Rationale	The user should be able to get recycling information, based on a picture/scan of a product/packaging barcode.
Fit criterion	User gets recycling information through the recycling guide, by scanning a package/product barcode.
Status	Open

[R] Enable users to provide feedback regarding the recycling information provided in the Recycling Guide (ALMANAC-202)

Use case	Find Recycling Information
Description	
Rationale	Users should be able to provide positive/negative feedback together with a brief justification, regarding the information provided in the recycling guide.
Fit criterion	A user should be able to provide a positive/ negative feedback regarding the recycling information associated to a particular object/packaging, together with a brief reason for it through a button in the recycling guide.
Status	Open

[R] Enable users to obtain recycling information associated to a specific object (ALMANAC-203)

Use case	Find Recycling Information
Description	
Rationale	The user should be able to get recycling information, by typing or browsing for the object name.
Fit criterion	A user gets information on how to recycle a specific object after typing its name or browsing in the recycling guide.
Status	Open

11.1.1 [UC] Edit Recycling Information (AI-362)

Scenario	Recycling Support
Description	Citizens are allowed to add new or update existing recycling information associated to a packaging/object on the recycling guide (crowd-sourcing feature).

11.1.2 [UC] Waste Collection Calendar (AI-359)

Scenario	Recycling Support
Description	A citizen would like to use the recycling support tool to visualize the collection calendar of his neighbourhood based on the day of the week.

[R] Enable users to consult the waste collection calendar (ALMANAC-184)

Use case	Waste Collection Calendar
Description	The recycling support tool must provide an updated waste collection calendar to the users (e.g. which type of waste is collected during each day of the week).
Rationale	Citizens should be able to check the collection calendar of their neighbourhood whenever they need to, in order to take out the right type of waste during weekdays.
Fit criterion	The recycling support tool must provide an updated waste collection calendar to the users (e.g. which type of waste is collected during each day of the week).
Status	Open

11.1.3 [UC] Managing reminders (AI-361)

Scenario	Recycling Support
Description	A citizen configures the recycling support tool settings to receive (or stop receiving) daily notifications/remainders related to the waste collection calendar of his neighbourhood.

[R] Enable users to set waste collection notifications (ALMANAC-185)

Use case	Managing reminders
Description	
Rationale	The system should be able to generate daily notifications based on the waste collection calendar, with information on the type of waste that will be collected during each day of the week.
Fit criterion	Users should be able to configure the application in order to receive daily notifications indicating the type of waste that should be disposed based on the collection calendar of the area.
Status	Open

11.2 [S] Issue Reporting (AI-355)

Context	Citizen-centric
Description	This scenario focuses on the citizens' need to report issues at different levels, identified and elaborated during the first co-design workshop in collaboration with the SHARING residents. An issue management system will be delivered by ALMANAC in which users will be able to report problems both at building and city level. At a building/community level, users could be able to report individual maintenance issues at their units (e.g. plumbing, electrical, etc.) and issues regarding the common areas of the residence and neighbourhood. At a city level, initially only one type of issue will be considered, but eventually the application could be extended to include several issue groups (e.g. traffic issues, strikes, public transportation, etc.) including also the waste issues handled by the Waste Application being developed in ALMANAC by the activities in task 8.3. The application should also integrate available individual consumption data, enabling residents to control their monthly expenses and thus promoting more sustainable behaviours through a more conscious use of the resources.

11.2.1 [UC] Create Issue (AI-367)

Scenario	Issue Reporting
Description	A citizen (or a particular type of citizen, i.e. a SHARING resident) needs to create a new issue using the issue reporting tool.

11.2.1 [UC] Find Issue (AI-363)

Scenario	Issue Reporting
Description	A citizen needs to use the issue management system to find an existing issue (according to his access rights), to get follow-up information whenever available, or update the associated information.

11.2.1 [UC] Update Issue (AI-364)

Scenario	Issue Reporting
Description	A citizen wants to update or add new information related to a personal or public issue that has been already created in the system.

11.2.1 [UC] Close Issue (AI-365)

Scenario	Issue Reporting
Description	The system administrator (in this case the SHARING management) needs to use the application to close an existing issue, while providing information concerning whether the issue has been solved or cannot be remedied.

11.2.1 [UC] View consumption (AI-366)

Scenario	Issue Reporting
Description	A SHARING resident wants to access his consumption data (i.e. electricity, water, gas) in order to check for possible issues or malfunctioning (that should be reported using the issue reporting tool), or simply to monitor/regulate his monthly expenses.

11.3 [S] Bike SHARING (AI-356)

Context	Citizen-centric
Description	The integration of different bike sharing services and other relevant open data from the city of Turin could improve the efficiency of these type of services through the use of a unified tool/application. An integrated bike sharing tool should allow to locate nearby bike stations, bike dock availabilities, and view bike paths in the city of Turin in real-time. In particular, it should be able to integrate information from the internal bike sharing system of the SHARING housing project from the city of Turin. Through the use of the bike sharing application, citizens will be able to: Obtain real-time information regarding bike availabilities, bike status and docking availabilities Visualize Turin's bike path and calculate the best route between two points, maximizing

	the distance on dedicated bike paths Furthermore, through the bike sharing app, SHARING residents will be able to manually report/update bike status and availabilities to improve the efficiency of the internal bike sharing service. The residents themselves will act as "human sensors".

11.3.1 [UC] View bike stations nearby (AI-368)

Scenario	Bike SHARING
Description	The citizen needs to find the bike sharing stations near by, based on his location. It should be possible to configure the settings applications to adjust the radius of the considered area. Plus, when location services are not available the user should be able to browse the map in order to find stations of interest.

11.3.2 [UC] View bike availability (AI-369)

Scenario	Bike SHARING
Description	A citizen needs to check the number of bikes available for sharing services in a particular area or station. A particular verifies when SHARING residents need to access bike availability information regarding the internal bike sharing service of the structure

11.3.3 [UC] View dock availability (AI-370)

Scenario	Bike SHARING
Description	Just as in AI-369 a citizen needs to check the number of free docking spaces available for bike sharing services in a particular area or station. A particular verifies when SHARING residents need to access docking spaces availability information regarding the internal bike sharing service of the structure.

11.3.4 [UC] View bike paths in the City of Turin (AI-371)

Scenario	Bike SHARING
Description	A citizen needs to view the bike paths in the city of Turin, and should be able to browse a city map with the bike paths represented in it.

11.3.5 [UC] Get directions (preferring bike paths) (AI-372)

Scenario	Bike SHARING
Description	A citizen needs to get directions to go from one location to another, preferring routes that include bike paths, whenever these are available in the city.

11.3.6 [UC] Bike Rental (SHARING) (AI-373)

Scenario	Bike SHARING
Description	In particular, when a SHARING resident needs to rent of one of the bikes from the internal

	sharing service he needs to report the start and end of the renting thorugh the Bike SHARING tool that will automatically update the availability of bikes and dock spaces of the internal service.

11.3.7 [UC] Report bike status (SHARING) (AI-374)

Scenario	Bike SHARING
Description	SHARING residents can report -generic- problems with the bikes of the internal bike sharing service to the management.

11.3.8 [UC] Subscribe to event notifications (SHARING) (AI-375)

Scenario	Bike SHARING
Description	Citizens can subscribe to event notifications informing them when and whether an issue related to the bike sharing service (only SHARING residents) has been solved, or when a bike or a free docking space becomes available in a particular station (all citizens).

12 APPENDIX D: ALMANAC Innovations

The technical platform has been developed along the lines of a set of Innovations. The Innovations have been defined as a response to end user application Requirements and are developed in an agile fashion using feature-driven development and the JIRA Agile product. The innovations have each been defined by an Innovations Form to be able to relate the innovative value of the components development. The Innovations have led to the definition and development of the platform components, which are targeted and described in detail in several deliverables of Y1, as well as in the Hackathon tutorial documentation.

12.1 Methodology

The Innovations have been defined by the technical team as a response to end-user application requirements (recorded in JIRA Volere) and are developed in an agile fashion using feature-driven development and the JIRA Agile product.

The Innovations are described in an *Innovation Form,* with classification according to four dimensions: "Fulfilment of the DOW", "Exploitability", "Usefulness in pilot applications", and "Demo ability". The Innovations are then prioritised for the next development period.

The parallel innovation and application requirements process has helped bridging the real world and the technology objectives of the project.

The overall structure of the innovation and requirement engineering process is shown in Figure 8:

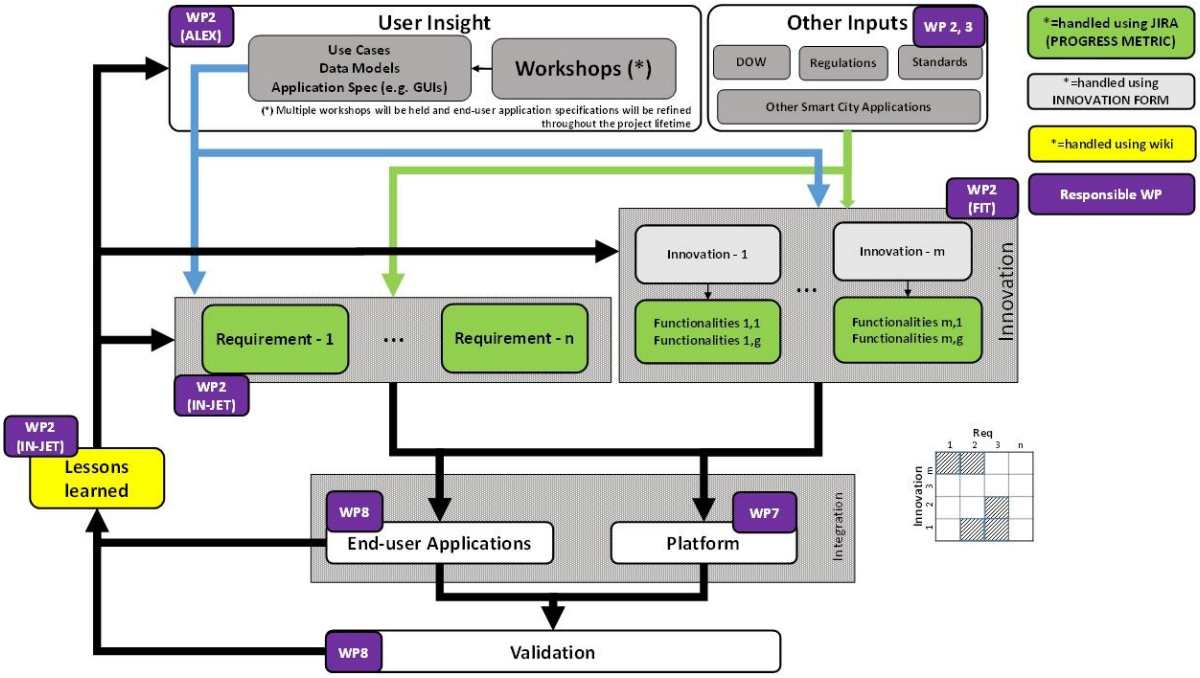

Figure 8: The ALMANAC Innovation and Requirement Engineering Process

Requirements are, as explained above, associated to specific use cases and end-users' needs. In ALMANAC they represent what is needed to manage waste, water and citizens' engagement in Turin. They must be measureable and they must be validated using quantitative and/or qualitative methods.

Innovations are not necessarily connected with the three domains above (Waste, Water, and Citizen-centric). They describe innovative aspects of the platform as a general system, designed and

developed for hosting Smart City applications at large. In this sense, Innovations are closer to the platform development as they could as well serve other Smart City applications.

Functionalities are decomposition of Innovations in simpler and implementable features of the platform. Functionalities are uniquely assigned to a specific component or "layer" of the architecture. Typically, one Innovation decomposes into multiple Functionalities. Functionalities related to the same innovation are not necessarily mapped to the same component. It is very easy to measure the progress with respect to a given Functionality: it is either implemented in the platform or not.

After the innovations have been defined, they are used when building the technical platform and the end-user applications. The end-user applications are finally evaluated to check whether a) they meet the needs of the end-users and b) that the platform allowed the application to be developed in an efficient manner.

As noted above, Innovations are managed using JIRA Agile, which allows for an alignment of the application development with the platform development. The consequence of this is that the fulfilment of application requirements and the progress in development applications are connected via Scenarios and Use Cases to Epics[6] and Stories, in line with generally accepted agile development principles and the structures supported by JIRA.

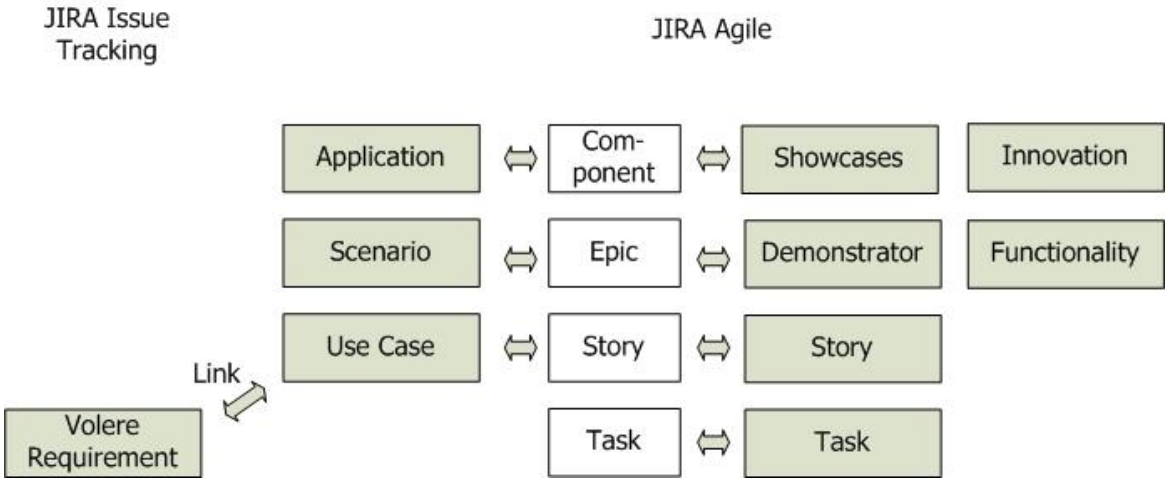

Figure 9: Illustration of the JIRA implementation used for Innovations, Showcases, Demonstrators, and Applications. White boxes are JIRA Issue types, grey is how they are used. The Epic is the controlled element, which is implemented in sprints.

In this approach, four specific links have been made between JIRA Volere and JIRA Agile (Figure 9):

- The application components (Waste, Water and Citizen-centric) are shared between JIRA Issue Tracking and JIRA Agile
- Scenarios are documented as JIRA Agile Epics
- Use Cases are documented as JIRA Agile Stories
- Single requirements are linked to one (or more) Use Cases.

The links mean that any Use Case will be implementable within a Scenario and attached to sprints, via the JIRA Agile Board. The single Use Case maintains a link to the single Volere requirement. The developer sprint can either use this link to the requirement, or add and link a development task as a *Feature* to be developed. or Stories/use Cases with requirements linked can be developed in their entirety in sprints by visiting the Scenario and Use case elements. The implemented features can be

[6] JIRA Agile Documentation: "An epic captures a large body of work. It is essentially a large user story that can be broken down into a number of smaller stories."

accounted for in the sprint development side, and the state of fulfilment of requirements can be reported in parallel using the JIRA issue tracker.

The full application specification and innovation descriptions are now fully contained within the same JIRA environment using the connection between JIRA Volere requirements and JIRA Agile processes, which enables the work to be carried out in an agile fashion, while keeping direct track of the application requirements. Also, new applications and scenarios can be inserted and linked directly to the existing, re-use and share requirements and use cases, etc.

12.2 Platform Innovations and Features Y1

The technical platform has been developed along the lines of a set of Innovations. The Innovations have been defined as a response to end user application Requirements and are developed in an agile fashion using feature-driven development and the JIRA Agile product. The innovations have each been defined by an Innovations Form to be able to relate the innovative value of the components development. The Innovations have led to the definition and development of the platform components, which are targeted and described in detail in several deliverables of Y1, as well as in the Hackathon tutorial documentation. The Innovations were evaluated qualitatively by Hackathon participants.

The specific innovations components can be grouped in the following way:

- Smart City Data Collection
    - M2M Gateway
    - Capillary Network
- Modelling of Smart City Objects
    - Resource Abstractions
    - Metadata Framework
- Federated IoT Clouds to Support Smart City Data Management
    - IoT Distributed Storage Manager
    - IoT Resource Catalogue
    - IoT Virtualisation Layer
- Developer Support
    - Smart City Semantic IoT Resources
    - Time-dimensional Properties
    - Data Fusion Language and Engine
    - REST Access and Event Generation
    - Privacy Control Framework

12.3 Smart City Data Collection

These Innovations focus on providing technologies that allows sensors and devices to connect to the Smart City networks to deliver data.

12.3.1 Capillary Network

The Capillary Network is an infrastructure composed by a set of transmitters embedded in sensor and a set of concentrator/gateways, which collect data produced by the sensors themselves. The concentrator collect data coming from a Short Range Radio Link (i.e., 169MHz or 868 MHz) using standard protocol like WM-Bus or DLMS/COSEM. The concentrator sends data through an IP connection to a M2M platform according to ETSI standard and or DLMS/COSEM standard.

The capillary network is implemented and functioning in a physical water pump demonstrator at the Telecom Italia premises. The network is integrates to the ALMANAC platform and is able to be found and publish data using the ALMANAC APIs (through the SCRAL)

12.3.2 M2M Platform

M2M platform is a partial "lightweight" implementation of a standardized ETSI M2M NSCL entity. The Network Capability Layer (NSCL) is a network server operating on specialized REST resources realizing the "store and share" paradigm where data coming from capillary network sensors is stored and shared in a controlled manner as well with notifications.

The capillary network is implemented and functioning in a physical water pump demonstrator at the Telecom Italia premises.

12.4 Modelling of Smart City Objects

A number of Innovations are related to how different entities in a Smart City environment are represented.

12.4.1 Metadata Framework

Based on Linked Data/Semantic web standards, the Metadata Framework provides a basic infrastructure to easily maintain, query and retrieve semantic models at all levels of the architecture.

This comprises among others domain entities, their properties and relations as well as system owned resources (SPARQL-queries, rules, namespace mappings). The underlying data structure is RDF (Resource Description Framework) graph. The framework is model agnostic, it does not enforce usage of a particular ontology.

External SPARQL Endpoint is used to implement the actual storage and querying using the SPARQL 1.1 Protocol.

12.4.2 Resource Abstraction

On top of the Metadata Framework a generic data model and a layer of dedicated services is provided in order to tackle recurring patterns of managing data in terms of identifiable resources. The Resource Description Framework (RDF) graph model based on simple statements (triples) misses the notion of "document", a discrete, resolvable entity defined by boundaries like single root element or a table row. This innovation introduces an abstraction of a "data resource" along with related concepts (life cycle, access, provenance, update, notifications, serialization, etc.) in order to make CRUD operations on RDF-stores much easier, resulting in a semantics-enabled resource-oriented architecture (ROA).

The Resource Abstraction Layer (SCRAL) is established and functioning, and have proven its ability to run in several instances simultaneously. The SCRAL has been running for all demo events, as well as the IoTWeek and the IoT360 exhibitions and Hackathon.

12.5 Federated IoT Clouds to Support Smart City Data Management

Smart City resources generate huge amounts of data that needs to be transferred and processed. The scalable data management framework in ALMANAC builds on an open federated architecture of cloud services to support elasticity and enable dynamic allocation including storage services when data and event load from IoT-enabled Smart City resources increases.

The cloud service federation exposes software-defined gateways to provide an API to different logical parts of the Smart City structure such as geographical districts or traffic systems enabling efficient aggregation, processing, querying and analysis of Smart City data.

12.5.1 IoT Distributed Storage Manager

In large IoT applications like the one envisaged in the ALMANAC project, data is generated and transferred in large amounts and at high frequency from sensors, gateways, back-ends and into

clouds. In a Smart City scenario we foresee that a huge amount of applications will need to access, aggregate, correlate, filter and present data. Much of the data generated are time-series related. Often Smart City data are hierarchical and requires several levels of grouping and aggregation (apartment, building, block, district,..) and is generated within a set of federated networks. A loosely coupled and federated approach to storage is required to support the wide range of Smart City applications we foresee.

The cloud Storage Manager is established and functioning at the CNET premises, and have proven its ability to run in several instances simultaneously. The cloud Storage Manager has been running for all demo events, IoTWeek, IoT360 and Hackathon.

12.5.2 IoT Resource Catalogue

The IoT Resource Catalogue provides a way to discover available IoT Resources in a local context (typically a gateway), and manages them and exposes them to the outside world for querying and actuation.

The IoT Resource catalogue is installed in several ALMANAC nodes with partners CNET and ALEX. It was launched in a first version as part of the M12 demonstrator.

12.5.3 IoT Virtualization Layer

The Virtualization Layer is established and functioning in the ALMANAC platform, and have proven its ability to run in all demo events, IoTWeek, IoT360 and Hackathon.

12.6 Developer Support

A number of Innovations are foreseen to enable developers to efficiently produce Smart City applications.

12.6.1 Smart Cities Semantic IoT Resources

Smart Cities Semantic IoT Resources (SITR) represents the real world objects in Smart Cities. It does not model the domain itself but physical objects in the domain that we are interested in collecting and analyzing data about. Examples of SITRs in a Smart City domain are WasteBins, Buildings, Streets, WasteProducers, Trucks, Apartments, etc. A Semantic IoT Resource connects automatically to a set of sensor and device services and the resource exposes data from sensor streams and events as properties. From a semantic description file the SITR automatically discovers and connects to available IoTDevices and IoTSensors and possibly to other data providers such as cloud data streams, weather forecast services. It configures the communication channel and the data resolution and frequency. The SITR exposes a cloud-based API for Smart City application developers to use. The SITR can be used by a developer without having knowledge about underlying IoT technologies like wireless sensor networks, M2M protocols, gateway, etc.

A first version of SITRs is available and will be shown as part of the month 12 demonstration.

12.6.2 Time Dimensional Properties

Many IoT applications are concerned with processing and aggregating measurements of different object property values, such as the energy consumption of a device, the temperature of a room. Not only do we need to get the current real time value but also historical aggregated data such as the energy consumption per hour/day/month/year. To make it easier for developers it will be possible to query any property of a Semantic IoT Resource for such aggregated property data without having to do these calculations automatically.

Time Dimensional Properties have been described on an Innovation form. It is a year 2 issue and is presently starting specification.

12.6.3 Data Fusion Language and Engine

We propose to specify a data fusion language in terms of an abstract model (ontology) based on and transformable into a variety of domain-specific languages (DSL) for complex event processing and event detection.

The model should cover:

- Path/navigation language (XPath, Java EL, etc.)
- Temporal relationships (coverage of Allen's temporal operators[7])
- Access to and evaluation of discrete event (streams) and (time-continuous, static) data
- Generation of new, aggregated high-level events
- Alignment with JDL/DFIG levels and concepts

The Data Fusion component is working in the first version and capable of defining sensor value queries over the network and executing these. The Data Fusion Layer was in use in the IoT360 Exhibition Showcases and Hackathon.

12.6.4 REST Access and Event Generation

REST interfacing and access is included in all the prototypes and a functioning part of the ALMANAC platform. Rest Interfaces have been used in all events generated from heterogeneous Smart Cities' devices. The event generation has been added introducing a MQTT component.

The latter has been integrated in the Hackathon and IoT360 demonstrator.

12.6.5 Privacy Control Framework

Building on the XACML and SAML standards, the Privacy Control Framework ensures authorization across the Smart City Platform. It is able to protect data collected by the platform at every location, accessed from any participating network or the cloud-based API. The framework supports federation of user privileges based on arbitrary attributes or trust metrics. This enables a more dynamic and robust authorization framework where policies can be easily maintained and privileges can be safely delegated. The innovation enables a safe real-world deployment of the system where users are in control of where their data are stored and who has access to them.

The privacy Control framework has been described on the Innovation Forms. It is an Y2 issue and the specification has started.

12.7 Innovation Assessment at M12

Every Innovation is classified on a scale 1 (low) -5 (high) for 5 different categories (D1.2.1). These categories are:

- Fulfilment of the DOW
- Demoability
- Exploitability
- Usefulness in pilot applications.

Every six months, the Innovation Manager and the technical work package leaders analyse the current state of the proposed innovations and compare their envisioned output with current user needs and other solutions available. This aims to establish the innovation value to be expected at the end of the project. At M12 result of the assessment was as follows:

[7] Allen, J.F: & Ferguson, G: "Actions and Events in Interval Temporal Logic", Technical Report 521, Univ Rochester, NY, 1994, at http://web.mit.edu/larsb/Public/16.412/pset%204/allen94actions.pdf

Innovations	DoW	Demo	Exploit	Pilot	Total
Capillary Network	5	4	4	4	17
Data Fusion Language and Engine	4	3	2	2	11
IoT-Cloud Enabled Storage Manager	5	3	4	3	15
M2M Platform	5	4	4	4	17
Metadata Framework	4	3	3	3	13
Privacy Control Framework	5	3	4	2	14
Resource Abstraction	4	3	3	2	12
Smart Cities Semantic IoT Resources	5	4	4	4	17
Time dimensional properties	4	4	4	3	15

This analysis resulted in the following recommendations for a revision of the innovations for the Y2 work of the project:

- Define a core set of city concepts/objects
- Define a clear mapping between ”city objects of interest” and the IoT resources delivering data about them
- Implement catalogues that manages the mapping
- Link SCRAL with Local Storage Manager and Catalogue
- Define a cloud-based, federated IoT data storage architecture that is based on city structure/core concepts
- Cloud Service descriptions/annotation
- Dynamic integration, changing of cloud services based on changing markets and/or business requirement
    - Cheaper storage
    - Better weather forecast elsewhere
    - New traffic prediction services

13 References

(ALMANAC Consortium, 2013) ALMANAC Consortium (2013). D2.1 Scenarios for Smart City Applications

(ALMANAC Consortium, 2014) ALMANAC Consortium (2014). ID2.2 Initial Requirements Report

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(ALMANAC Consortium, 2014) ALMANAC Consortium (2014). D8.4 Application Definition – Waste Management2.2 Initial Requirements Report

(ALMANAC Consortium, 2015) ALMANAC Consortium (2015). D8.6 Application Definition – Citizen-centric Applcation