ALMANAC

RELIABLE SMART SECURE
INTERNET OF THINGS FOR SMART CITIES

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Executive summary

The *first objective* in the ALMANAC requirement engineering process is to develop and analyse a range of Smart City application scenarios including those relevant for the ALMANAC pilots: waste management, water supply and citizens' engagement, and to derive relevant use cases and storylines. The scenarios help formulate a common understanding of the challenges and possible ways forward in a very concrete way, making the abstract and complex framework more tangible and operational for people with a non-technical background.

The *second objective* is to develop summary technical use cases from which the initial requirements can be derived and feed them into the requirements specification process.

This deliverable presents the work done in T2.1 to meet the above objectives during the two first months of the ALMANAC project. The scenarios and use cases presented take their point of departure in the visions for applications defined in the project proposal but also from the process of defining the scenarios. A substantial work effort has been put into analyzing and co-creating the best scenarios for the project and getting a deeper insight into the domains in a Turin context.

Three specific applications (waste management, water supply and citizens' engagement) have been selected for proof-of-concept implementation and evaluation in the ALMANAC platform. These applications are deemed to be sufficiently representative for a large number of applications, as will be visible from the use case descriptions. Given the challenging objectives, we have aimed for a set of 1) cross application domain use cases, that 2) consist of a large amount of heterogeneous devices; devices that 3) generate large amounts of data.

The Turin Smart City strategy was launched in 2011 and represents a new innovation policy framework for its territory and institutions. It provides new ways for collaborative actions in the field of R&D led sustainable, intelligent and inclusive growth and is focused around five priorities: smart energy, smart mobility, smart planning and environment, smart government, accessibility and social innovation. It is important that the results already obtained in Turin in the area of Smart City are closely linked to the ALMANAC project in order to obtain the highest possible degree of synergy between the two, benefiting both the project and the city.

Five waste domain scenarios support the city's goals and lead to a better and more efficient waste system: a) Issue entry management, b) just-in-time approach to waste collection planning, c) collection optimization, d) locating waste bins, and e) waste quality inspection. The stakeholders are: The governance bodies with main focus on accountable and efficient waste collection system, the professionals, and private operators provide human and technical resources for the waste collection system and operate the daily routines with a focus on efficiency of the system and citizens and citizens' associations with the common goals of a clean city.

In the water domain, two scenarios are defined: a) water system main data collection and b) irrigation views, measurements and states. The stakeholders are: The governance bodies with the main focus on an accountable and efficient water system, professional and private operators where the efficiency of the system is in focus, with topics like overview, planning, and citizens and citizens' associations with the common goals of a clean city and clean water. The water scenarios will be updated and will be included in the updated requirements report D2.4.1 (M14).

Finally, five waste domain scenarios have been defined to support the City of Turin in engaging with their citizens: a) A Collective Awareness Platform, b) cooperative policy development c) Hackathon workshops, and d) demonstrations.

In order to facilitate the transition from scenario thinking to requirements, a number of technical use cases define the technical components necessary to enable the services described in the scenarios.

Overall, the scenarios and use cases presented lay the foundation for the initial requirements work in the project and are useful to our attention on the potential services enabled by the ALMANAC platform and their relevance not only to developers, but also to citizens in a broader sense.

1. Introduction

The aim of the ALMANAC requirement engineering process is to maintain a continuous discovery and analysis of user centric requirements, needs and prospects, to be used in the design, development, implementation and validation of the Smart City platform and the pilot applications.

In the beginning of a project it is important to establish a shared and detailed understanding of the task at hand. What is this project about? Why is it relevant? What are the assumptions and methods guiding our work? The Smart City domain offers space for developments in a broad number of applications and directions; therefore it is important to align these different views to settle on the way forward. The ALMANAC project has chosen the method of scenario thinking as a guideline in this process to help obtain a shared understanding of the direction and goals of the project.

The *first objective* in the requirement engineering process is thus to develop and analyse a range of Smart City application scenarios including, but not limited to, those relevant for the ALMANAC pilots: waste management, water supply and citizens' engagement, and to derive relevant use cases and storylines.

However, it is important to remember, that such user generated scenarios are NOT the primary source of the requirements for the ALMANAC platform. The user generated Smart City application scenarios first have to be translated into technical use cases that describe the process of developing the relevant Smart City applications. Then the "real" requirements can be derived from both sets of use cases.

The *second objective* is therefore to develop summary technical use cases from which the initial requirements can be derived and feed them into the requirements specification process.

After the initial requirements have been derived, the continued requirement engineering process will progress further into the user needs by applying a limited set of ethnographically inspired tools and techniques, e.g. interviews with citizens, story-lines and document and artefact analysis to explore the challenges, problems, needs and opportunities of Smart City applications for citizens and city administrators, as well as technological and organisational challenges addressed by specific issues in the scenarios.

1.1 Purpose, context and scope of this deliverable

The purpose of this deliverable is to document the user scenario process undertaken and set out an initial set of domain specific user generated scenarios with relevant use cases as well as a set of summary technical use cases developed by software developers from the user generated scenarios.

The deliverable thus covers the work of the WP2 partners during the first three months of the project as defined in task T2.1 Scenario Thinking and Analysis

The deliverable contains in chapter 3 the scenario thinking method and the work undertaken to produce the user generated scenarios.

The Smart City landscape and background for the scenarios are outlined and discussed in chapter 4 and chapter 5 provides the set of typical user generated domain specific scenarios with corresponding use cases developed in the process.

Finally, the summary technical use cases are provided in chapter 6.

The initial set of requirements for the ALMANAC platform will be derived in task T2.3 Initial requirements specifications and will be reported in the *D2.2 Initial Requirements Report* in M3.

1.2 Background

The ALMANAC Smart City Platform (SCP) collects, aggregates, and analyses real-time or near real-time data from appliances, sensors and actuators, smart meters, etc. deployed to implement Smart City processes via an independent, pervasive data communication network. ALMANAC aims at achieving pervasiveness by defining a short range capillary radio network providing local Machine-to-Machine (M2) connectivity to smart things and enabling their active involvement in Smart City processes. The SCP allows decision support and implements intelligent control of the devices through the capillary networks with a M2M management platforms, as well as management of local installations.

The technological work in connection with the development of the ALMANAC Smart City platform will be highly influenced by requirements generated in the City of Turin. Its path to become "Smart City" started 2 years ago, when the City Council took the decision to take part in the initiative of the European Commission "*Covenant of Mayors*" and – as one of the first Italian cities – engaged itself to elaborate an *Action Plan for Energy* in order to reduce its CO_2 emissions more than 20% by 2020.

Three specific applications (waste management, water supply and citizens' engagement) have been selected for proof-of-concept implementation and evaluation in the ALMANAC platform. These applications are deemed to be sufficiently representative for a large number of applications, as will be visible from the use case descriptions. Given the challenging objectives, we have aimed for a set of 1) cross application domain use cases, that 2) consist of a large amount of heterogeneous devices; devices that 3) generate large amounts of data.

2. Methods and processes

2.1 Overview of the research methodology and requirement engineering process

The work in ALMANAC follows an evolutionary requirement and usability engineering methodology with the aim of having Smart City business models and applications consistently driving the research and development work towards solutions with real user interest and in line with the latest trends in the development of Smarter Cities.

The methodology calls for requirements and stakeholder analysis based on initial requirements from Smart City applications derived from scenario thinking. These requirements would encompass the needs and priorities of all users as well as the wider marketability and exploitation of the resulting solution. Hence, the ALMANAC evolutionary requirement engineering process complies with the following broad template for each iteration:

- Business Model development in Smart City applications
- User requirements engineering
- Architecture design specification and refinement
- Enabling 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

The selected domain descriptions, scenarios and technical use cases correspond to a large extent with the three specific Smart City applications (waste management, water management and citizens' engagement) that have been selected for proof-of-concept implementation and evaluation[1].

2.2 The Scenario Thinking process

The method of scenario thinking is very flexible and can be used in a variety of ways, depending on the time and resources available. In this context, one of the most important gains of working with this method is that it offers a useful way for people to communicate across different backgrounds, technical as well as non-technical.

The scenarios help formulate a common understanding of the challenges and possible ways forward in a very concrete way, making the abstract and complex framework more tangible and operational for people with a non-technical background. This has been crucial to the process, as it has involved both technical experts and user domain in a co-creational process to define and select relevant scenarios for the project.

The scenarios reflect what is known at this stage in the project and should be seen as the starting part of the iterative process pointing out possible ways forward and making it clear where what is required from a platform that will facilitate the development of innovative and useful services to support Smarter Cities.

The development of the ALMANAC Smart City platform shall be driven by requirements from the project partner TRN (City of Turin). The ALMANAC platform will be structured to be easily extendable to other cities and domains, but the initial validation will be performed in Turin. TRN has thus played an active role in providing domain knowledge within the different areas and in choosing and defining the scenarios that are relevant to the challenges the city faces.

To have the different perspectives represented, all relevant partners were engaged in a co-creational process to develop the scenarios. In addition to ordinary workshop tools, a set of ethnographical tools was used to generate input for the scenarios. This includes field visits, scenario observations and interviews with people from the city's environmental department, who are responsible for the running of the waste collection service.

[1] For more detailed information about requirements gathering see appendix 3 – an excerpt from deliverable ID2.2

For practical reasons, two scenario workshops were conducted allowing participants to think out of the box and imagine what the future might look like from different perspectives. Details of the workshops are presented in the sections below. The workshops were facilitated by a user involvement (UI) specialist with the primary role to bring out and structure the different perspectives, to keep focus on the potential end users and to ensure transparency in the method.

By using this multimodal approach of co-creation combined with ethnographic tools, the best possible outset has been created for the definition of high-quality, relevant scenarios.

2.3 Copenhagen scenario workshop

On the 1st of October 2013, the first full-day scenario workshop was held in Copenhagen with the participation of IN-JET, FIT, ALEX

The main goals of the workshop were to:

- Define the broad set of scenarios for the ALMANAC platform based on initial discussions undertaken with the City of Turin.
- Define and agree on a procedure for defining and validating the scenarios
- Generate validation procedures and tasks for the partners from the city.

Joao Fernandez (ALEX) was invited to give an inspirational talk on the approach to the scenario work which had been used in the SmartSantander project. Further inspiration was found from other projects such as OUTSMART, ebbits and Urb-Grade as well as from the IoT Comic Book[2], the Smart Aarhus report[3], and Arup Change Makers to get the scenario thinking going[4]. Several rounds of brainstorms were conducted and the ideas were discussed and grouped according to the different relevant domains to get a better understanding of how they related to each other.

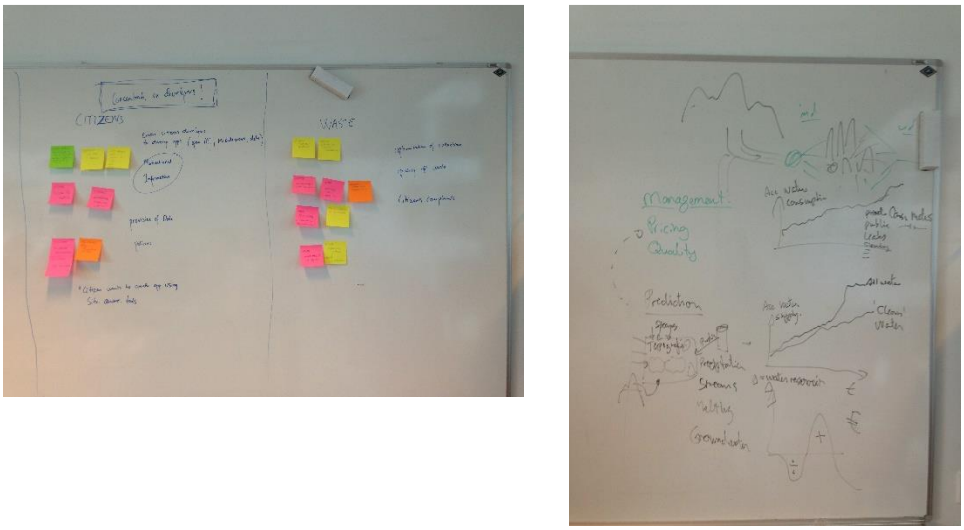


Figure 1: Grouping and elaboration of scenario ideas

The different ideas were grouped within the domains that were identified as primary focus points: waste management, water management, and citizens' engagement. Afterwards, the scenario ideas in relation to the waste and water domain were elaborated and described in more detail[5]

[2] http://www.alexandra.dk/uk/About_us/Publications/Publications/Inspiring%20the%20Internet%20of%20Things%20-%20Business%20Edition.aspx – accessed 31st of October 2013
[3] http://issuu.com/smartaarhus/docs/smart-aarhus-a-scandinavian-third-w/8?e=0/3557983 - accessed 31st of October 2013
[4] Some of the scenarios and Smart City initiatives reviewed and analysed are presented in appendix 2
[5] A full list of the scenario ideas, as well as a few elaborate examples, can be found in appendix 3

At the end of the workshop, the direction for the scenarios was agreed and questions to be discussed in the workshop with the City of Turin were generated.

2.4 Turin scenario workshop

On the 2nd of October 2013, a two-day workshop was held in Turin with the participation of TRN, ISMB and ALEX.

The main goals of the workshop were to:

- Elicit input from the City of Turin on the ideas generated for the initial scenarios
- Get a deeper understanding of the current processes, work flow and challenges within the different domains
- Perform field visits to relevant city establishments

The output of the Copenhagen workshop was presented and discussed and the challenges the City of Turin face were elaborated. Specific questions as to how applications developed with the ALMANAC platform could help the city achieve its goal of becoming a real Smart City. What are the wishes for the future and can they be related to the defined scenarios, and are they relevant and possible for them to work with?

After the workshop, the participants made field visits to the new TRM Incinerator[6], a Waste Collection Centre (WCC) and a Plastic separation plant. The purpose of the visits was to gain a deeper insight into the processes of the different types of waste management, and how they are structured and communicated in the Turin context. This is a type of knowledge that can be difficult to obtain by simply talking to people about it, because some of the processes are so familiar to them that they become a sort of embodied knowledge that is difficult for them to put into words These visits therefore offered a unique opportunity to have a look inside the engine room and experience first hand some of the processes.

Figure 2: Photos from field visit to TRM incinerator

On the second day a SMAT water purification plant was visited to learn more about the treatment of drinking water. In this case, it was not possible to consider in more detail aspects related to the distribution of water and get information about the communication with consumers, but a new visit will be organized about these issues for the second iteration.

[6] Still under construction so only partially operating – but expected to be 100% in operation by May 2014

3. Domain descriptions

3.1 Turin Smart City requirements for the ALMANAC Platform

Turin's path to becoming a "Smart City" officially started in 2007, when the City of Turin defined an Integrated Territorial Programme called "Sustainable energy as Local Competitiveness factor: a plan for Turin", the first integrated urban action plan in the field of energy, aimed at supporting both the demand (public and private) and supply of smart and clean products, services and technologies.

The path continued in 2009, when the City Council took the decision to be part of the initiative of the European Commission "Covenant of Mayors" and – as one of the first Italian cities – engaged itself to elaborate an Action Plan for Energy in order to reduce its CO_2 emissions more than 20% by 2020. The Turin Action for Energy represents a fundamental step towards defining Turin as a Smart City.

To face the challenge of the European "Smart City" initiative, Turin then started a redefinition of its administrative structure by constituting the "Turin Smart City Foundation for a Sustainable Development", whose purpose it is to manage, strengthen and develop the course of action of the strategic Smart City path.

The Turin Smart City strategy was launched in 2011 and represents a new innovation policy framework for its territory and institutions. It provides new ways for collaborative actions in the field of R&D led sustainable, intelligent and inclusive growth and is focused around five priorities: smart energy, smart mobility, smart planning and environment, smart government, accessibility and social innovation.

To more deeply define the Smart City approach, the City of Turin and the Turin Smart City Foundation chose Turin Wireless[7] as coordinator for a project that would develop a plan for Smart City Turin. This master plan was delivered in July 2013 and called "SMILE" - Smart Mobility, Inclusion, Life and Health, Energy". SMILE represents an important point of reference for the future development path of the "Turin Smart City".

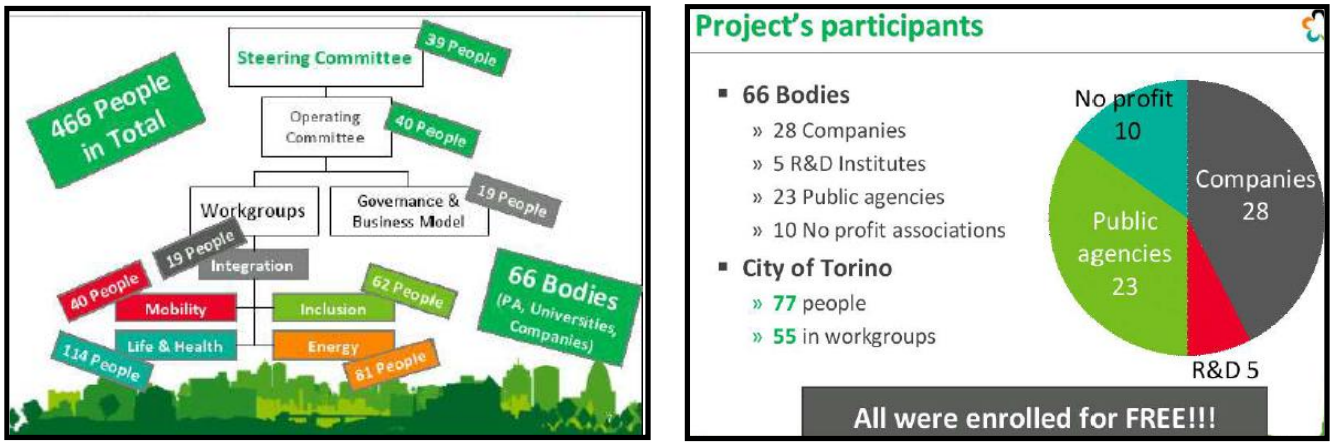


Figure 3: Turin Smart City (SMILE) main components

466 persons and 66 Bodies (Public Administrations, Universities, and Companies) have been involved in four different tables of discussions: Mobility, Inclusion, Life and Health, Energy[8]. The output was a list of 45 possible actions, identified on the basis of real feasibility (existing solutions) and "desiderata" of the City (based on existing assets, both infrastructural – e.g. the infrastructures to support mobility – and informative, e.g. Open Data). These actions have to be prioritized in the next months in order to arrive at a list of "implementable" actions.

[7] Stefano Pisu, who was also present at the ALMANAC Kick-off Meeting

[8] A list of participants and topics in tables of discussion most relevant to the focus areas of the ALMANAC project can be found in appendix 1

It is important that the results already obtained in Turin in the area of Smart City are closely linked to the ALMANAC project in order to obtain the highest possible degree of synergy between the two, benefiting both the project and the city. Therefore it is also the plan to gain a deeper understanding of the Turin context, especially in relation to the domains identified as relevant to the project and establishing a good working relationship, thereby ensuring quality and relevance in the solutions developed.

The following sections are dedicated to the refinement of information about waste, water and Citizens engagement in the Turin setting to better understand the context, the relevance to the project and the potential value for the City of Turin and its citizens within these three domains.

3.2 Waste management

Waste collection in the City of Turin is handled by the company AMIAT (Azienda Multiservizi Igiene Ambientale Torino), a partially public company that has a contract with the city to handle all waste collection.

There are currently three different methods of waste collection in Turin, named by the people running the service as: "Door-to-door", "underground ecological islands" (UEI) and "stradale" (i.e. street-based collection in English)

The door-to-door system covers about 405,000 citizens (2011), which represent about 45% of the total population of Turin. The door-to door waste bins are small bins located directly on the property, where possible, and it is thus possible to match the specific bin to the household or apartment using it. The waste collected in this fashion generally is of higher quality[9]. Part of the explanation is thought to be that it makes citizens feel a higher degree of ownerships and they therefore pay more attention to the way they sort their waste. Moreover, citizens get fined if they do not meet the requirements to sort their waste in the prescribed manner. In the last years, there has been a decrease in the amount of waste deposited in landfills and a move towards a greater degree of reuse of materials. At least part of this move is thought to be caused by the more personalized collection that characterizes the "door-to-door" system.

In addition to the door-to-door system, there is an on-going experimentation with "Underground Ecological Islands". UEIs are underground containers consisting of metal containers with a large storage capacity (5 m^3) in underground concrete pits. UEIs are bigger than traditional waste bins so they do not have to be emptied as frequently as "door-to-door" bins or the regular street bins. The UEI system can be used where the door-to-door collection service cannot be carried out due to practical problems, such as very large apartment buildings or very small backyards. To date, the experiment includes nine UEIs located in five test areas. In terms of quality, UEIs are deemed not to be as effective as the door-to-door system, for example there are frequent issues of waste being abandoned beside the UEIs. However, it is thought to be a good alternative both in terms of the citizens' felling of ownership and responsibility towards waste management and in terms of collection optimisation.

The last type of waste collection is the street collection system called "stradale", which refers to regular waste bins located on the side of the streets. This is the type of waste collection that produces the poorest quality of waste. The recyclable waste is often of such poor quality that it cannot be reused and therefore ends up as unsorted waste that is taken to an incineration plant or landfill. Another big problem is waste abandonment, where people leave waste beside the bins, because they are often overloaded due to users' irregular waste depositing needs. The problem is most significant for this type of collection.

[9] Quality of waste denotes the ability to turn the waste into recycled products. A quality protocol sets out how to fully recover waste and turn it into a quality product. It defines the point at which waste ceases to be waste and can be used as a product without the requirement for waste management controls. By following quality protocols, producers can create sustainable resources in which end users can have confidence.

Despite the positive effect of the UEI initiatives, which seem to generate a higher quality of waste and create a higher degree of ownership, there are still issues to be addressed. The main focus areas identified are:

- Optimisation of collection
- Quality of waste
- How to engage/educate people to recycle their waste

Some of the main problems in relation to these issues are:

- There is still a quite low percentage of recycling with the street collection system. The experience at regional and provincial level is that there is a maximum of 32-33% recycling.
- Low percentage of recycling is thought to equal low interest/awareness about environmental issues.
- Widespread abandonment of waste next to the bins, which doesn't look good and can lead to additional costs.
- Widespread abandonment of waste in peripheral/industrial/riverbank areas. This leads to additional costs and also a risk of pollution.
- For street collection system: cars parked in the second row in front of the waste receptacle also pose quite a challenge. If the lorry cannot get close enough to the bin to empty it, the bin has to be left for the next shift. This type of double collection equals additional time and cost, and there is also a risk that it will lead to overfilled bins.

Figure 4: Pictures from field visit to the plastic separation plant

There is a desire to reduce the cost of collection and final treatment at landfills, incinerators and recycling plants. Turin, as well as other cities, has an interest in finding ways to optimize their waste collection and solutions that can help increase the percentage of recycled waste. There is a great interest in creating awareness that can affect people's behaviour and make them act in a more sustainable way.

The scenarios in this domain should therefore represent solutions that aim at optimising the collection to save time and money, giving information and feedback to the citizens that will potentially enable them to make more sustainable decisions and also allow the citizens to provide feedback to the municipality or AMIAT in relation to different waste issues.

3.3 Water management

The City of Turin is involved in the definition and coordination of the water management policies in the Province of Turin together with other relevant institutions in this field. Water management is led at local level by the ATO (Associazione d'Ambito Torinese) authorities, who organize and control the "Integrated Water Service", including all services of collection, transportation and distribution of water for domestic use, sewerage and waste water treatment.

The Management of the integrated water resource services is made by SMAT (Società Metropolitana Acque Turin). SMAT operates in the areas of engineering, construction and management of: diversified water sources, state-of-the-art drinking water treatment systems, urban waste water purification and recycling systems, collection, sanitation and recycling networks, and energy cogeneration and recovery systems. The City of Turin, as well as all the other local authorities belonging to the ATO/3 territory, participates in the ATO/3 Conferences in order to define and coordinate the water management policies in the Province of Turin.

According to the WssTP Strategic Research Agenda10, achieving a sustainable management of the water cycle in and around urban areas will be one of the key issues for the EU in the next years. Since urban water systems are necessarily complex and concentrated, usually "complex management tools are necessary to resolve conflicts between water system requirements and more general land management". Pervasive sensing and actuation technologies could thus provide valuable information to such tools, enabling real-time collection of data and detection and forecast of current or possible issues in the water infrastructure.

Figure 5: SMAT water treatment facility

Important use cases to proposed to be investigated in the ALMANAC project are 1) deployment of sensors to identify water leaks, 2) open data access to the city's water management made publicly available, partly to inform citizens about the municipalities activities and partly to promote a sustainable behaviour enhancing awareness about water consumption, and 3) use of aggregated information to forecast water demand based on dynamic users' behaviour modelling, waste production, and weather conditions.

Another area of interest is the city irrigation system for parks and other public areas. At this point it is not completely clear what the current processes are, so it is assumed that no centralised system is in place. Therefore a system has to be built from scratch in order to enable a combination of sensor data with other types of data, like weather forecasts.

Another aspect of the water scenario will be to give citizens access to data relating to the water domain. This part relates well with our focus on citizens engagement in the project and also aligns with initiatives already developing in Turin, some of which are described in the following sections.

3.4 Citizens engagement

In recent years Turin, like many other cities around the world, has felt a stronger need for new ways to bridge the gap between the Public Administration (PA) and citizens. The PA of Turin has started a path from an institution viewed as "closed" and "difficult to reach" to an inclusive and participatory one offering transparency and openness to citizens. This process is aimed at assuring:

- More "publicity", dissemination and communication about public policies, plans, strategies, documents, laws, regulations, etc.
- More "transparency" to provide information concerning the PA organisation and activities, also in order to ensure a "democratic control" on public activities
- A higher degree of "accessibility" to information, data or documents, unless explicitly prohibited by law for security reasons.

[10] WssTP - The European Water Platform – Strategic Research Agenda 2010, page 22. Available at: http://www.wsstp.eu/content/default.asp?PageId=911

Some of the most important advantages foreseen by this process is that it will create closer links between citizens and the PA, more knowledge for citizens and stakeholders about: the public administration in general, its services, its activities and its plans. The hope is that more knowledge will lead to more participation and co-creation that will result in a richer, more complete and shared decision making process and that the closer link will also enable a higher degree of "democratic control" on public activities which can help improve the quality of these activities.

3.5 Current tools for citizens engagement

In relation to the involvement of citizens, four kinds of tools are identified in the City of Turin:

- Traditional tools: The City of Turin has a "physical" contact-point, where citizens can ask for information. The "Office for the relations with citizens" provides information to citizens, receive/accept suggestions and ensures the citizens' right to access different public documents. Furthermore, the Municipality has a set of dedicated helpdesks and green numbers (managed by single departments and focused on specific issues (environment, energy, enterprises, social issues, etc.) that the citizens can also use to find information on specific topics.
- Tools for direct involvement: E.g. campaigns or "awareness" initiatives.
- Traditional online tools: These are the websites, such as the (website of the Municipality www.comune.torino.it) and the websites of individual departments of the city.
- 2.0 Services: The Municipality of Turin, by means of its ICT Department and its utility "CSI – Consorzio Sistemi Informativi", is developing new tools to communicate with citizens: they are internally named the "2.0 Services" and include social media, Smart Platforms, Data Portals. Some of them have already been realised, others are "under construction", as detailed in the following section.

3.5.1 The new 2.0 Services – Data Portals and Smart Platforms

In recent years, also in line with the path to becoming a "Smarter City", the Municipality of Turin has started to develop a set of new tools to communicate with citizens. These services are named "2.0 Services" and include social media, Smart Platforms or Data Portals.

Social media: dedicated channels to spread information and gather reactions on public platforms such as Facebook and Twitter

Smart Platforms – the Urban Dashboard for Turin Smart City: to manage the large amount of data generated by a Smart City, the Municipality of Turin intends to develop an Urban Dashboard, the idea of which is presented below:

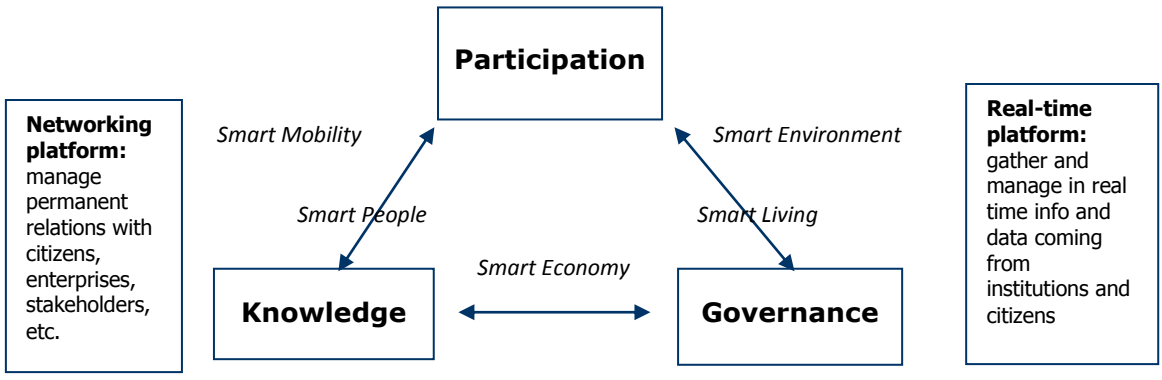


Figure 6: SMART mobility

Data Portals: so far, the City has realised 3 dedicated "portals", which are: The "Geoportal"[11], an ICT Portal that gathers municipal territorial data and provides them to citizens. For example, urban and cadastral data, geographical data concerning services of interest to citizens, schools, hospitals,

[11] http://www.comune.torino.it/geoportale

museums, etc. The "Opendata Portal"[12], that ensures free access to a lot of information and public data, including administrative data, environmental data, demographic data. "MappaTO"[13], a 2.0 service, which allows users to create and share thematic maps displaying art, culture, tourism, and transport.

3.5.2 2.0 Services for the future - a link with the Smart City strategy

The "Turin Smart City Platform" is intended as the framework for the new urban innovation strategy on the path to achieve a sustainable, intelligent and inclusive growth and it aims at identifying:

- A collection of problems and new ideas to solve them.
- The strategic investment priorities.
- Social and economic inclusion paths/Turin Social Innovation Program

The fields of interests in the Smart City strategy have been identified on the basis of the EU guidelines but also of some previous experiences and special needs of the city (for example, pollution due to the road traffic, level of unemployment, etc.) and they are: Smart environment, smart mobility, smart energy and grids, digital city, social innovation.

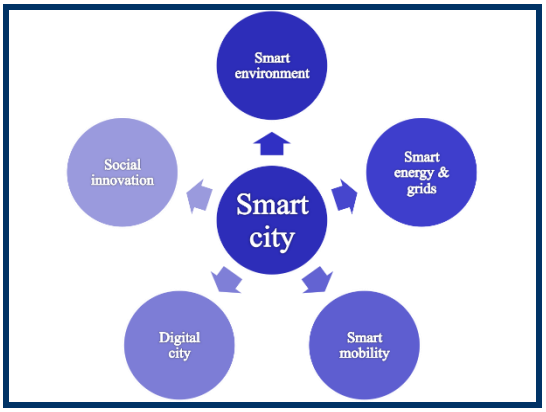


Figure 7: Turin Smart City / Main Components

In general terms, the main idea behind Turin Smart City is to improve the overall urban infrastructure and services to achieve better environmental conditions, to maximize connectivity and to enhance opportunities for all. This puts the city users, including citizens, institutions, enterprises and organizations of all kind, at the centre of where policies are developed. The attention to the city users is related to the vision for the City of Turin to proactively engage all the relevant stake-holders in co-creating innovation, directly involving them into the value-generation processes, also in order to take into account the territorial and social needs in the definition of the urban policies design.

Some of the actions proposed in the SMILE plan are related to citizens' involvement and contain ideas for new tools in the future to assure their participation in the public processes[14].

SMILE table "Integration"

Two potential actions are of particular interest in this context:

The first action is related to the "*informative system*" of the City, its management and its availability for all. It has to be studied which data could be made "public", what their potential is and possible privacy issues. Among other actions, it is foreseen to realize:

- A Data Governance Tool of Turin Smart City (TSC), able to classify, order, make "rational", integrate and make available to the end-users the informative asset of TSM and to make

[12] http://aperto.comune.torino.it

[13] http://www.comune.torino.it/servizionline/mappaTo/mappaTo.php?context=mappaTo&submitAction=browse&areaTematica=redazioneWeb

[14] The actions contained in SMILE still have to be prioritised, in order to identify which of them will be really "implementable". So, it is not sure that all the actions listed below will be realised. They are however still relevant to give an idea of the City "desiderata".

possible the integration with the information coming directly by citizens or stakeholders, starting from the existing databases (Geoportale, Opendata Portal, MappaTO)

- A Data Protection and Privacy Tool
- An Indicators System Database

The second action is strictly related to the "*communication and participation*" issue: it is foreseen to develop new communication and participation tools, in order to let citizens "access" and "produce" information. The idea is to develop and test a new Communication Platform between citizens and PA to facilitate the exchange of contents about issues/topics of interest for citizens and strategically important for the urban development.

SMILE table "Mobility"

The City of Turin wishes to realize: an ICT infrastructure/database for the optimal use of data concerning mobility; a dedicated ICT infrastructure to better manage and organise the freight transport and distribution in the urban territory; better and more spread services to support intermodality (by means of infomobility system) for a better use of the public transport system.

SMILE table "Inclusion"

- The Digitalisation and Dematerialisation Collaborative Platforms: leads to the development of technological tools to digitize administrative processes and services and to create collaborative platforms to ensure interactions in the Administration, between administrations and between administrations and citizens
- Study of the demand of service: try to identify a new methodology to outline/define the demand of services in order to reduce the distance between services end-users and institutions and to support the PA in the development of services, building on needs of citizens (Departments involved: Social Policies, Education, Transport, Culture, ICT).
- Open data: promote the open data in order to support a better governance (support the decision-making process for integrated plans thanks to sharing information and data) and to spread information and new services (tools to gather inputs from citizens and to let them have access to information in order to better understand the PA)
- Social Participation: promote the social participation in the public policies by means of technological tools (internet, mobile) in order to better interact with citizens, and in particular:
    - Development of strategies to involve citizens in the quality evaluation of the services supplied by the PA
    - Web platforms to gather citizens' feedbacks and contributions about public policies
    - Studies and experimentations of new methods and communicative channels to involve citizens (f. ex., social media)

SMILE table "Life and Health"

Actions aimed at fostering the reduction of waste production (especially construction waste) and to enable waste control/traceability in the disposal phase. How to communicate with citizens on the "waste issue"; how to involve them; and how to make them more responsible etc.

SMILE table "Energy": in this field, among several technical actions, there is also an action line related to the "*Citizens awareness and involvement*" about environmental issues not only by means of targeted communication campaigns (traditional tools) but also by means of ICT tools in order to make them responsible about consumptions in real time and to optimise the management of technical information.

All of these envisioned actions to engage citizens can inspire our approach in the ALMANAC project. The strong focus on user involvement and applying new technologies in the effort to engage citizens in city processes correspond well with the ALMANAC vision and we will continuously work to elaborate these links.

4. Scenario Descriptions

The overarching goal of the ALMANAC project is to provide an architecture and a platform for generating and supporting applications for Smart City citizens and professionals. This goal is in nature an ambitious endeavour, but at the same time, not a very tangible one. The architecture as a notion covers all possible IT elements needed for a Smart City, but at the same time the elements all relate to the project partners and the project description's selling point of new functionality. In order to direct the project activity and be able to demonstrate functionality and performance, it is necessary to point out some tangible, concrete and specific scenarios that can direct the priorities in the development work and help to assess product performance and project evaluations. The scenarios shall be in user context and should be able to fulfil user / customer needs, and will as such in general be broader than the focus of the project components.

In ALMANAC, we envision the activity to take place in the thematic areas of waste, water, and citizen engagement. The present chapter serves as a combination of idea catalogue of scenarios to be demonstrated and as a link between the domain descriptions and the specific technical requirements and the architecture to be specified. It is the intention that it can be used during the ALMANAC project for prioritising the requirements, such as to have a means of setting the direction and enabling iteration for the development. The textual format of scenarios and use cases is not completely consistent, due to differing degree of uncertainty of the vision at the present point of time.

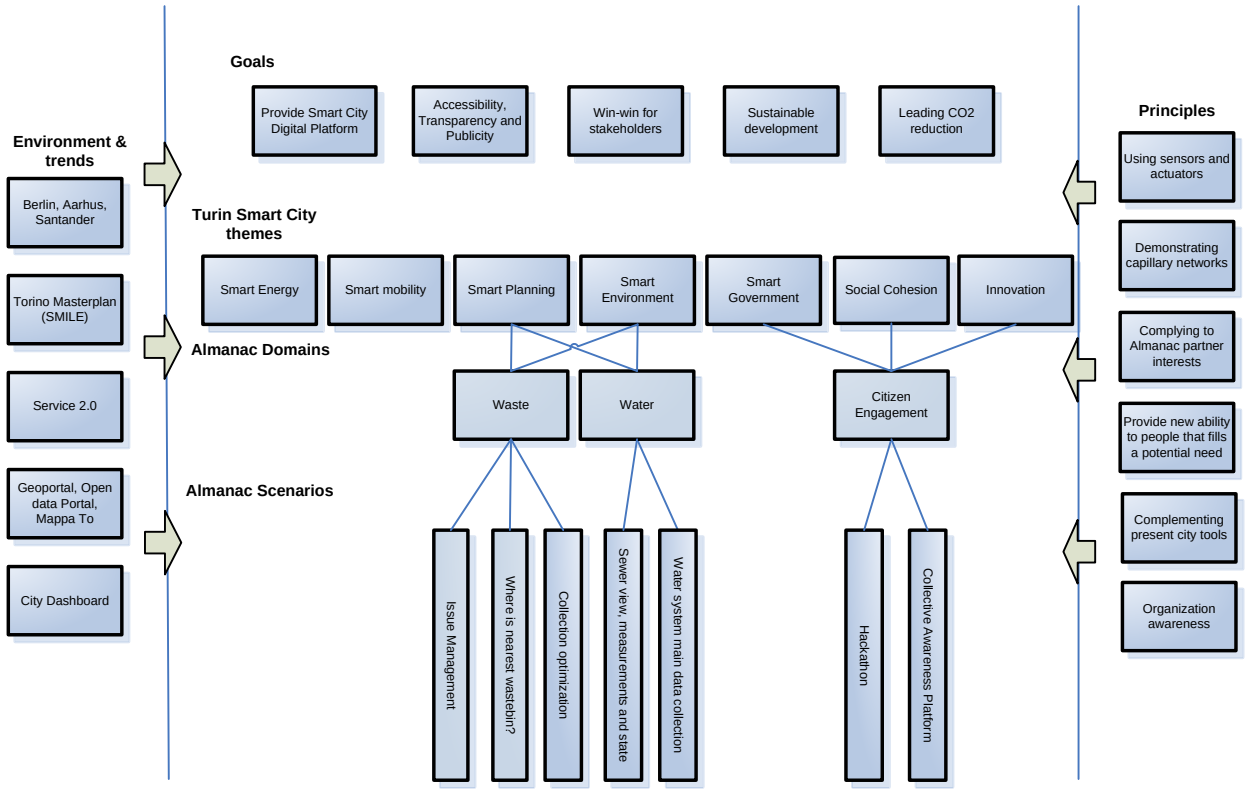


Figure 8: The ALMANAC Scenarios in a strategic context

In Figure 8, the proposed scenarios and domains are depicted in a strategic context, to visualise the connection of the project work between Turin Smart City Goals, their theme set, the trends and initiatives ongoing alongside the project, and the principles needed to be followed by a "good" scenario. The figure shows the context that defines the focus of any scenario and the topics ("principles") that need to be addressed for the scenarios developed. The ongoing embedding of the scenario in the "world of change" in Turin (and its Smart City among other EU Smart City programs) also indicates the need for the scenarios being further developed and re-addressed during the

project lifetime span, as many of the strategic factors may change underway, making a specific scenario out of focus.

The strategic figure is thus to be read in the position of a decision maker on the scenarios. If we go a little in detail in the figure, we can see the following:

In the top, the overall goals of the ALMANAC Smart City project and the Turin Smart City project are listed, in order to be able to shape content, plans and communication with the stakeholder's preferences.

The total thematic definition of the Turin Smart City project is defined within the theme boxes. It is seen that these encompass the ALMANAC domains and scenarios.

The Turin Smart City Program is more than the ALMANAC project alone. Other initiatives are listed in the left side of the figure.

Figure 8, among other things, the service 2.0 web digital citizen service toolsets, the Open Data platform initiative, and the City Dashboard. All of these will have potential cooperative business and interfacing to do with the ALMANAC platform, which can be both advantageous as well as problematic to take up, generating potential project constraints and risk. In this strategic view it serves as a way to scope the work as we go along, or generate questions to other initiatives on whether they actually provide something the ALMANAC project would otherwise have to do.

On the right side of the strategic diagram, the principles are listed. These are factors that any domain scenario should consider in order to be successful within the ALMANAC project. All contributors and partners have their own reasons and business cases for taking part in the project, and these business elements should be listed here and considered along the way, in order to keep a successful programme.

4.1 Stakeholders

To all the domains and scenarios, the main stakeholders and their characteristics are

- The governance bodies: The interests of this group of stakeholders are supporting the goals listed in the strategic diagram. The main focus is, besides being the political owners of the strategy of a sustainable urban development, an accountable and efficient system of services in the different domains. The governance bodies also represent the citizens of Turin and so emphasize end-user accessibility and transparency. This can be monitored by maintaining complaint systems and continuously holding an overview of the issues reported from the citizens.
- Professional organisations, private operators end contributing partners: These stakeholders provide human and technical resources for the system of services and implement developments and operate the daily routines. The efficiency of the systems is the main focus, as much as possible automating reporting of performance and quality, such that the agreements and contracts are easily reported and agreed upon.
- Citizens, citizens' associations, and environmental associations (NGO - Non-Governmental Organisations): All share the goals of a clean city and a sustainable development, and are generally helped by an easily accessible reporting of issues, as well as the swift reaction from both service system and regulators.

4.2 Waste management

The waste domain scenario supports the goals listed in the strategic diagram, and at the same time leads to a better and more efficient waste system.

The stakeholders will, apart from the general issues above be particularly interested in:

- The governance bodies: The main focus is an accountable and efficient waste collection system. The indicators of efficiency are on the one side the cost of maintaining the system, and on the other the level of recycling, which again corresponds closely to the collection procedures and to the efficiency of using them. User accessibility and transparency is monitored by maintaining an overview of the issues reported from the citizens.
- AMIAT, professionals, and private operators are contributing partners: These stakeholders provide human and technical resources for the waste collection system and operate the daily routines. The efficiency of the system is in the main focus, with special emphasis on minimizing the number of extra collections, efficient usage of professional resources, personnel as well as supporting systems (lorries, bins, etc.) and as much as possible automating reporting of performance and quality, such that the agreements and contracts are easily reported and agreed upon.
- Citizens, citizens' associations, and environmental associations: Common goals are a clean city. This group is generally helped by an easily accessible reporting of issues, as well as the swift reaction from the collection system. The citizens will also be happy about easily understandable and operating sorting systems, which are considered out of scope for the ALMANAC development.

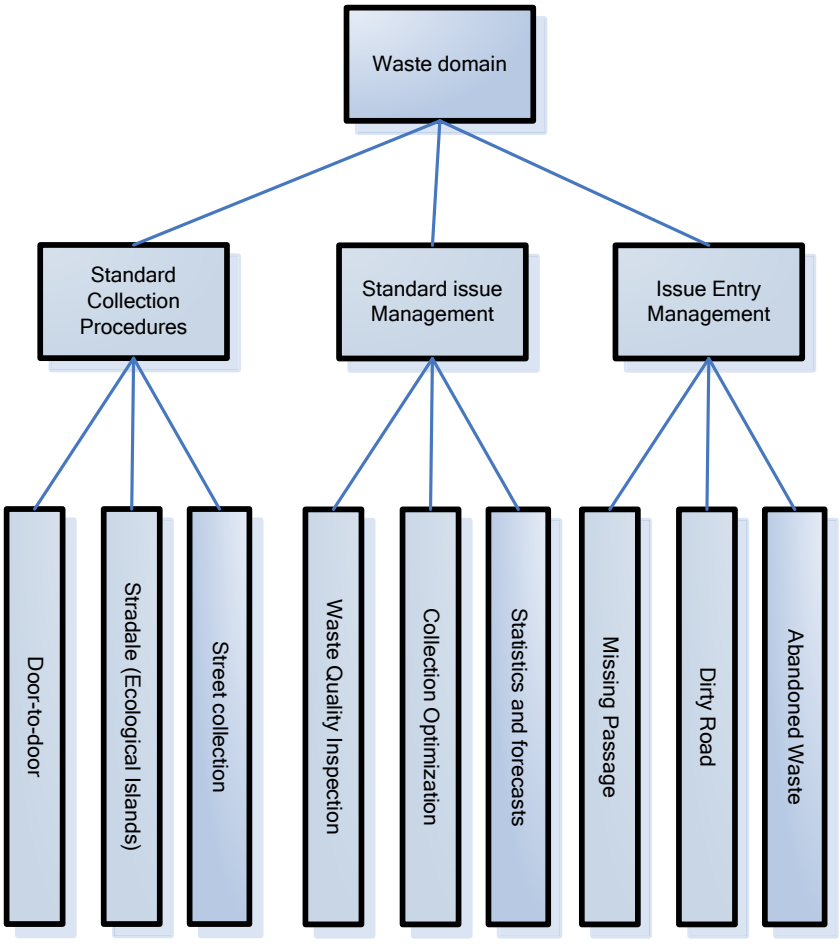


Figure 9: Envisioning an issue management metaphor for waste collection

4.2.1 Issue entry management

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 lying in a road junction. They think it might have fallen off the back of a lorry. The pile is disturbing the traffic. They take out their mobile phone and take a photograph of the pile. Now they bring up the ALMANAC-compatible mobile device app. The app automatically creates a new waste issue in the ALMANAC application set, and uploads the newly taken photograph

to the ALMANAC platform issue tracker. Now it is possible to tick off the SMS mark, enabling information of what happens to the pile, and when the issue has been handled. The issue is transmitted to the ALMANAC platform as is entered into the platform's collection optimization planner and transmitted to the nearest waste handling lorry. At this point, the user gets an SMS saying that the issue is being handled, perhaps including estimated time of completion. The professionals in the lorry follow the continuously updated issue plan in their waste collecting routine. Their handhelds 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 an SMS.

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 realizes 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 extra lorry is sent specifically to handle the issue.

4.2.2 Just-in-time approach to waste collection planning

The waste bins in a Turin habitation 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%. In a condo area, waste bins are shared by a group of families. In this case, the issues can be still be generated by individuals but also with a group profile. Using their mobile phone, they can themselves generate an issue if they have just generated an extraordinary waste issue at a communal garden workday, by an inhabitant moving in or out, or cleaning out storage area. In the ALMANAC system the end user can observe whether their waste bins have a collection scheduled, and they can generate issues to get an extraordinary collection.

4.2.3 Collection optimization

With waste bin sensors and issue track lists, it is possible to connect to a plan and route optimizer that generates and updates optimal collection routes for a fleet of waste collection lorries. In this way, all issues are guaranteed handling. The collection optimization scenario makes this possible by equipping and connecting the waste collection lorries, the sensor-equipped waste bins and standard collection routes, the citizens and the professionals with equipment, in order to control and maintain optimal just-in-time optimal routes.

The lorry personnel accesses the waste collection team route app, which is updated in near real time with re-planning based on the present execution schedule. The system updates the near future plan on a device screen in the lorry or on the professional's mobile unit. A re-planning and re-routing is performed for every collection issue handled, and for any issue creation that leads to a necessary update.

4.2.4 Locating waste bins

A citizen (or tourist) in the city accesses the ALMANAC platform through a client app on his mobile device, where there is a city map with the location of waste bins in the area. The app returns the placement of accessible public waste bins, by finding all bins equipped with sensors, accessing their position and showing this on an electronic map of the vicinity of the user. The app then determines the nearest bin using the GPS position coordinates of the device. The app shows direction and walking distance on the screen. This is a very simple example of sensor fusion provided by the ALMANAC platform.

4.2.5 Waste quality inspection

A collection 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 input a waste quality indicator on handheld equipment, which automatically takes up information of the individual bin and the owner, and can automatically return information to the citizen on the waste quality. Hereby the citizen is helped to engage in better sorting, and can see the result of own work in form of a "smiley"-type indicator. A fine penalty system might be attached to the person-to-person communication, the usage of which might at the same time be minimized with this information, with better waste quality to follow. Hereby, a higher recycling rate and happier stakeholders are obtained.

The use cases proposed to be implemented in the ALMANAC project are 1) Just-in-time approach to emptying waste bins by measuring the fill level in the waste bin, 2) Involvement of citizens by allowing them provide photo-documentation of areas that needs cleaning, 3) collected information to be used to make forecasts and other types of intelligences for the municipality, and 4) the information from the different sources mentioned above will be aggregated with other sensor measurements from the city such as temperature, noise levels, pollution, etc. All this will be made available in a "health of the city" type of overview for the citizens.

4.3 Water management

The water domain scenario development shall support the goals listed in the strategic diagram, and at the same time lead to a better and more efficient water system.

The stakeholders will, apart from the general issues above in this domain be particularly interested in:

- The governance bodies: The main focus is on an accountable and efficient water system.
- SMAT, professionals, and private operators are contributing partners: As above, the efficiency of the system is the main focus, with topics like overview, planning. The operators will like a system which is as open as possible, without giving away controllability or adding risk of threats to efficient operation.
- Citizens, citizens' associations, and environmental associations: Common goals are a clean city and clean water. This group is generally helped by an easily accessible reporting of issues, as well as the swift reaction from the professional and governance stakeholders. As most citizens know very little about water systems, the first step is providing the citizens with knowledge of purpose, function and parts. Encouragement for citizens to act more sensibly and environmentally friendly follows with empowerment in their daily life - e.g. with knowledge followed by an ability to see and feel the effect of ones' changed habits and actions.

These scenarios will be specified in detail for the second iteration together with the Turin municipality and SMAT, to agree on what is possible and desirable to demonstrate and share with the citizens.

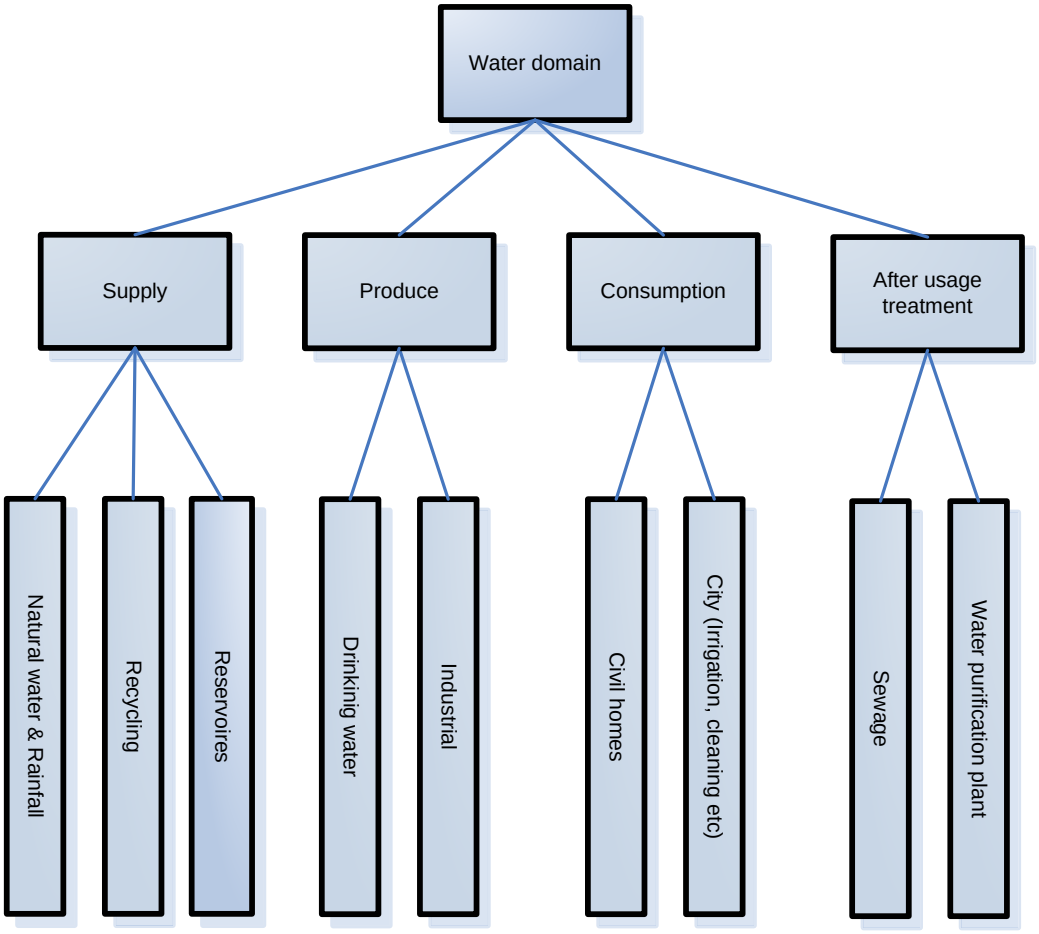


Figure 10: Preliminary identified composition of the water system

4.3.1 Water system main data collection

Citizens and their associations can access a water system explanation system, which outlines the main technical, informational and physical systems of the water system. These are functional and geographical maps showing the water flows in the supply lines, the consumption lines (potable and non-potable systems) and the waste water lines (rinsing, re-using and removing).

The functioning is supported by a number of key sensors measuring the main state of the system, e.g. m^3 incoming water, m^3 rinsed and the effort to do this, the rinse degree, and m^3 passing through key point in the sewer system. The collection can be complemented by measuring the consumption of water in a representative or exemplifying set of consumption sites, for example a municipal building of sufficient size, a living environment, a production site, and / or a water purification plant.

4.3.2 Irrigation views, measurements and states

Sensors are placed in a number of irrigation zones of Turin parks. These might be for example humidity in soil, Flow meters for water speed and/or usage in cubic metres, and water pressure for fountains. Citizens and/or professionals utilize the ALMANAC platform to access the sensor data through the capillary networks.

Data is loaded through the ALMANAC Platform. Some sensors would be sending data in real time, but a much larger number of sensors will be simulated in order to gain a better user experience in the ALMANAC scenario prototype.

The use cases identified in the water domain from the domain chapter are 1) open data access to the city's water management made publicly available, partly to inform citizens about the

municipalities activities and partly to promote sustainable behaviour enhancing awareness about water consumption, 2) deployment of sensors to identify water leaks, and 3) use of aggregated information to forecast water demand based on dynamic users' behaviour modelling, waste production, and weather conditions.

4.4 Citizen engagement

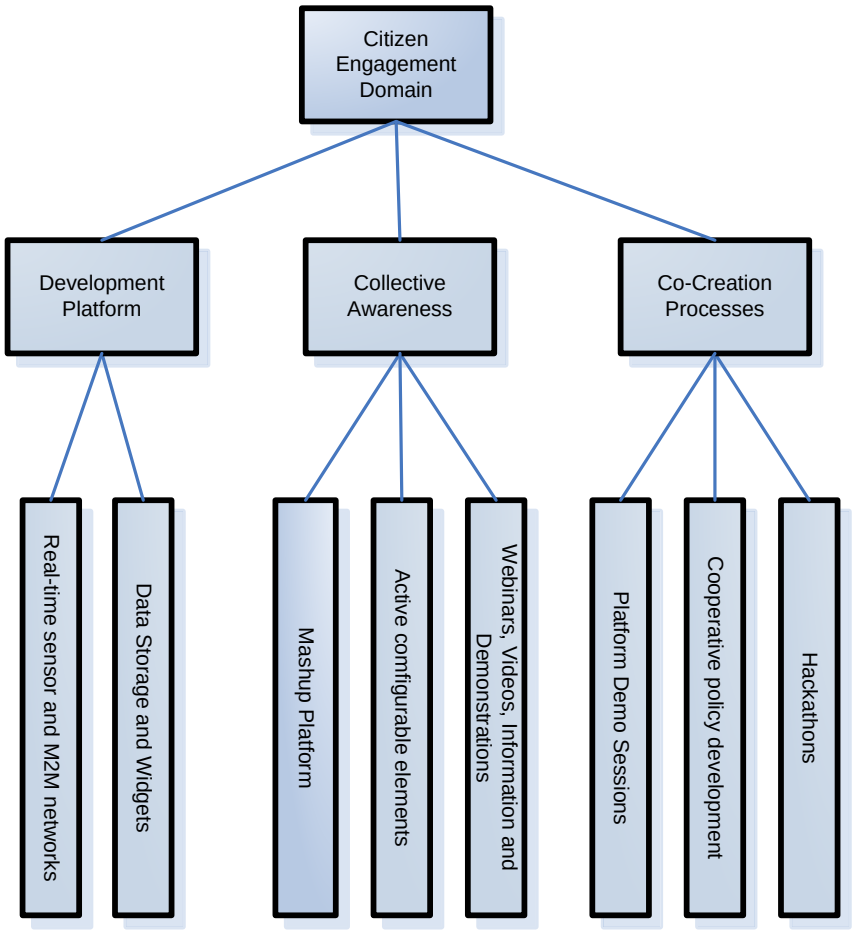


Figure 11: An attempt to structure the Citizen Engagement domain

In support of the "Smart City" goal, the City of Turin works with citizens, political and environmental organisations as well as the professional enterprises. It supports open political discussions and encourages conceptual innovation based on co-creativity processes. With this goal, the "Citizen Engagement" domain becomes a *common purpose for all the stakeholders*, rather than having specific goals for the different roles. In the end, all individuals are citizens of Turin, regardless of profession, political activity or competences and interests. So in the citizen engagement domain, all stakeholders lower their barriers and lend and add knowledge and competencies from others, in order to reach new results in common.

The development plans focus on issues such as: infrastructure renewal, mass transportation and environmental impact. Engaging in local, direct democracy to push for social innovation, Smart city development is an essential topic of Turin's citizens, because of its huge impact on urban life. In all districts of the city, there are many different projects regarding Smart City development. The question of how to shape the future of waste and water management in a large city is highly relevant for its development. Regarding all these topics, citizens participate in the decision process and contribute to social innovation via an ALMANAC Collective Awareness Platform.

Typical sensors like motion sensors, position sensors, cameras and microphones are already built into smart phones owned by many citizens and professionals. Human interaction Apps could be used for voting, sharing, crowd sourcing and crowd funding. Other IT elements, whether on mobile or computer-based platforms, can be used to access and visualise sensor data. Examples of simple external sensors could be the above mentioned waste bin measurements in high-profile areas, e.g. tourist or public transportation places, temperature measurements, waste bin counters, etc. Access to sensors could be provided free of charge from the municipality and apps will be able to automatically connect to the sensor using a LinkSmart middleware for IoT interoperability.

Moreover, citizens groups will be able to make live broadcast (webcast) of their meetings and events. Using a consumer video camera and a laptop encoder card, the video can be streamed live via a Visual Element on the ALMANAC platform to viewers. This can be a strong tool for citizen engagement and inclusion and participation.

4.4.1 A Collective Awareness Platform

The ALMANAC platform can be instantiated and individually customised for a large number of citizens or citizen groups. Each end-user can have a personalised appearance. The customisation allows the city to select which widgets (and hence functionality) they want the citizens to use in their collaborative work.

The platform will have widgets that can display and analyse real-time contextual information from Apps and sensors in the physical world, and thus allow users to provide contextual situational information and factual evidence for their work and discussions. Users can collect and send situational awareness data to the ALMANAC platform using smart phone Apps with internal or simple external sensors connecting via Bluetooth or WiFi. Measured data can be presented in dedicated widgets or collectively, e.g. in combination with geo-coding.

The ALMANAC scenario for a Collective Awareness Platform is based on a scalable community mashup platform connected to the "Turin Smart City Platform". The mashup platform is an IT environment providing tools to the single user. It makes it possible to choose and integrate visual IT elements, in form of apps and widgets, for contextualisation and integration of domain knowledge, real time or static information into social networks. The ALMANAC platform will also contain a number of standard widgets that citizens can choose from for enriching functionality based on their needs: Geo information, on-line webcasting or TV, weather forecast, RSS and news feeds, agendas, blogs, etc.

4.4.2 Cooperative policy development

The City of Turin has to create and manage policies/services covering a specific topic of interest. This "decision process" has to cover 3 phases: the preliminary definition phase; the implementation/experimentation phase and the evaluation phase. To better manage this policy/service, the City uses the ALMANAC platform, co-creation meetings and Hackathons to support and implement, where citizens could find data about the policy/service. In some cases, they could provide and upload data in real-time. The platform would be used by all stakeholders also to provide their feedbacks about the policy/service, to provide info about their satisfaction concerning the policy/service, and to provide contributions to improve the policy/service.

4.4.3 Hackathon workshops

A group of curious Turin citizens with social interests and IT literacy (either as interested IT users or IT developers) attend a Hackathon workshop. During the Hackathon, the present tools of the municipality are presented, and the Smart City initiatives service2.0, Urban Dashboard and recent open data sets (depending on the state of initiatives and project, maybe models provided by ALMANAC) are shown, supported by the Collective Awareness Tools and Platform. The process of the Hackathon is supported by easy access to stationary data about the city, development tools, APIs, and real time and query data from the networks and sensors.

The Hackathon will most likely work best accompanied by other meetings of knowledge dissemination and sharing, policy co-creation and technology demonstration, in order to generate

interest with not only IT literate people, but maybe also engaged citizens, potential users, school classes, and other users and generators of ideas. Hackathons are for developers, but other citizens might find it interesting to participate, especially if other meetings with knowledge sharing can empower them with a role in the development sessions.

4.4.4 Demonstrations

At one or more organised citizen meetings, it might be possible to engage with simulations or live examples, in form of system test demonstrations, webinars or the like. In live demonstrations, an "intelligent" waste bin equipped with sensors can be filled with waste, while a waste issue is automatically generated and observed and the update of route plan with a collection lorry can be followed and understood, using simulated data.

At a combined demonstration and Hackathon meeting in the town hall, Municipality technicians, SMAT technicians, NGOs and citizens as well as application developers are invited to learn and discuss about the water systems. The ALMANAC platform shows a functional model of the water systems, and the main sensors are shown in real time with the OpenData APIs. The meeting continues with discussions on preferences and app ideas for open use. Which initiatives and legislations could be interesting to add for generating constructive activity?

5. Technical use cases

In order to facilitate the transition from scenario thinking to requirements, the following section defines some of the technical components necessary to enable the services described in the scenarios.

5.1 Waste management

Creating such applications depends on various data types that have to be acquired and correlated. Obviously, first of all, a great number of sensors, both active and passive, are deployed to capture fill levels, waste lorry positions, etc. Active sensors can periodically report through a local cellular network gateway or exploit delay tolerance features and wait for gateways installed onto waste collection Lorries to opportunistically connect to them and push all queued data.

Developers are able to access these sensors independently from the specific communication technology used and data is uniformly processable even though specific representations that are used by different sensors. This is enabled through a uniform Virtualization Layer which adds meta-data and semantic information to all measurements making data interpretable on its own. The Virtualization Layer consists of device specific proxies which translate web service based requests – either remote procedure call or resource based – into specific device queries.

In addition to sensor information, external third-party services are involved into the reasoning. Such services are for example the Enterprise Resource Planning systems and Fleet Management Software that were already in use in the city and contained many relevant pieces of information, or even other cloud-based services.

To be able to uniformly handle issues and be able to assign resources or states to them the Virtualization Layer also holds digital representations of entities, issues or resources that can be accessed programmatically. This way SMS notifications or resource associations can be handled uniformly and eased the development of such applications.

Naturally collection of this amount of data raises many privacy issues that have to be dealt with. The privacy features of the platform automatically enforce anonymization or authenticated access to sensitive customer data to align to related regulations.

5.2 Water management

Building up a data collection platform and making it openly available is a difficult task. To collect all the envisioned details of the water supply network a huge number of sensors have to be installed, where sensors for different aim support different network technologies or protocols. Additionally, the task of connecting installed sensors to the system backbone is to be solved.

To integrate a new location into the ALMANAC platform, readily available gateways are used to connect cellular networks and sensor networks. Gateways contain components for middleware services and, in order to deal with various sensor technologies, also an Abstraction Layer which provides readily usable plug-ins. This way, devices can directly be discovered after installation and talked to.

Additionally, discovered services can immediately be shared over the Internet where services are automatically consumable from anywhere. Obviously, we do not necessarily want to share all measurements or not to anyone. In order to protect our data we can define trust relationships and based on these provide fine granulated access policies about what level of trust is required for which type of access.

The tools and GUIs for creating these policies also acknowledges the fact that not everyone is a security expert and probably needs support in defining coherent and secure rules. All this acquired data has to be processed in a scalable and persistent way. For this means the platform provides a

multi-layered data management system which is able to correlate and fuse information based on easily adaptable fusion rules.

The fusion rules automatically link processing layers to each other and deal with proper load balancing between links. This fused data can then be used in near real-time to detect important events and timely respond to maintenance issues. But stored data is also used by data mining capabilities provided by the platform for reasoning and optimization or forecasting.

5.3 Citizen engagement

The ALMANAC platform creates a number of components and services which are be accessible through an open cloud-based API especially evaluated against usability and productivity criteria. These services range from access to raw data collected by sensors and annotated with meta-data to already processed and interpreted information.

The platform enables developers to build their applications directly on data made available by the Smart City and also gain support in finding data sources based on location, data type or other freely definable attributes.

The platform provides tools for semantic reasoning about acquired measurements, manual filtering and fusion of the vast amount of data available.

Additionally, developers may choose to have the platform create situational awareness based on user configurations and only receive notifications about state changes deduced by the platform from automatically selected information sources. The data fusion language provided for this by the platform together with the Virtualization Layer eases the composition of rules describing the interplay of different sensors and enables capturing relevant events of the observed environment.

Additionally to being a platform for developers the cloud-based APIs act as input for a community portal where some of the collected information is visible. The portal enables citizens to browse over information sources or automatically create queries over the data collected by the platform or over information which has already been composed through data fusion.

It is also possible to personalize and compose data configurations for specific interest groups through the use of standardized widgets. These widgets benefit from the resource-oriented view provided by the ALMANAC platform as they can be linked to any type of data source through the standardized layers. If the user wishes to use virtual representations of entities or data fusion configurations stored in the platform, there are additional widgets that can visualize these data configurations and further enrich portal based views.

6. Conclusion

The generation of requirements for the ALMANAC platform posed a delicate balance between, on the one hand, the requirements end-users placed on the Smart City applications that they wanted to see in the pilot applications, and on the other hand, the requirements for a developments system and platform to be used by software developers to develop those applications.

Using simple scenarios in combined workshops was found to be an effective approach to keeping a developer use focus throughout the application specification process, and at the same time to allow early end user involvement.

In the same process, the technical use cases were created, and used to collect direct user feedback. The user workshop conducted was thus well structured and focused on context of use and developer user requirements.

The domain descriptions, scenarios and technical use cases presented in this deliverable reflect ideas for knowledge at this point in time and will act as the foundation for the future work on requirements in the ALMANAC project. This is not to say that the work is finished. Different elements might (and probably will) change as the project moves forward.

The process that lies ahead has to transform the insights gained in this task into real functional and non-functional requirements that can be fed into the development work for the platform and for the envisioned applications.

The first iteration of the development process will be finished with the testing and evaluating the first prototypes. The pilot environment will be created according to the scenarios that built the foundation for the first iteration. The evaluation of the prototype yields further requirements. From our experience in similar projects, we expect that the future refined set of user requirements will be more complete, more concrete, and more reliable.

7. Appendix 1: Inspirational Smart City Cases

In the process of defining the right set of scenarios for the ALMANAC project a range of different Smart City experiences and scenarios were reviewed, analyzed and discussed. Brief descriptions of some of the most important ones are presented below.

7.1 Outsmart

Outsmart focused on a range of city services, including, water, energy, mobility and waste as well as the environment[15]

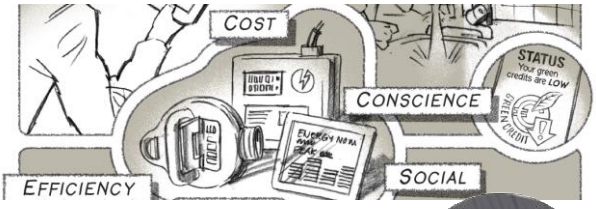
Waste Management

//Berlin:
service:*smart waste baskets
platform:*internet of things

In Berlin, the primary focus was waste management, and the main idea was to deploy fill level sensors in public waste bins to optimize waste collection

The idea of "smart waste bins", using sensors to detect fill levels, can also be used in our context, but our focus goes beyond this as we also seek to find ways to engage citizens actively via information and feed back, and also want to investigate how we might address the issue of the quality of the waste.

Water and Sewage



//Aarhus:
service:*sharing utilities data
platform:*open data

In Aarhus the focus was on water and sewage. The focus in the Aarhus cluster came to be very much on Open data and the ODAA (Open Data Aarhus) platform

The ODAA was a key factor in the Aarhus cluster business case. The primary goal was to develop ways of enabling companies and public authorities to share data openly, without compromising the integrity of their internal information systems and at the same time showing them the potential value of opening up their data. As a test case we have worked with Aarhus Vand (the water utility in

[15] You can read more about the different scenarios on: http://www.alexandra.dk/dk/om_os/Publikationer/Publikationer/OUTSMART_annual_report_FINAL_OPSLAG.PDF - accessed 31st of October 2013

Aarhus) to show how production data relating to the water utility can be made easily available via ODAA without compromising the integrity of the SCADA system.

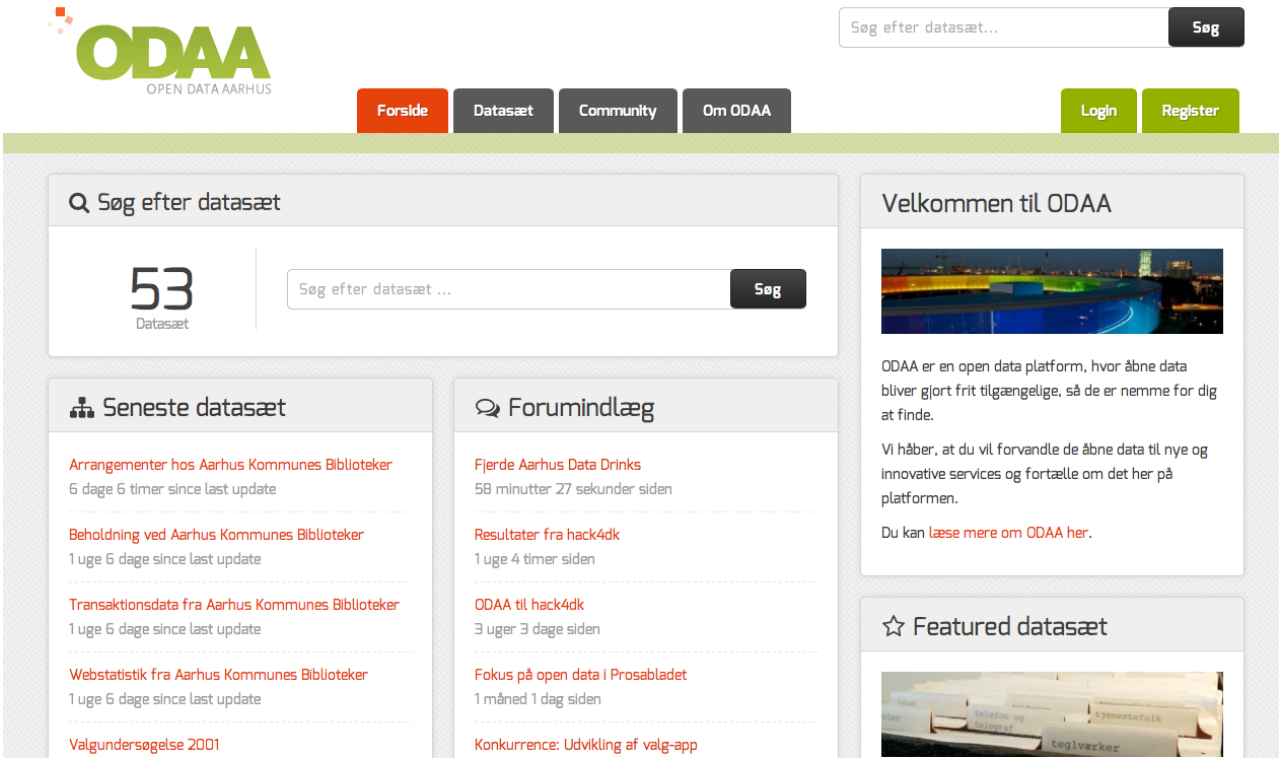


Figure 12: The ODAA website

Via the ODAA platform, Aarhus Vand provides a free data catalogue for non-commercial uses. Only parts of the data will be open to everybody, while other parts of the more sensitive data will be licensed, ensuring that only authorised users will be able to access it. The main intended user, at least in the short term, is educational institutions, but other potential relevant users (including professional users who could make new apps or develop new types of data modelling based on the data available) could benefit from the service as well. In the long run, the vision is to create alongside the technical platform an ecosystem of app developers and hackers using the data to create useful applications of economic value, to open up a new platform for ideas and initiatives to prosper, potentially creating new business opportunities and value for the city and the citizens.

In order to have a more tangible test case to present to people, the Alexandra Institute has made the "Aarhus city Dashboard". The dashboard can be seen as an attempt to make a prototype that shows what can be done with the types of data made available on ODAA in terms of both visualisation and functionality to make the data relevant and easily accessible to citizens. This example will also be used in relation to relevant data owners (both private and public) who still need good examples as motivation for them to provide data for the platform. They need something that can show them how their data can be used to make life in the city better, smarter and more fun for the citizens - and what the value is for them and for the city. The Dashboard was tested as part of the OUTSMART evaluation and the insights gained will be used to qualify the design and to look into different approaches for engaging citizens and motivate them to take part in the future development of the city by using and providing different types of open data[16].

[16] Read more on: http://www.alexandra.dk/dk/om_os/Publikationer/Publikationer/OUTSMART_annual_report_2013.pdf - accessed 31st of October 2013

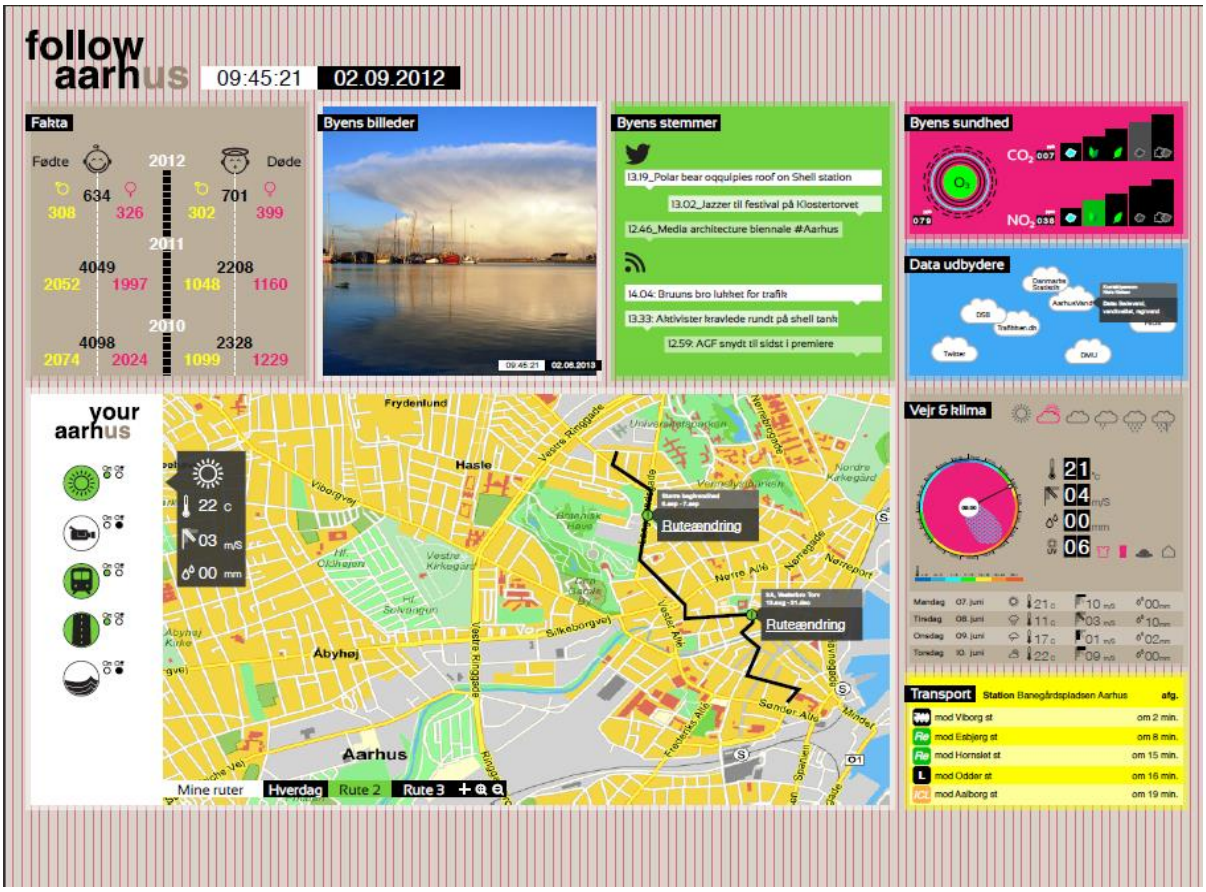


Figure 13: The Follow Aarhus website

Both the open data platform and the city Dashboard can apply to the ALMANAC context as well. For the citizens' engagement scenario, we envision a Hackathon that engages citizen developers, but we also think it to the next level by suggesting a potential service, a Caps, that might look something like the dashboard or use elements of the experiences from the ODAA on how data is accessed and maintained.

7.2 SmartSantander

Another FP7 project that was used for inspiration during the scenario generation was the SmartSantander project - especially in relation to the citizens' engagement, with focus on the participatory sensing app and the app developed for the cultural and tourism scenario.

The participatory sensing app allows citizens to report incidents to the municipality and follow how these reports are being handled. It is also possible to post other types of events and geotag them on a map. It is also possible to search for events using different parameters like themes, time or location, as shown in the pictures below:

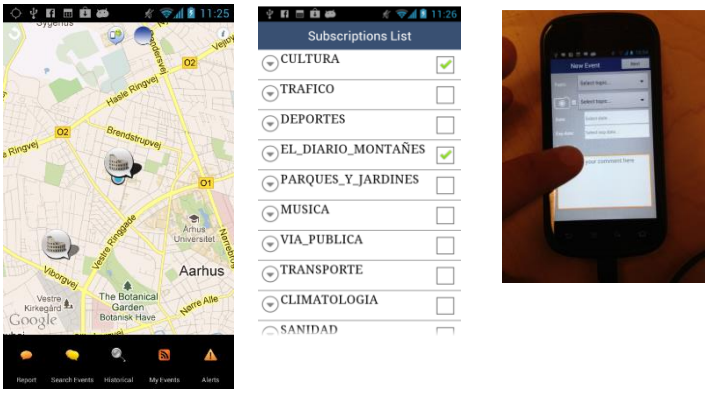


Figure 14: SmartSantander search facility

For the *tourism and cultural scenario* an app was also developed. City information is made available to visitors & citizens through Smartphone Applications (iOS and Android) based on Augmented Reality technology. The types of information available include: public transport, weather, events, and parking. Some examples are shown below:

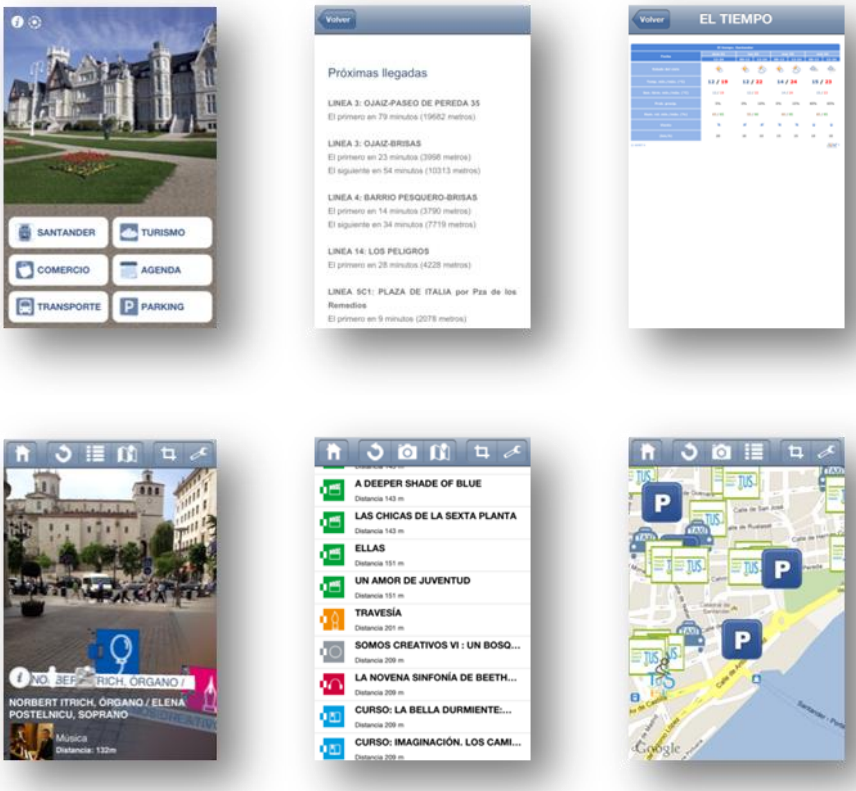


Figure 15: SmartSantander tourism app

If we take the ALMANAC citizens' engagement scenario a step further, we could also find inspiration and draw on the experiences of the SmartSantander project, where ALEX did the qualitative evaluation of the participatory sensing app, and is currently working to develop an Aarhus version of the app for another project

7.3 Drivers of change

Drivers of Change is a research-based publication developed by Arup to help its business and clients identify and explore leading factors which will affect our world in the future. The publication is a

planning tool that helps the user to ask the right questions in order to plan effectively for the future. It investigates themes including: energy, waste, climate change, water, demographics, urbanisation and poverty.

Each card depicts a single driver. A factoid and rhetorical question are on one face, backed up by a more detailed exploration of the issue on the reverse. We used the cards during the workshops to get inspiration[17].

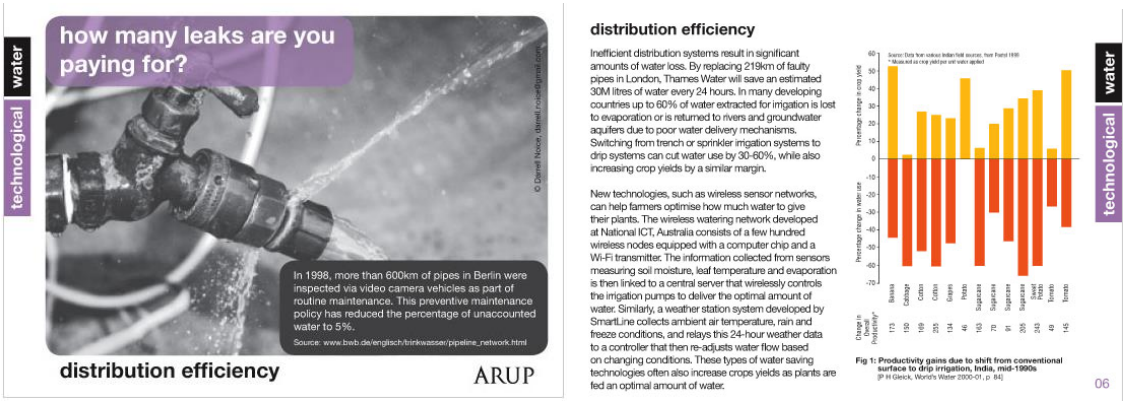


Figure 16: Arup Drivers of Change

7.4 Urb-Grade

The Urb-Grade project works to develop a platform, the DaaS (District as a service) platform that provides decision support to policy makers (e.g. city authorities and utilities). With the DaaS platform, city authorities can supplement and combine traditional data sets from surveys and statistical sources with real-time data to get an overall picture. This increases the cost effectiveness of energy-saving initiatives and enhances the ability to design flexible and customized solutions for both public and private organisations, as well as private consumers.

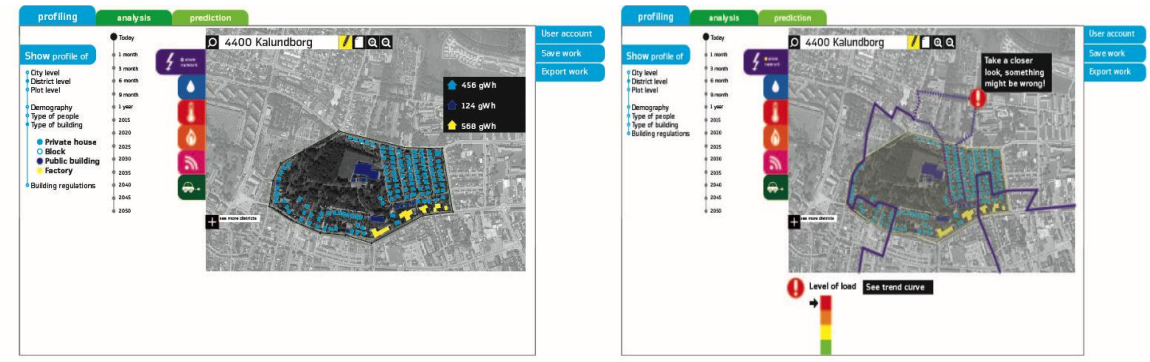


Figure 17: Urb-Grade

This type of platform thinking could be relevant for several of the ALMANAC scenarios, maybe mostly so in relation to the citizens' engagement, where citizens could access a platform with different types of data from the city, maybe zooming in and out of different areas as well as topics?

All of these different projects and scenarios inspired the process of scenario generation and we will continuously work in the project to draw upon these experiences as we go along to ensure that we are able to make the best possible solution, building on existing knowledge to create innovative ideas.

[17] Luebkeman, Chris (2009) Drivers of Change. Arup.

8. Appendix 2: Scenario ideas from Copenhagen workshop

During the Copenhagen workshop a lot of different ideas were generated. These are shown below in a raw format. The purpose of including them here without further processing is both to ensure transparency in our method and to allow us the opportunity to go back at a later stage and revisit some of these initial ideas if this becomes relevant.

Citizens

City Health level: traffic + waste + noise + water

- In general for this scenario one could have a scale of city health and compare it to other cities. This would include an application that the citizens use to measure noise. Knowledge on water and waste handling (connection to residential homes smart metering – water and waste – connection either to the municipality services or subcontractors) and traffic intensity sensors. One could compare with other cities or even different areas of the city of Turin.

Citizens app developers

How can ALMANAC assist app developers to use data from the system and create Smart City applications?

- Plug-in your own data + API, business model federation
  - How can ALMANAC assist developers to feed the system with new data + retrieve data from other devices + develop an application that uses both datasets.
- District of the month
  - Typical competition between districts of the city to see which is the healthiest area of the city (links to the city health level case).
- Citizens' awareness factual via IoT
  - How much the citizens can be aware of what is happening in the city (weather conditions, noise, waste bin levels, etc) through the use of different types of sensors around the city.
- Citizens' IoT data collection
  - Collecting measurements from the citizens' mobile phones (GPS, noise, temperature, etc.) and use this to give people a better understanding of the live in the city and how they actively play a role.

Waste

The areas discussed in relation to waste were:

- Optimisation of Collection
- Quality of Waste
- Citizen engagement
- Citizen Movement Adaption
- Collection Team Composition
- Collection Optimization
- Sorting for Quality
- Autonomous Informed Waste Collection Teams
- Waste Recycling Amounts Per Fraction
- Waste Quality in Households
- Availability of Bins
- Fuse Weather (Smell) and Waste Collection

For the waste scenario we should have a focus where the perspective of both the citizens and the waste collection professionals (employees, AMIAT and TRN) are represented. Both professional and private users should potentially benefit from the proposed solutions and be actively engaged.

Citizen follow my waste

- Citizens could get an app to follow the process of their waste. See where it goes, how it is being recycled and what impact this has on the environment.
- There could also be a feature to measure the amount of waste generated by the individual household (This would only be possible for the door-to-door service and only in areas where one bin is associated with a particular household, and not for bigger apartment buildings, where several households share the bins) This feed back on the quantity of waste would possibly make people more aware about their own consumption – and it could also be used to optimize the waste collection because it would make it easier to predict the amount of waste produced in different parts of the city

Water

For the water scenario different ideas was discussed within the areas of:

- Supply
- Consumption
- Conservation
- Prediction of supply / demand
- Irrigation
- Leakage

Post-its

- Remote monitor of water consumption, with alert module and estimation of KPIs like irrigation applet, water absorbed, water wash, savings etc.
- Compare own consumption of heated water
- Leakage
- Irrigation
- Fountains
- Water quality: Pollution, Pesticides
- Water waste - Monitor sewage
- Water quantity: Too much, Too little, Too much, at the wrong time or wrong place
- Rainwater - Prepare for excess water / flooding
- Water price - Dynamic pricing

Two main ideas were elaborated. One relates to irrigation, the other to consumption,

For the irrigation scenario there would be a combination of different types of data – sensor and other to give more accurate information about where and when irrigation is needed.

Sensors could measure soil moisture and the information could be combined with e.g. weather forecasts to determine the need for irrigation.

For a more consumption related scenario the focus could be to try to get people to drink tap water instead of bottled water

- Making people more aware of the consequences of using bottled water instead of tap water, and encouraging them to drink the good quality water from the tap instead.
- Could compare data on the environmental impact of bottled >< tap water
- Live feed of sales of bottled water + environmental impact
- Possibility to earn green points by drinking tap water

Transport/Mobility

Transport/Mobility is out of scope for the ALMANAC project – but still kept here for inspiration – something that we could think about in relation to the citizens' engagement – private people sharing different types of information enabled by the ALMANAC platform or the Turin Smart City platform

Participatory sensing

Monitor/predict

- Traffic app – monitor and predict traffic junctions, online route re-planning; overlay to GIS
- Ad-hoc car sharing (trust)
- Transportation advisor (cheapest, fastest, etc. solution)

Example:

It is a typical nice summer weekend afternoon in Turin where many people are in their cars going to the beach. This of course creates congestion in the main arteries of the city. Moreover, Michele is driving to the city centre where he will meet with his friends to go to the cinema. Because of the traffic jam he is not aware which route he should take in order to avoid arriving late for the movie.

His smart phone runs a navigation service that uses ALMANAC to integrate different data coming from different services, including traffic intensity and parking management service. Given that the weather is good it is highly probable that the shopping mall parking areas are all occupied. Apart from showing Michele the most efficient way to the centre it is shown to him several options for parking (nearest, cheapest, etc.). After selecting the most suitable possibility Michele is shown the current best route, this can of course change depending on the traffic flow.

9. Appendix 3: Excerpt from ID2.2 outlining process of requirements gathering

Sources for the Derivation of User Requirements

For this initial requirements deliverable an initial set of user requirements has been identified and proposed, starting with the scenarios documented in deliverable [D2.1 Scenarios for Smart City Applications]. These user requirements will be elaborated and refined using the methods described in this document. It is an iterative process, that starts with the identification and analysis of user needs. Then ideas and concepts are developed, considering the user insights. The concepts are operationalized through requirements that specify the implementation, and finally the prototypes will be tested and evaluated possibly leading to new insight, revised concepts. adjustment of requirements and applications. The figure below describes this iterative user involvement process

Figure 18: User involvement process

The requirement derivation has to be founded on different sources or information. The two classical sources of deriving user requirements are scenarios and field studies, which consist of interviews, workshops and ethnographical methods like participatory observations of the domain context and experimental testing of existing solutions.

User Involvement

The users are not the drivers of the process. They provide valuable insight and input that is essential for the process, but it is up to the project partners to transform the user's insight into requirements that can help drive the development of the technical solutions. Often it is needed for developers and concept makers to identify basic requirements and scenarios. Especially in the cases where the target domain is of potential value. In these cases, as in the ALMANAC water and Citizen Engagement areas, it is commonplace for concept makers, academics and technologists to compile a set of vision scenarios to begin with, and in turn identify and engage with the targeted user groups.

Stakeholder and End User Workshops

Workshops establish an interactive group setting, where participants are asked to actively engage in developing ideas or concepts. They are explorative and creative in their outset. User workshops often aim at acquiring feedback regarding new ideas and they provide invaluable information about the potential market acceptance of the product or the idea. The facilitator of a workshop will ask questions and/or set different tasks, but the form is very informal and loosely structured. Especially if a workshop is set up to discuss new, not yet realized ideas or settings, scenarios can be introduced to make it possible for the participants to imagine the new system. The scenarios help capturing and illustrating the features of the new system, its modes of usage, and its benefits.

Workshops can help generate and feed requirements into the project at different stages in the development. They can be used internally involving different project partners in co-creational activities, translating user insights or domain knowledge to more specific requirements for the platform or the applications or externally to get input or feed back from potential end users

Focus Group Interviews

A focus group is a qualitative research method using a group of experts or potential end users, to find out what their opinion is about a new idea, a product, service, or concept. The focus group is more oriented towards feedback and attitudes and less on generating ideas. It is a way to engage with multiple stakeholders at once and get them to discuss different topics. The moderator will ask questions and the participants are then free to discuss with other group members. Stakeholders in the ALMANAC platform include:

a) Individual citizens, citizens' organisations, environmental organisations and other civilian special interest groups

b) Professional organisations, private operators and contributing partners (subcontractors) and

c) The municipality and governance bodies.

These stakeholder groups will potentially work and interact with the ALMANAC applications and their input will be relevant at different times of the project through workshops, participatory observation and interviews.

The output of focus groups in a requirement gathering process is a set of feed back statements or ideas that then needs to be translated into requirements internally in the project group, in collaboration between user experts and technical experts in order to act as valuable input in the development process.

Scenario Observations and Semi-Structured Interviews

Interviews can be used at all stages of a project, and for various purposes. Using a multimodal approach of combining participatory observation and interviews has proven its potential to deliver the best insight into understanding the processes among all stakeholders. Often, but especially in the initial clarifying phase, it is useful to combine observation and interviews in scenario observation sessions. It is often much easier to observe users in their domain context and their activities than to ask them in interviews.

In this type of setting it will often be easier for users to explain what they are actually doing and why, and it will also be possible for the user expert running the session to combine what the user explains with own observations and notes of the events in focus. The type of knowledge we are looking for is often implicit and therefore hard to express in words – so we need the observation as well to capture the blind spots of the user or any discrepancies.

In order to create a more comfortable and conversational situation, it is common practice to perform semi-structured interviews. These interviews loosely follow specific guidelines and a list of questions, but leave room for a spontaneous adaptation of the progress and development of the conversation. The documentation of this information is done either by taking direct notes or, if all details must be captured, by videotaping the participants while using the system and capturing the environment by taking pictures.

Prototype Testing and Evaluation with End Users

Testing of prototypes with end users is also a way to get concrete feed back that can be used to adjust the requirements. By qualitatively evaluating applications with end users new requirements can arise while others may prove no longer relevant. It will be possible for users to be more concrete in their assessment when they have the actual element/application as a point of reference for the discussion.

This type of testing can be performed both individually as interviews and scenario observations or as larger workshops/focus groups with multiple users participating.

For these qualitative evaluations, the model of change, developed by the Alexandra Institute, will be used as a tool to guide the evaluation sessions, as well as the following requirements derivation. The model provides a method for documenting and assessing effects of different development initiatives in a holistic and systematic way. Each part of the model can be associated with a line of measurement points related to both perception, interaction and effect. A measurement point is a concrete sign to look for, showing that a change has occurred. These points offer a systematic way of determining which aspects of the elements that have an effect and what this effect is.

Using the model of change will enable us to focus on the different elements that cause a given effect, which will also help us assess applications and revise requirements accordingly.

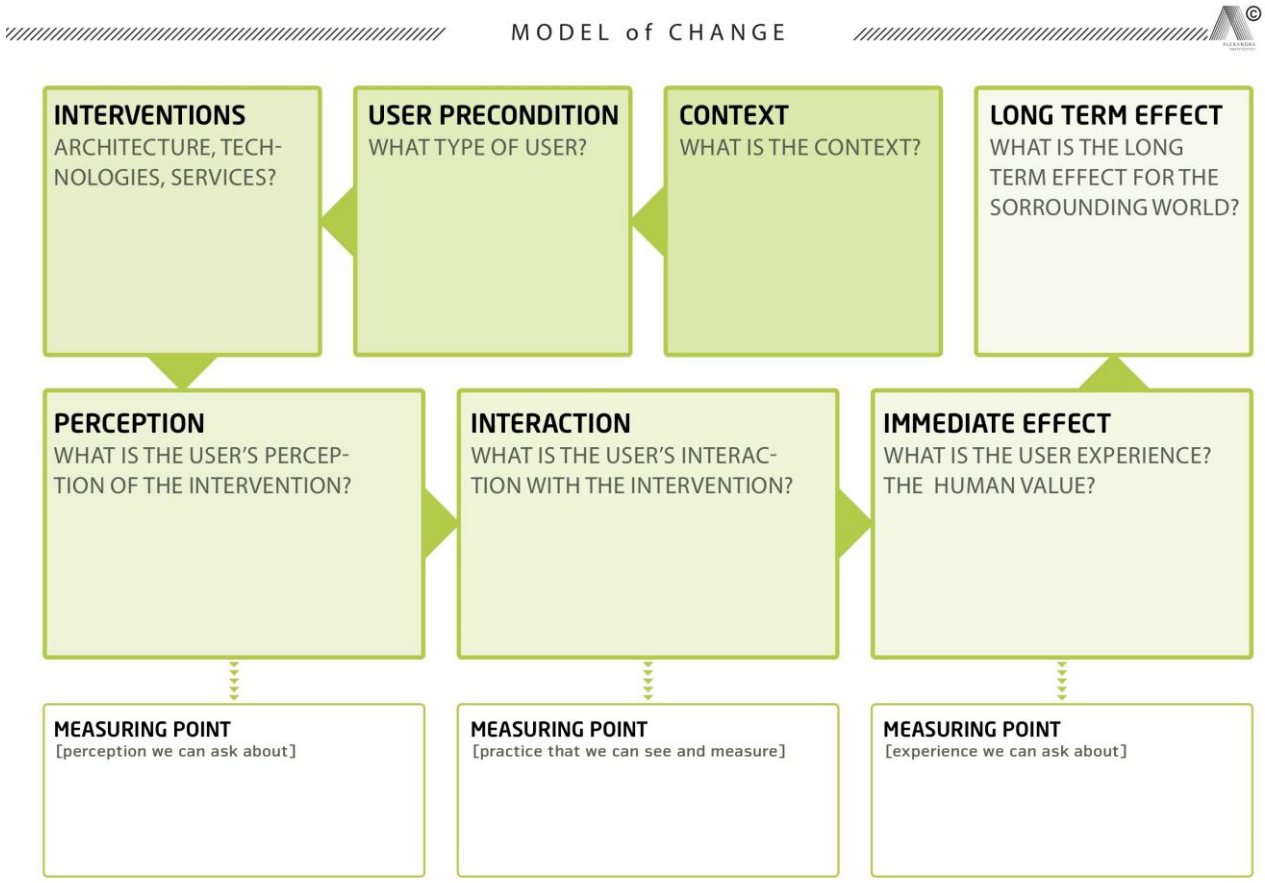


Figure 19: Model of Change

User Involvement Plan

The goal of the future user involvement in ALMANAC is both to help generate and appropriate end-user requirements and serve as part of the evaluation (the qualitative part of the evaluation). It is hard to separate these two aspects, as the different user involvement activities planned can generate input for both requirements and evaluation.

The table below proposes a way to carry out this involvement to ensure that we keep users' perspectives in the loop and align our design with their needs.

Time	Activity	Output
Jan – April 2014	Work-shops, scenario-observations and interviews Discuss scenarios with developer users to validate relevance and if necessary make appropriate changes before launch of the first prototype	Validation of relevance to developer users (usability and needs of the development platform) Derivation and better understanding of developer user requirements
1st prototype M12	Data collection platform and early development platform	
	How (if at all) do we want to evaluate first prototype with end users	Qualitative evaluation?
	Workshops with developer users about specific needs/wants in relation to the specific elements in focus for 2nd prototype	Input for design-modification to development platform Better understanding of application end user requirements
2nd prototype M24		
	Evaluation with developer users Workshop/focus group and, if possible, scenario observations	(Field trial and) evaluation How does the development platform help solve the application developers challenges and possibilities?
	Evaluation with end users Workshop/focus group and, if possible, scenario observations	(Field trial and) evaluation
	Work shop to engage end-users about specific needs/wants in relation to the application with focus on the specific elements of the 3rd prototype	Input for design-modification How does the application help solve the challenges they face?
3rd prototype		
	Evaluation with developer Workshop//focus group	Test of platform relevance and suitability for app development
	Evaluation with end-user Workshop//focus group	Test of application set relevance and suitability

Table 1: User involvement plan

Structuring User Requirements

The main task after the completion of workshops and interviews is the consolidation of the information gathered from the discussions. The output of the discussions and interviews are user statements. The analysis of the original users' statements in the respective workshops leads to the elicitation of requirements at different levels of detail and their aggregation in a structured way.

First, all user statements need to be extracted from the discussion protocols and statements referring to the more global constraints need to be separated. These statements, though not referring to the ALMANAC project, contain valuable information about context of use and need to be archived.

The second step is a preliminary classification of the remaining statements relating explicitly or implicitly to the support the ALMANAC platform might provide. Such user feedback to scenarios may relate to various aspects of the system and its use, and be classified according the Volere template.

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