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Real-Time IoT Stream Processing and Large-scale Data Analytics for Smart City Applications

Collaborative Project

Evaluation Scenarios

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Lead Contractor	AA
Author(s)	Michelle Bach Mikkelsen, Matti Bugge, Camilla Tække
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Executive Summary

This report provides a tool box for the selection, evaluation and refinement process of going from a variety of 101 Smart City Use cases to 10 specific Smart City Use Cases that are to be implemented during the CityPulse project. The tool box has been developed by the Alexandra Institute and Aarhus Municipality and features an online questionnaire designed to allow interested stakeholders to evaluate the proposed 101 Smart City Use Cases on a set of parameters. This crowdsourced evaluation process will give the CityPulse partners an idea of which of the Use Cases citizens and stakeholders rate the highest.

The Smart City Evaluation Tool can be found here: http://ict-citypulse.eu/scenarios/

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1. Introduction

This report presents the methodology on going from a variety of 101 scenarios to the 10 scenarios that are to be implemented in the project.

The set of focused scenarios is produced by a careful selection from the pool of scenarios (as presented in D2.1) that serve as input to the requirements and Smart City Framework design process. These are then to be further decomposed into simple realizable use cases and user stories with measurable/verifiable results.

In this report a toolbox for the selection process is presented. It first presents the Smart City Evaluation Tool kit and how it is spread to a broad community over a variety of different stakeholders. Then the methodology of turning scenarios into use cases is described followed by a description of the evaluation metric. Finally, an interview guide that is to be used to refine the use cases before starting the implementation of the selected use cases is presented.

This means that the report does not specify which use cases will be chosen but presents the selection process as well as the methodology, which every scenario will go through before implementation.

The final scenarios evaluated, refined and created into use cases will be presented in D6.2.

This process is chosen to ensure an agile and iterative process where it can be taken into account that cities are organic entities and ever changing (Agile Cities, 2013). Because of this an agile process is necessary when new IT is implemented in cities. *Cities must be agile – fast and flexible in identifying challenges and implementing solution* (Ibid.).

This ensures that the CityPulse project will choose and work with the most relevant use cases at the given time, which is aligned with the stakeholder's wishes. Another benefit from this approach will be that the city partners- Aarhus and Brasov - will have more time to collect the relevant data (if relevant/possible) for the specific use cases as well as gain access to the concrete locations or organizations for implementation, as experience has shown that collection and gathering data is a long term process.

The report is structured as follows:

Section 2 focuses on the methodology on how the Smart City Evaluation Tool kit has been designed and how it is spread to a broad community.

Section 3 describes the evaluation and refinement method to be carried out on the final chosen 10 scenarios.

Section 4 describes the theory on user stories.

Section 5 summarises the report and describes the further plans for implementation of the final chosen 10 scenarios.

Section 6 provides the references for this report.

2. Methodology

Following D2.1 with the ambitious goal to collect 101 smart city application scenarios to get the highest possible diversity in ideas for discussion with city stakeholders and to the wider community, the project needed to narrow the selection down to a more reasonable number of scenarios to be turned into prototype implementations.

This section describes the methodology on how the project wishes to narrow down the 101 scenarios to the 10 scenarios that are to be implemented in the cities.

In WP2 101 smart city application scenarios were created via three sources:

1. **Stakeholder need based scenarios** – scenarios emerging from a dialogue with a group of selected end users or key stakeholders.
2. **Scenarios from project participants and literature** – scenarios collected from project partners' internal reference materials and generally literature such as previous projects.
3. **Crowdsourcing scenarios** – scenarios coming from previously unknown sources and collected by means of crowdsourcing mechanisms such as an online design competition.

Internal selection

An internal selection process was carried out in work package 2. This process concluded with a top 11 of scenarios. The methodology of this process and list with the 11 scenarios are described in D2.1.

External and crowd sourced evaluation

The 101 smart city application scenarios are furthermore to be evaluated externally and crowd sourced via an online website questionnaire - a Smart City Evaluation Tool, available for all interested parties to access. When accessing the Smart City Evaluation Tool any interested party will be asked to evaluate the scenarios on a range of usability parameters, ensuring a user-driven ranking system of each scenario.

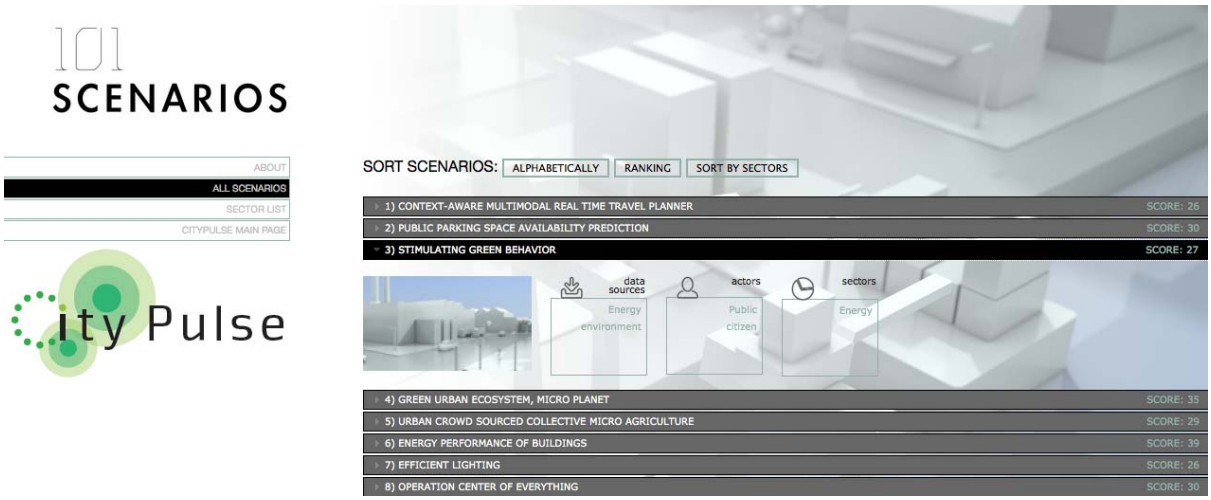
The Smart City Evaluation Tool can be visited here: http://ict-citypulse.eu/scenarios

Being more than a questionnaire it should be regarded as a generic tool for Smart City scenario evaluations. It is a hybrid between an evaluation tool and an informing disseminating Smart City tool. Later on it is intended that the Smart City Evaluation Tool will be further developed so that interested stakeholders can submit their own Smart City application scenarios.

Presentation of the Smart City Evaluation Tool Kit and its design concept

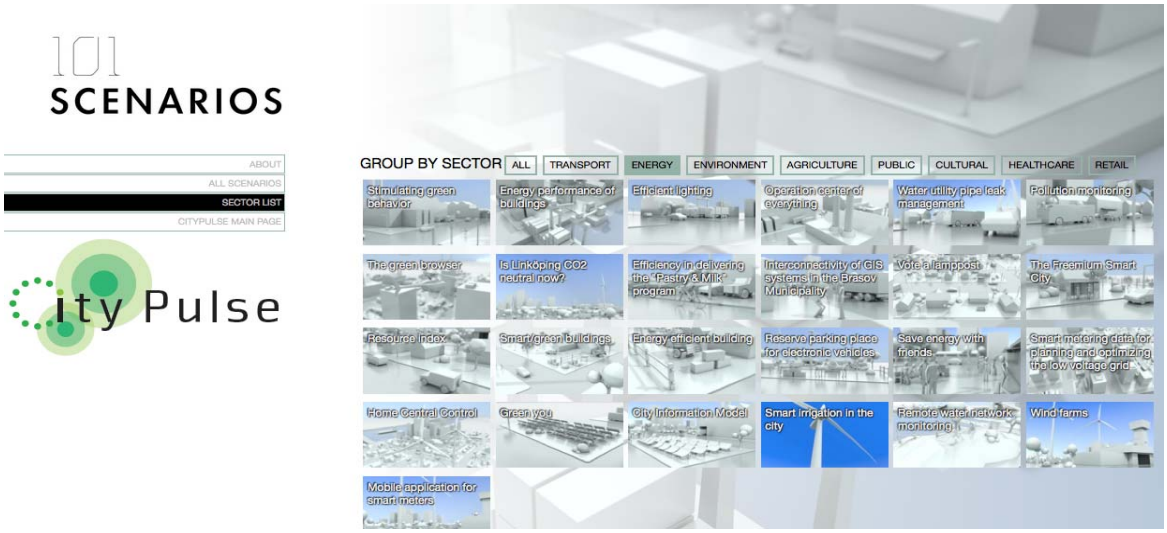
The design concept of the 101 use case scenarios revolves around quite a few aspects:

- One being the opportunity to use the CityPulse project as a platform to showcase the 101 scenarios, as well as the potentials of the modern smart cities in a broader sense.
- Exhibiting the current experienced issues emerging in cities all around Europe
- Provide inspiration for solutions to the current issues
- Provide a simplified market analysis that can indicate which issues, domains, and wanted features are most relevant and interesting from a city perspective, right now
- Gives the CityPulse project access to citizens and their view of the city. Additionally, the tool provides qualitative documentation for CityPulse, giving us the opportunity to select scenarios for implementation on a stronger knowledge base.
- The second aspect revolves around including any interested parties in the evaluation of the scenarios.



The 101 scenarios feature use cases from each of the 10 different partners involved in the project, resulting in a very diverse set of use cases. This in turn ensures a very broad showcasing of the possibilities when using ICT in the future development of cities. Any user seeking out the 101 scenarios will then be able to pick out single scenarios that they wish to inspect more closely. The user will then be able to read the scenario in the context of the evaluation system, which will be presented alongside each scenario. It is possible to browse the Smart City Evaluation Tool scenarios either alphabetically, via a ranking system (which scenarios at the moment are rated highest or lowest) or by sectors. The ranking itself is calculated by averaging evaluations done on a specific scenario. This approach makes is possible to directly compare scenarios on the ranking value alone. A specific ranking value can go up and down over time, and can only reach a maximum value of [all evaluation questions * 5]. A current issue in the calculation is that we don't take into account how many times a scenario has been evaluated. Concretely this means that two scenarios could have the same rating, but scenario 1 has five evaluations, and scenario 2 has 1000. Scenario 2 should probably be ranked higher than scenario 1 since it's more qualified. On the other hand, the rating tells something about the "likeability" of a scenario, from the perspective of the people who

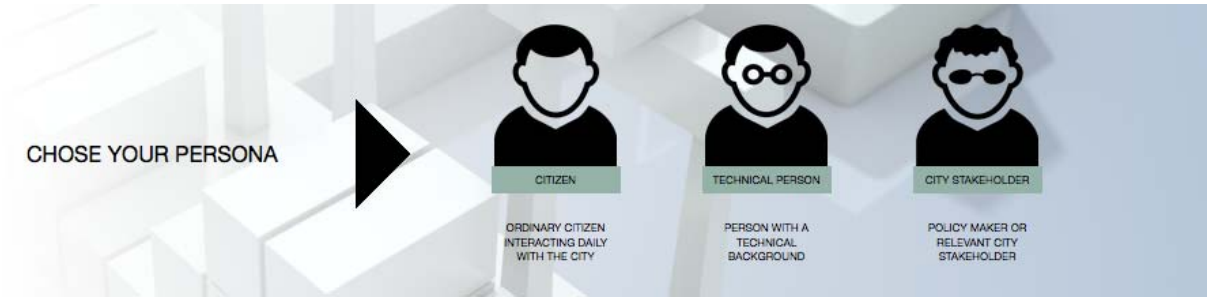
evaluated the scenario. Therefore it might not make sense to rank a more qualified scenario higher than a less qualified one. We have had some discussions on this particular matter, and have been investigating the possibility of having the basic average rating (as we have now), and then show the qualification factor next to the ranking. We still need to come up with a good solution for this issue, but are satisfied with the current result since it, despite of the flaw, gives an indication of what cities find relevant and interesting.



Just as the scenarios are diverse in nature, so will the interested users have different backgrounds and incentives to seek out the CityPulse project. This means they will have different priorities when evaluating the scenarios.

The first part of the survey will be a simple introduction to the purpose of the evaluation. In order to account for the diverse set of users, the evaluation system will then require each user to choose one of three profiles in order to rate the scenarios in relevant fashion. The current three profiles are as follows:

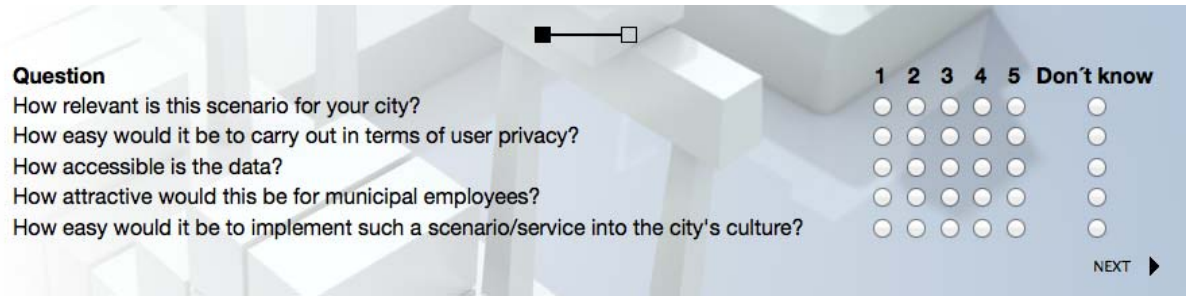
- I'm a city stakeholder (working for the city or municipality)
- I have a professional technical interest (working with IT, digital services or city development)
- I'm an ordinary citizen (no relation to municipality or professional technical interest).

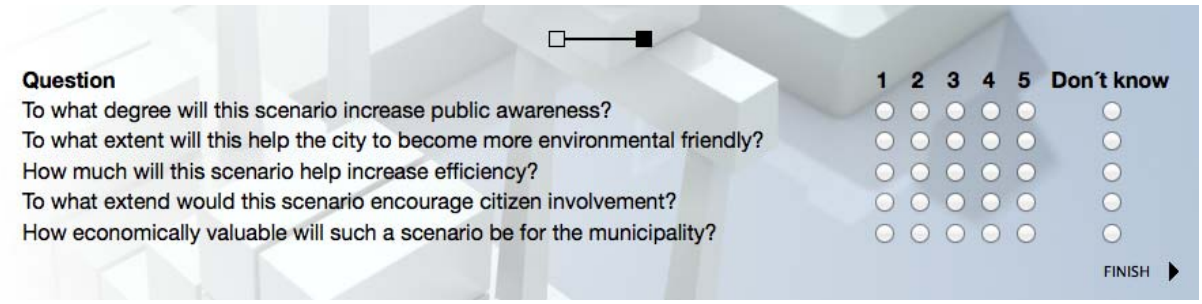


The evaluation tool will accompany each scenario, and the questions will depend on the chosen profile. This means a city stakeholder profile will receive more questions relevant for his or her job

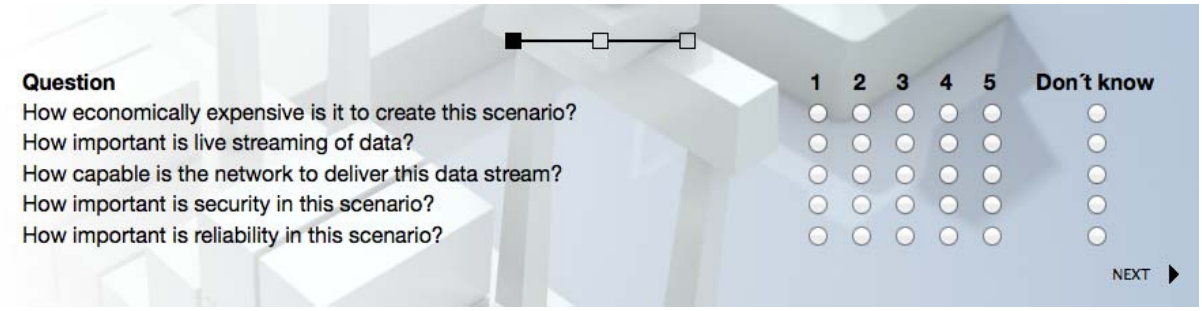
as a municipal employee, while the others will receive questions relevant for their own profile. The point of the division of profile and questions is of course that each user will find the evaluation more attractive and relevant.

The following screenshots show the questions connected to each profile. It was decided that each question should be answered on a 1 to 5 scale in order to obtain a more nuanced perspective of the results, while also making it possible to rank all aspects of each scenario in comparison to other scenarios. Inevitably this produced the exclusion of simple yes/no questions. Each 1-5 evaluation also includes the 'don't know' category in order to exclude randomly placed evaluations in the lack of an option outside 1-5.

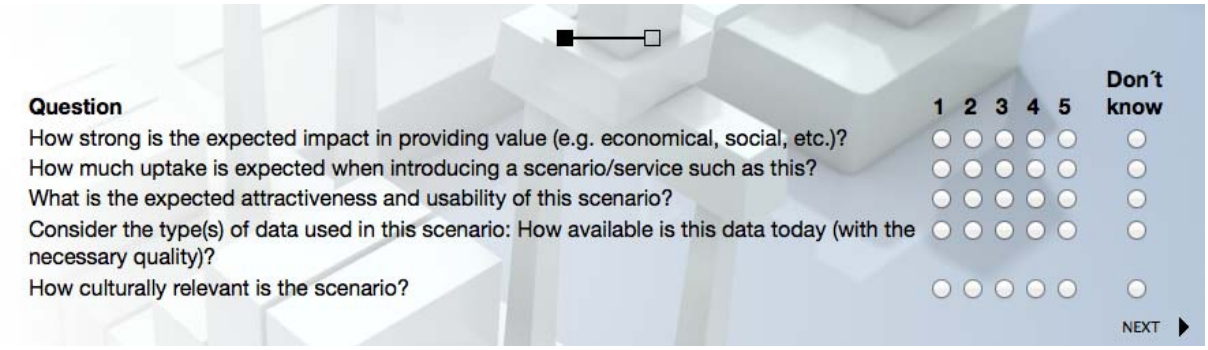




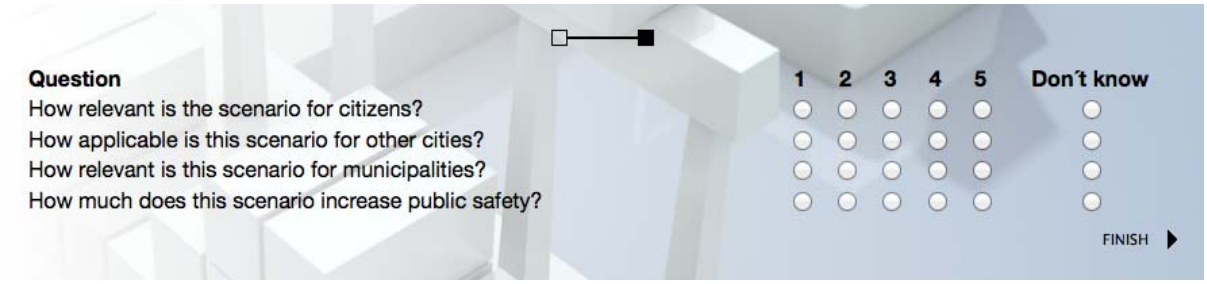
Questions for 'City stakeholder' profile.



Questions for 'Professional technical interest' profile.



Questions for 'Ordinary citizen' profile.



The Smart City Evaluation Tool was tested in a usability test with different relevant stakeholders.

Usability test

In order to represent the evaluation tool presented to the users in the final design, the usability test was set up using a common online survey system (defgo.net) as the Smart City Evaluation Toolkit was not ready to be deployed at this stage. Using the defog.net survey system still served the purpose of attaching the different questions to each profile. In order to test as many scenarios as possible, 10 randomly selected scenarios were assigned to each of the three profiles. The main purpose of the tests was to determine the users' reactions to the questions in relation to the scenarios, and to enquire about their thoughts of the final design and the project as a whole.

Each test consisted of three parts:

- An introduction to the project, smart cities and the idea of the final concept for the 101 uses case scenarios.
- Reading and evaluating the 10 scenarios one at the time.
- Answering questions posed by the tester.

The introduction was deemed necessary for the simple reason that users of the final concept will most likely be familiar with all three aspects before seeking out the 101 scenarios. The purpose of an

introduction was thus to ensure a better understanding of the test itself and to prevent misunderstandings of the task set before the test subjects.

Each participant was asked to 'think out loud' during his or her evaluation of the scenarios. This allowed the tester to better determine the focus, understanding and opinion of each subject and how they approached the test. In the end this method was chosen to determine the general usability of the ideal concept and to understand the nature of each participant's evaluation scores.

Finally each test ended with the subjects answering a few questions in regards to the scenarios, questions and concept as a whole.

Participants

According to renowned usability expert Jakob Nielsen, a total of 5 test subjects will more often than not find as many important problems as a larger number of participants (http://www.nngroup.com/articles/how-many-test-users/). Sometimes it can be valuable, but often there's little additional benefit in recruiting additional subjects. Therefore our aim was to include 5 participants in our usability test.

Furthermore it was important to find test subjects resembling the targeted end users. As a result we targeted employees to fit within each of the three profiles.

The selection method was done by targeting end user archetypes – in this case preferably from all three types of profile. Therefore several municipal employees from The City of Aarhus were contacted, as well as a student at the University of Aarhus. None with any close affiliation to the project consortium was chosen, as this may have produced a conflict of interest.

Setup

Each test took place at the test subjects' own location – all but one at their own workplace. As mentioned, each participant was given an introduction, and the testing of the 101 scenarios commenced.

A total of 5 usability tests were performed, and each of the three profiles was chosen at least once. Three chose the 'city stakeholder' profile, one chose the 'technical professional' and the remaining chose the 'ordinary citizen'. The tests were somewhat diverse in terms of length, and spanned from anywhere between 25 – 60 minutes. Some chose to talk a lot about the relevance of each scenario while others focused more on completing the survey, or talked about the complexity of the questions. This is relevant for the test as different participants focused on different aspects, suggesting an outcome influenced by other factors than the evaluation itself, such as the tester's job type, personality, skill qualifications and so forth.

Outcome

The evaluation of each scenario will not be accounted for in detail since that would exceed the purpose of the usability test. The focus instead will be on the subjects' general approach to the scenarios, which will give a better understanding of the concept of evaluating the 101 use cases as a

whole. Each of the three profiles produced different outcomes and reactions, but several common denominators persevered throughout all the tests.

City stakeholder

As mentioned the profile mostly chosen was the 'city stakeholder profile', due to a larger part of the test subjects working within the municipality. Each three had different jobs within the municipality so the diversity was maintained. Below is listed the relevant results of these tests.

1) The diverse types of job profiles of the test subjects turned out to have an impact on the evaluation of the scenarios. Each of the three pointed out that the understanding of both scenarios and questions is very much fashioned by their own knowledge and job function. For instance, one participant found the question "How economically valuable will such a service be for the municipality" very difficult to answer, simply because she had nothing to do with any financial aspects in her daily job. The other two never brought this up, but they in turn had difficulty in relating to other questions in the evaluation chart unfamiliar to their respective jobs. Similarly, two subjects had difficulty in defining the general term 'efficiency' in some contexts and one user had the same problem with 'user privacy' as a term.

Possible solution if needed: Tailor the questions to the users. This could be done by including the choice of what sort of job function/professional knowledge they withhold.

2) The diversity of the questions turned out to conflict somewhat with the 1-5 options. One user for example chose '5' in the question "how difficult would it be to carry out in terms of privacy" even though he meant to say it would not pose a problem. The 1-5 scale occasionally conflicted with the respective adjective of the questions.

Possible solution: Specify above the numbers '1' and '5' that they are respectively low and high.

3) In some cases, the language itself posed a problem. Some of the participants had some difficulty understanding some aspects of specific scenarios. This was both concerning single words and sentences that sometimes affected the entire context. One participant was not as skilled in the English language, and required translation of the scenarios. This of course removed some of the desired effect of the test.

Possible solution: Less complex language in general. The participant requiring translation suggested, that perhaps the scenarios could be translated to the specific language of the test subject.

4) In general the test subjects were very interested in discussing each scenario and the relevance of this in their own context/ own city's context. This can be considered a positive thing, as they reacted well to the scenarios and were intrigued by their content. Similarly they were reflective about each scenario's relation to the proposed questions, meaning the entire setup seemed to function quite well. Some scenarios were more difficult to understand than others, and as mentioned, not every question fit every use case. But in general they found it to be a good way of showcasing smart city potentials for interested parties – especially for users who by themselves seek out the project. All of them mentioned that it could be valuable for municipal employees if these were working with, or beginning to work with, smart cities, especially in terms of finding inspiration.

Professional technical interest

Only one person chose this profile. The person worked within the municipality, but was convinced that the technical profile would probably be best suited for her.

1) One general problem arose in this test: the employee's technical profile was either not technically 'strong' enough, or the questions fitted for this profile was not within her area of expertise. This resulted in a general tendency to fill out several evaluations in the 'don't know' category for each use case. The questions most frequently placed in this category were number 3, 5, 7, 8, 9, 10 and 11. Where this hampered the test quite a lot, it made for good consideration of the understanding of a profile with a 'professional technical interest'. She was very pleased that there was a 'don't know' category, and would probably otherwise not have completed the evaluation.

Possible solution: Define technical interest or tailor the questions to different types of technical expertise.

This possible solution has not been implemented. Defining a technical interest at the beginning point of an evaluation would require several extra layers of text for the 'professional technical interest' profile, and would in turn increase complexity for the user of the test as well as the developers of the graphic interface of the Toolkit. The increased complexity would make choosing this profile seem like extra work for the user compared to the other two while potentially risking the chance of them not choosing it simply because of the increased complexity.
Tailoring questions to different types of technical expertise would likewise require several additional layers of complexity which would damage the easy accessibility of the Toolkit. A user fitting this profile would potentially have to answer a series of questions to determine which technical expertise he or she has, before actually beginning to use the evaluation tool. Furthermore, this would result in the development of a range of very technically specific questions with required assistance of professionals working within each of these.

2) This test subject also had the occasional difficulty in differentiating between 1 and 5 and which was highest/best.

3) She thought most of the chosen scenarios were too long. She did however confide, that it would probably not be a problem had she chosen to seek the tool out of her own interest, as the final design concept intends.

4) Some of the questions were hard to understand. Some, such as 'to what extend does this scenario involve actuation', were difficult in a lingual sense – she did not understand what actuation was. Also the question 'how complex is this scenario' was sometimes interpreted as how complex it was to grasp as a concept and other times how complex it would be to carry out in the real world.

Possible solution: Reduce lingual complexity of the questions.
The solution of reducing the lingual complexity has not been implemented as it conflicts with the initial propositions of what elements the evaluation Toolkit should contain. Terms such as 'actuation' are commonly used in this field of work and represent important aspects to be evaluated upon.

In regards to the 'how complex is the scenario' question it has been deemed unnecessary to alter this explanation. Should the user find the concept of the scenario complex, she would in turn presumably also find it complex to carry out in terms of actual realization and vice versa. Thus the 'complexity' concept will likely result in same type of evaluation either way. Having to implement a detailed description of the concept of complexity would most likely result in a disturbing element in an otherwise straightforward evaluation process.

5) In general she found the scenarios very interesting and very relevant to her own job function and her own city. She also liked the ideal concept of users having to seek out the evaluation system themselves, as this will provide a bigger incitement to produce better answers. All in all she found the questions difficult but relevant for people with a technical interest in the overall subject.

Ordinary citizen

The final participant, the University student, chose this category. He's enrolled in a relevant IT education, but did not consider his profile technical enough to choose profile number two.

1) He pointed out that some questions were unfit for certain scenarios. For instance, some scenarios were completely unrelated to municipal work/employees, and therefore he had difficulty in answering 'how relevant is this scenario for municipal employees?' The same was the case for 'how much does this increase public safety?' as it is a very specific criteria, and several scenarios did not include public safety at all.

Possible solution: Each scenario could have different questions. Alternatively, a list of common questions relevant for every scenario could be applied to all scenarios, while a few questions were only applied for certain types of scenarios.
These solutions have not been implemented. Implementing different questions for each scenario would have resulted in a very time consuming extra task as there are 101 scenarios, of which each would require 10 specified questions. Furthermore, this would make it increasingly harder to identify common traits or problems between scenarios, as there would be no logical way to standardize the answers to so many different questions.

2) Difficulty in distinguishing between 1-5 as either high or low, as the others had.

3) The question 'how long of an uptake is expected when introducing a scenario such as this?' was considered too broad and could be narrowed down.

Possible solution: more concrete questions.
This possible solution was not implemented. This arguably is not a big problem, simply because the broad definition is favorable in comparing the answers to the different scenarios, and again, this can be traced back to the issue of having to create very specific questions for each scenario.

4) His own background (in terms of education) meant a different interpretation of the scenarios / questions. For instance his focus was often on factors like "Would people actually use this service?", which in turn affected his evaluation choices.

5) In general he found the scenarios very interesting, and was positive about the final end design where users themselves seek out the project and evaluation system.

Conclusion of the usability test

The usability served its purpose in pinpointing aspects relevant to consider in the final design of the evaluation of the 101 scenarios. The users were in general positive about the concept, and through their testing several obstacles were made clear. The most common problems seemed to be the very broad definition of profile and question types, which in some instances inhibited some participants in performing a correct evaluation. A recommendation would be to re-evaluate the profile types and the questions connected to these. Additionally, more usability tests could shed more light on the individual profiles – especially the 'professional technical interest'. Furthermore reducing the complexity in language could have a positive effect in some scenarios and question types.

Some of the possible solutions to the issues addressed were not implemented. Mostly because several of these would require redesigning numerous elements of the user interface, or otherwise implement solutions that could potentially reduce the simplicity of conducting an evaluation of the Smart City Use Cases. Easy accessibility and execution was thus preferred in order to create a tool box that allows for non-complicated contribution to the CityPulse project from stakeholders and citizens.

Spreading of the Smart City Evaluation Tool

To get the evaluating feedback from the stakeholders, the Smart City Evaluation Tool has to be spread out to the stakeholders. The project consortium consists of different partner types; universities, municipalities and industries spread over various countries - all with different media channels and access to different types of relevant stakeholders.

Therefore the project consortium will spread the Smart City Evaluation Tool via all the different relevant channels that the consortium has access to at a whole. The following table illustrates the different channels, which target groups will be addressed via the channels based on the three overall stakeholder types as presented in the Smart City Evaluation Tool (Citizens, Technical Professionals, City Stakeholders), the respective countries and cities and the approximate number of recipients. The list does not entail how many recipients will actually answer the Smart City Evaluation Tool but shows how many e.g. "likes" a Facebook page has or how many subscribes there are to a newsletter and so forth.

Channel	Target Group	Country, City	Aprox. number of recipients
Personal twitter twitter.com/mirkopres	Citizens, prof. interested, city stakeholder		500

ser			
Personal Twitter twitter.com/lassesteenbock	Citizens, prof. interested, city stakeholder		11
Alexandra Institute Newsletter	Citizens, prof. interested, city stakeholder	Denmark	1000
Alexandra Institute internal mailinglist	Alexandra employees = prof. interested,	Denmark	100
Alexandra Institute LinkedIN page	Citizens, prof. interested, city stakeholder	Denmark	1566
Alexandra Institute Twitter: twitter.com/AlexandraInst	Citizens, prof. interested, city stakeholder		570
Alexandra Facebook page: www.facebook.com/thealexandrainstitute	Citizens, prof. interested, city stakeholder	Denmark	730
SERA energy & recources e.U. (www.sustain.at): sustainable development company with joint projects in Austria	prof. interested	Austria	

Aspern Smart City Research (ASCR) (www.ascr.at): Smart City project in Vienna	prof. interested, city stakeholder	Austria, Vienna	
Vienna's municipality (www.wien.gov.at): A few people there are involved in Smart City projects	city stakeholder	Austria, Vienna	
MOOSMOAR Energies OG (mmenergies.at): Consultancies in the domain of energy supply and energy management	prof. interested	Austria	
Wiener Netze (www.wienernetze.at) Vienna's energy distribution company	prof. interested	Austria, Vienna	
Blog at www.odaa.dk	Citizens, prof. interested, city stakeholder	Denmark	
ODAA twitter twitter.com/OpenDataAarhus	Citizens, prof. interested, city stakeholder		371
Personal twitter account twitter.com/Michelle_Bach	citizens, city stakeholder		329
Smart Aarhus blog: www.smartaarhus.dk	Citizens, prof. interested, city	Denmark	

	stakeholder		
Smart Aarhus facebook page: www.facebook.com/smartaarhus	Citizens, prof. interested, city stakeholder	Denmark	627
Aarhus Data Drinks Facebook: www.facebook.com/AarhusDataDrinks	Citizens, prof. interested, city stakeholder	Denmark, Aarhus	251
Aarhus Municipality intranet	city stakeholder	Denmark, Aarhus	15.000
City of Brasow Website	citizens, city stakeholder	Romania, Brasow	15.000
Agenda of the Metropolitan Area (published weekly in the local newspapers)	citizens, city stakeholder	Romania, Brasow	10.000
Brasov Metropolitan Agency's Facebook accounts	Citizens	Romania, Brasow	200

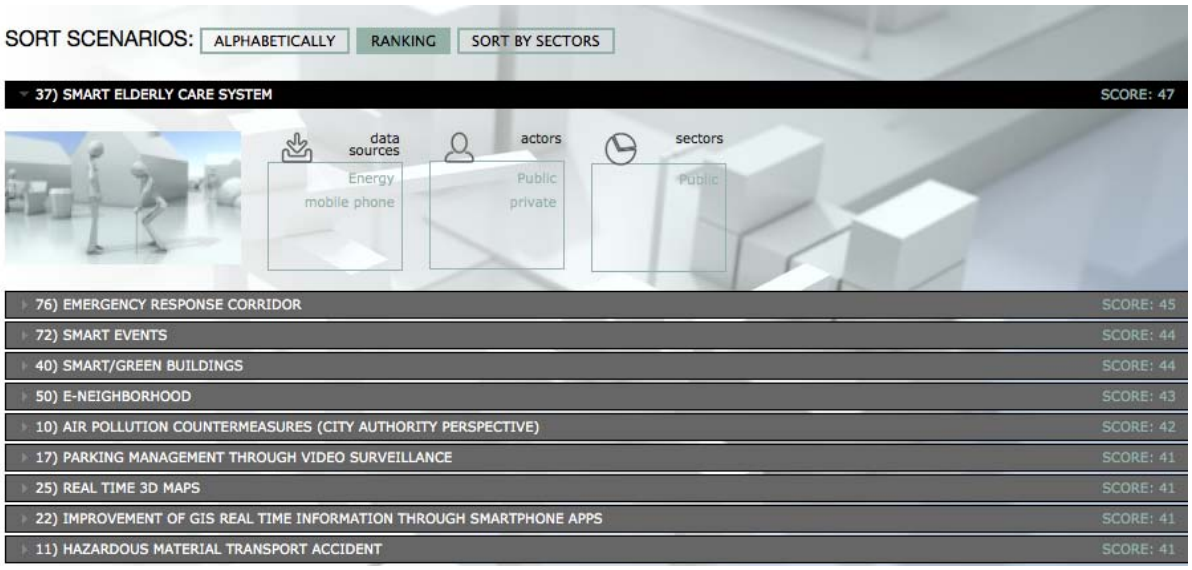
The collection of answers from the relevant stakeholders should be regarded as an on-going process during the whole project period, where the project consortium will revisit the Smart City Evaluation Tool kit as they go along and are ready to implement the scenarios.

By the end of the activity period (end M18) the Smart City Evaluation Tool Kit had received 197 external reviews.

3. Presentation of Top 10 scenarios at the moment

The picture below illustrates the current Top 10 scenarios as selected by nearly 200 external reviewers. This Top Ten should be regarded as a momentary indicator of the most popular use cases as determined by the 197 external reviews. As the CityPulse project strives to work in accordance to agile principles, these use cases will continually be revisited as the number of evaluation reviews increase, which in turn will allow us to directly develop the solutions most valued by the citizens and

stakeholders. The 197 reviews is currently a narrow and focused group of reviewers in the relevant target group. In order to increase the number of reviews, as well as receive answers from a broader segment of the stakeholder communities, Aarhus and Brasov will conduct several workshops with the Smart City Toolkit at later stages of the project.



4. Evaluation and refinement

As the project continues and the project consortium is ready to implement yet another scenario, the project consortium will revisit the Smart City Evaluation Tool to review the scenarios and their ranking and hereafter chose a relevant scenario to implement. Before implementation the scenarios will be evaluated on several KPIs and afterwards refined through interviews with relevant city stakeholders.

Technical KPIs

Before choosing to implement a scenario, the scenario will be evaluated in technical terms with input from the technical partners in the project. Here they will focus on:

- Implementation complexity level
- Interest/relevance for the consortium
- Is the data readily available?

Evaluation based on concrete KPIs

After the technical review the scenario will be evaluated based on concrete KPIs. The following schema is an evaluation template for the Smart City scenarios. The evaluation will be based upon the Smart City Scenario KPIs from WP6 which were the following:

1) Business value
2) Societal value

3) Multiple sectors are addressed
4) Suitability for selected use-case (e.g. utilisation after the life-time of the project).

In addition to the original KPI's, the evaluation template will also try to take into account some aspects of the KPI's from WP2 as can be seen in the following model:

User differentiation	City relevance	Data streaming	Decision support	Big data
How strong is the expected impact in providing value (e.g. economical, social, etc.)?	Is the scenario culturally relevant?	Is the data accessible (pull/push/subscribe/ broadcast)?	How complex is the scenario? (0=simple 3=med 5=high)	Is the data available?
What is the expected uptake?	Is the scenario relevant for citizens?	Is this scenario using a live stream? (Yes/No)	How many data modalities are used? (1=few 3=med 5=high)	Is the scenario scalable?
What is the expected attractiveness and usability?	Is the scenario generally applicable in other cities?	Is there capability in the network to deliver this data stream?	Are there control loops in the scenario? (Yes/No)	What level of privacy consideration does the scenario require?
Is the required data readily and available with the necessary quality and granularity?	Is the scenario relevant for municipalities?	Does the scenario require security (e.g. encryption)?	Is automation included in the scenario? (Yes/No)	
	Does the scenario increase public safety?	Does the scenario require reliability (e.g. data loss)?	Is actuation included in the scenario? (0=no 3=simple 5=complex)	

Not all of these will be accounted for individually, but the evaluation will, without becoming too complex, revolve around a mixture of relevant KPIs. This also means that the two first KPIs (Business value & Societal value) will be rewritten in order to become more contextually relevant.

Example:

Evaluation of scenario 1) 'Context-aware multimodal real time travel planner'

The evaluation will be made quantifiable, and evaluations will therefore be given on a scale from 1-5 with 1 being the lowest score and 5 being the highest.

	The scenario	**Overall**
To what degree will the [scenario/user stories] create growth and value for the private market?	2	2

How much of an impact will the [scenario/user stories] have on the everyday life of citizens?	4	3.5
To what degree is multiple sectors are adressed?	2	1.5
What is the level of suitability for selected use-case after the projects lifetime?	4	4
How well does the [scenario/user stories] take into consideration the aspects of user differentiation?	3	3
How well does the [scenario/user stories] take into consideration the aspects of city relevance?	4	3.5
How well does the [scenario/user stories] take into consideration the aspects of data streaming?	3	3
How well does the [scenario/user stories] take into consideration the aspects of decision support?	4	4
How well does the [scenario/user stories] take into consideration th aspects of big data?	3	3.5

Interviews with City Stakeholders

After selection and evaluation the use cases will further be refined through a number of interviews with relevant City Stakeholders from the City Stakeholder Group to ensure that the scenario is adjusted to fit with the stakeholder's needs.

Each city is to find a relevant person who could have a professional interest in the given use case. In this way each use case will be evaluated across the City Stakeholder Group to ensure that the use case is suited for different cities. The template below illustrates this on scenario 37.

Use case/City	Aarhus	Brasov	Stockholm	Vienna
37: **Smart Elderly Care System**	Interview with Lasse Skjalm, MSO, City of Aarhus	To come	To come	To come

Interview guide

The qualitative method makes it possible to analyse the peculiar relationships that are expressed through in-depth interviews and observations (Alvesson, 1999). The qualitative method can be used by way of individual interviews, focus groups and observation. The greater depth in the qualitative method makes it possible to produce more nuanced data, and create an overall understanding of a phenomenon than with the quantitative method that creates more general images (Kvale, 2009).

Single interviews are chosen based on the view that by using focus groups the possibilities in asking the individual's understanding, perception and experience in relation to the different scenarios will be minimized. This is due to the fact that in focus groups there may emerge consensus, which may cause the respondents to be limited in their opinions (Halkier, 2008).

The interview guide is prepared prior to the interviews, and stands by itself as a basis to the standardized open-ended interview (Patton, 1990) with detailed questions and a thoughtful progression in the order of questions. The approach in the interview situation, however, can advantageously be an open and freer interaction with the interview guide, than the standardized interview suggests. With this in mind the questions below are open so the interviewer can follow up on interesting facts highlighted by the interviewee.

Questions

- Do you understand the scenario?
- How do you understand the scenario?
- What do you think of the scenario?
    - Why?
- What benefits do you see in the scenario?
- What disadvantages do you see?
- Who do you see as the scenario's target group?

- How would you improve the scenario?
- Can you see the scenario improve your daily life?
    - How? / why not?
- Can you see a similar scenario improve your life?
    - What?
    - How?
- How would you rate the scenario from 1-10?
- How would you build the same scenario, if it was entirely up to you?

4. From scenarios to user stories

A user story is the term for an early stage tool used in the common Agile software development process, and more specifically within the region of Extreme Programming. The point of developing user stories is to create several, very simple and short stories about a user's interaction with the functionality of a finalised system (Cohn 2004, Rees 2002). The software development process is notoriously hard to predict, and new features, changes and new time estimations are very common to occur during the entire process. User stories are therefore created at the beginning stages of the development process to ensure a representation of the user requirements of the software. User stories are however agile as to fit the development process, and are not by nature finalised, must have features, and can therefore be thrown away, or if needed new ones can be created during the software development process. They are typically written by stakeholders and not by the developers.

How to write user stories

A good user story must always take into account what is useful to the end user. A user story should therefore not include, as an example, technically relevant aspects to the sprint backlog. The common template for user stories looks as follows:
(http://www.mountaingoatsoftware.com/agile/user-stories#faq)

> As a <type of user>, I want <some goal> so that <some reason>

The "so that <some reason>" part is optional, but can serve the purpose of highlighting the end user's motivation and end goal of the interaction with the system. Additionally the 'I want' is not to be used in a very strict sense, but could also be written as for example 'I can'.
Some user stories are by far too complex to work with iteratively and must be split up into more specific stories. A very general, and complex, user story is called an epic. An epic could look as such:

> As a citizen I want access to all available parking sports so that I can find the best parking space.

This is a complex user story, which does not entail much of the user's interaction with the concrete functionalities of the software. It can thus be divided into several more concrete user stories. Arguably it is always possible to create more and more detailed stories, but this is not the point. The point is to create user stories that are adequately detailed (not too much or too little detail) and are realistic and reasonable.

The difference between user stories and scenarios

The most obvious difference, in regards to the already developed 101 use case scenarios, is the difference in length and detail. A scenario includes settings, actions, plots and events – all of which are excluded in a user story. A scenario can furthermore include several actors whereas user stories consequently have one user in mind. Within a scenario it is possible to create user stories in order to specify users' concrete interactions with particular aspects of the system.

An example will illustrate the difference and also the purpose of user stories. The example is the current leading Use Case of the 101 Smart City Scenarios "Smart Elderly Care System" which looks like this:

"Caroline works for the home care in Aarhus Municipality. Every day she drives the same route to the elderly and provides home care. The municipal Health and Care Department has just implemented a Smart Elderly Care System, which gives Caroline the opportunity to change the routes of the day according to the needs of the elderly. At each home of the elderly several sensors are installed, for example sensors on light switches and water taps. In that way the Health and Care Department is able to see if for example Mrs. Jensen has been at the toilet several times during the night or if she hasn't turned on any light in 24 hours. Given the first example of data they can assume that Mrs. Jensen has some bladder problems and react on that. Given the last example they can assume that something is very wrong with Mrs. Jensen and therefore change the route so e.g. Caroline drives by Mrs. Jensen immediately. From the city's point of view the Smart Elderly Care System could help them provide better elderly care and plan better. From the citizen's point of view the system can provide security and safety - also for the relatives of the elderly."

This scenario has several actors and use situations included, which can all be turned into more concrete user stories. The methodology in creating the user stories has thus far been to find the relevant "user roles" (the different users wanting to complete a desired task) and creating a set of user stories for each one.

User roles:

- Health and Care Department (H&C) worker alerts local home care worker departments of relevant sensor activity or lack hereof.
- Home care worker planning her route based on feedback from H&C.
- Home care worker notifying H&C of action being taken when visiting the citizen.
- Elderly citizen notifying H&C or local home care worker of sensor malfunction or planned activities that will trigger sensors.
- H&C worker gathering statistics in regards to efficiency of the new Smart Elderly Care System.

A set of user roles have now been established. Possibly more of these can be created, although it is important not to create user roles for every single set of interactions there might be in the interaction with the system, as this will create an immense and boundless amount of complexity when reviewing the user stories. For each user role we will create an "epic" and several user stories for this epic. The creation of these is a result of personal opinion, ideas and imaginations of the crafter. For example, I have assumed that there could potentially be a person working for the H&C

department looking at the data, while this could also be completely automated in the finalized design concept.

User stories:

Role: Health and Care Department (H&C) worker alerts local home care worker departments of relevant sensor activity or lack hereof.

The epic: As a H&C worker, I want to easily gather an overview of relevant incoming sensor activity and redirect this information to the local home care departments.

- Looking at feedback from sensors in elderly citizens homes, I want an interface that grants me easy and non-complex access to an aggregated information tree of each sensor, for each address, in each local home care department and the designated home care worker responsible for said citizen.
- Sending out relevant information of sensor feedback to the designated home care worker, I want to include my own written text in the message to the home care worker, so that the complexity can be reduced.
- Sending out relevant information of sensor feedback to the designated home care worker, I want to be able to easily send out a standard message of "no urgent sensor activity as of last night in the home of mr. X", so that neither H&C or the local home care worker will waste time checking data from each home.
- Sending out very urgent feedback from sensor activity, I want to include an alert or notification to the local home care department, so that they will know to respond fast.
- Reading sensor activity from different homes, I want access to feedback from the citizen, if he or she has reported a malfunction or plans on conducting activity that will disrupt the sensors, so that ressources are not wasted when misinterpreting sensor data.

Role: Home care worker planning her route based on feedback from H&C.

The epic: As a home care worker, I want to be able to access all relevant information of sensor activities from citizens in my care in a structured and easy to use interface, either via my computer or mobile device.

- Checking in at work in the morning, I want to quickly gather an overview of feedback from H&C about sensor data from the homes of citizens in my care, so that I can determine which citizens are in the need of a visit sooner rather than later.
- Reading the feedback from H&C, I want to be able to access personally written information from the H&C worker stating for example "The sensors read that mrs. Jensen has been to the toilet 10 times this morning, but she was only cleaning her toilet and had to flush many

times – there is no urgency", so that I won't rush over to a citizen when there is no need for haste.

- Planning my route, I want the system to automatically arrange for certain visits to be at the top of my list, if certain predetermined sensor activity has been registered (for example, no movement in the last 12 hours), and automatically integrate this on a list of residences I have to visit.

Role: Home care worker notifying H&C of action being taken when visiting the citizen.

The epic: As a home care worker, I want to easily report that urgent sensor activity has been responded to.

- Responding to urgent sensor activity, I want to quickly give feedback through a predefined set of functions such as a click on a physical button on the sensor in the house, via my smartphone or something similar, so I won't have to report back in detail if no further action is required and thus saving time.

- As a home care worker, I want to easily be able to report sensor malfunction to H&C and my local home care department.

Role: Elderly citizen notifying H&C or local home care worker of sensor malfunction or planned activities that will trigger sensors.

The epic: As a citizen, I want to easily communicate with H&C or my local care department, that the sensor activity might not be accurate.

- Seeing a sensor isn't functioning right (such as no battery life), I want to communicate with my local care department in a way that is accessible and doable to me, such as through an audio conversation, a physical "malfunction" button in my house or similar.

- Knowing how my sensor work, I want to notify my local home care department if I know I will be conducting activity that will disrupt the sensors when I'm inside my house in a way that is accessible and doable to me (audio contact with a H&C worker for example).

- Knowing my sensors will alert the H&C personel, I want to notify them easily, if I know I will be away from my apartment in a while (family visits, holidays, prolonged trip somewhere), so they won't react to the sensors not registering any activity in a while.

Role: H&C worker gathering statistics in regards to efficiency of the new Smart Elderly Care System.

The epic: Working within the H&C department, I want easy access to statistical data presented in a visual manner that reduces complexity.

- Looking at statistics for a certain neighborhood, I want a visual presentation of each household on a map, and the number of urgent sensor activity, non-urgent activity, malfunctions etc., so that I can quickly discover patterns of relevant activity.

- Looking at statistics for each household, I want easy access to data on feedback from local home care workers when responding to irregular sensor activity, so that I can find insights into whether or not the system functions correctly and efficiently.

This is an example of how we have conducted the process of creating user stories and the result hereof. The user stories will provide early ideas of functionalities that must be addressed when designing complex systems such as these use cases. For a next iteration of use cases (for new scenarios) it would be relevant to include the actual users or stakeholders of such systems, and have them create said use cases.

6. Conclusions and plan for implementation of scenarios

The overall goal in WP6 is to select a number of relevant use cases to be implemented. This report has presented the tools for the selection of the scenarios. As stated in the introduction cities are organic and ever changing, and therefore an agile process where the CityPulse project consortium goes through this selection process during the whole project duration ensures that the chosen and implemented scenarios are aligned with the stakeholders, to best accommodate the stakeholder's needs.

We have now initiated the development process, where we have selected the first scenario for implementation (Scenario 37 – smart elderly care system). What we are doing now is creating wire frames and use cases. As of this writing those are being defined and soon the use cases will be broken down into tasks for actual implementation – development is started march 2015. We will refine the methodology and procedures as we go along. Experience says that it's best to use the development tools that fit the particular development team.

We aim for developing three prototypes per six months. We won't make production ready implementations; it will only be show cases that SMEs or project partners can develop further on. If we were going to create a full blown production ready implementation, the implementations wouldn't be as scalable or eligible to other cities

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