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Deliverable D6.1
"Use Case implementation and validation plan"

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DEFINITIONS

Pilot project A pilot project is an initial small-scale implementation that is used to prove the viability of project ideas. This could involve either the exploration of a novel new approach or idea or the application of a standard approach recommended by outside parties but which is new to the organisation. The pilot project enables an organisation to manage the risk of a new idea and identify any deficiencies before substantial resources are committed[1].

Use Case A use case is a description of how a person who actually uses a process or system will accomplish a goal. It's typically associated with software systems, but can be used in reference to any process. A use case helps you understand where errors could occur in the process and design features to resolve those errors. Three elements that a use case must contain[2]:

- **Actor**, which is the user, which can be a single person or a group of people, interacting with a process
- **System**, which is the process that's required to reach the final outcome
- **Goal**, which is the successful user outcome

User story In software development and product management, a user story is an informal, natural language description of one or more features of a software system. A user story is a tool used in Agile software development to capture a description of a software feature from an end-user perspective. A user story describes the type of user, what they want and why. A user story helps to create a simplified description of a requirement[3].

Scenario A (usage) scenario, describes a real-world example of how one or more people or organisations interact with a system. They describe the steps, events, and/or actions which occur during the interaction[4].

[1] https://www.apm.org.uk/resources/find-a-resource/what-is-the-difference-between-a-trial-and-a-pilot/
[2] https://study.com/academy/lesson/what-is-a-use-case-definition-examples.html
[3] https://www.visual-paradigm.com/guide/agile-software-development/what-is-user-story/
[4] http://www.agilemodeling.com/artifacts/usageScenario.htm

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List of abbreviations

Abbreviation	Explanation
2D	Two dimensional
3D	Three dimensional
AI	Artificial Intelligence
AIV	Information Flanders Agency, now Digital Flanders
API	Aplication Programming Interface
cvs	Comma-Separated Values
DMS	Digital Surface Mode
DoA	Description of Action
DTM	Digital Terrain Mode
DUET	Digital Urban European Twins
ENG	Engineering
GDPR	General Data Protection Regulation
GIPOD	“Generiek Informatieplatform Openbaar Domein”/ Information consultation platform regarding cables and pipes in the underground
GRB	“Grootschalig ReferentieBestand”/ Flemish large scale base map
GTFS	General Transit Feed Specification
IMEC	“Interuniversitair Micro-Electronica Centrum”/ Interuniversity Micro-Electronics Center
IoT	Internet of Things
IT	Information Technology
KBO	“Kruispuntbank van Ondernemingen”/ Crossroads Bank for Enterprises
KR	Key Result
LOD2	The level of detail (LOD) concept of the OGC standard CityGML 2.0
MAGDA	Name of the Flemish platform which enables technical access to personal data (not an abbreviation, Dutch for “May I?”)
NIC	“Nationaal Intermutualistisch College”/ concertations of Health Insurance Funds
OSLO	Open Standards for Linked Organisations
OSM	OpenStreetMap

PC	Personal Computer
PDF	Portable Document Format
POI	Point of interest
RIZIV	"Rijksinstituut voor Ziekte- en Invaliditeitsverzekering"/ Belgian Institute for Health and Disability Insurance
RR	"Rijksregister"/ Belgian population register
RSZ	"Rijksdienst voor Sociale Zekerheid"/ Belgian Social Security Service
SANT	Santander
SDG	Sustainable Development Goals
SHP	Shapefile format
Statbel	Statistics Belgium
TEC	Technalia
UC	Use Case
URL	Uniform Resource Locator
VAPH	"Vlaams Agentschap voor Personen met een Handicap" / Flanders Agency for Persons with Disabilities
VMM	"Vlaamse Milieumaatschappij"/ Flanders Evironment Agency
WHO	World Health Organisation
WP	Work package
XML	Extensible Markup Language
YTT	Yesterday – Today – Tomorrow

1 Executive Summary

Deliverable 6.1. focuses on the implementation and validation plans of the pilot use cases. This deliverable is the starting point to realise the *Urbanage* pilot solutions and agile developments. This deliverable is based on the outcome of the co-design workshops that are part of Work Package 2, tasks 2.1, 2.2 and 2.3.

Santander focusses on two pilot cases. The goal of the first case is to provide **comfortable routes for ageing people** by developing an age-friendly route planner (app or external URL, still to be defined). The comfortable route considers different variables, such as streets' conditions, obstacles, urban furniture, noise, temperature among others. For this first case, four use cases were worked out in detail, involving (older adult) citizens, civil servants and politicians. Integrated age-friendly features include route planning, warning of incidents, the simulation of incidents and the evaluation of the impact to citizens for better planning of maintenance operations.
The core of the second case is a **simulation tool for long-term urban planning**. Seven use cases were worked out, addressing public administration, civil servants, politicians, the older people´s community, companies and other private organisations. Features include the development of the simulation tool, the establishment of an age-friendliness index, multicriteria analysis, the prioritisation of areas to be investigated, simulation of future scenarios, the visualisation of strategies & objectives and the access to urban planning info. As Santander has no previous digital twin installed, these use cases implemented associated tools will form part of Santander's new digital twin enabling beneficious functionalities since its beginning

The **Flanders** Digital Twin will focus also on two cases. In the first case, a **Green Comfort index** will be defined for older citizens. Ten user stories were worked out for this case. This case requires 4 roles: website visitors, users with an account, experts/specialists with an account and administrators. With an account, extra role-specific functionalities will be available, such as gamification and simulation tools. The target group is very broad, ranging from citizens to qualified specialists. Features for this case include the establishment and evaluation of the dynamic green comfort index score, the presentation of the scores and their components on 2D- and 3D-maps, management of account and preferences, simulation of city adjustments (gamification), data export, reporting (by dashboards), uploading/updating of datasets, monitoring of server and software and the creation of cases on an external platform. The second case focuses on the improvement of decision-making processes by setting available broadly accessible datasets (**age distribution and the distribution of people with a reduced physical mobility**). These data layers can be easily combined with existing datasets and models or data driven applications.

Helsinki will focus firstly on a case and new method to collect **accessibility-related feedback,** generated by citizens using **physical IoT-devices** and/or a browser-based feedback interface. The procedure and the IoT devices are designed in an age-friendly way. The resulting data will be visualised on a live, customisable browser-based map view. The second Helsinki case is quite similar to the first Helsinki case with the difference that specifically Point of Interest data concerning pleasant/enjoyable zones for older people will be gathered. Data visualisation and management methods will be fine-tuned together with city officials. The third Helsinki case focuses on updating and iterating existing Travel-time matrix for the Helsinki metropolitan area. The

current version was developed in 2018 and doesn't take into account the needs and requirements of older people. Attribute data will be added, regarding the accessibility of senior citizens.

Last but not least, a technical validation approach is proposed to set up a quantitative and qualitative validation framework to test the *Urbanage* solutions. This validation framework will also provide the necessary input to fine-tune the developments during the *Urbanage* developments and the project life cycle.

2 Introduction

Deliverable 6.1 describes the cases and use cases (user stories) as elaborated by the pilots, crossing local needs, gathered from civil servants and older people in WP2, and data availabilities. Together, all cases contribute to the final realisation of the *Urbanage* goals as described in the Description of Action document. The document is the starting point for further, mainly technical, analysis and development process (WP4) that will run until month 30 in the project. This deliverable is the result of task 6.1 use case scenarios Design and Planning that is closely tight to T6.2 implementation and T6.3 validation that will run until the end of the project. The www.citytwin.eu Digital Twin platform as an outcome of the DUET project can be extended as a communication platform to present the *Urbanage* Digital Twin use cases.

This deliverable is based on the outcomes of the co-design workshops that are part of Work Package 2 tasks 2.1, 2.2 and 2.3.

Chapter 3 outlines the Santander pilot case related to providing comfortable routes for ageing people and providing a simulation tool for long-term urban planning.

Chapter 4 covers the Flanders pilot case, focusing on the creation of a green comfort index, addressed to older citizens.

Chapter 5 describes the functional design of the Helsinki case, gathering accessibility-related feedback from older citizens.

Finally, chapter 6 focuses on the set up of a validation framework to be used during the design and development phase of the *Urbanage* use cases. The user validation and testing will comprise qualitative and quantitative indicators.

3 Santander

3.1 Use case approach, goals and outcomes

Santander has a higher proportion of older people (25%) than the regional average (22%), which is already one of the highest in the country (Spain has a value of near 20%, data of 2020). This proportion is expected to be increased in the following years. This scenario is producing demand in services at the local authority for improved and new public services to the general public to all the aspects of the city, from which liveability and city friendliness could be good examples.

As many other cities, Santander has started to put in place different measures to soften the difficulties experienced by older adults in several aspect of their daily life like mobility, and since 2012 the city has been member of the WHO Global Network of Age-friendly Cities and Communities. Additionally, the city council has participated in several projects, including EU funded innovation projects to actively search, identify and test the applications of innovative technologies. This may lead to a scenario with exponentially growing demand while the increase in resource capacity has a linear and limited growth.

Several more concrete actions have been carried out, as the creation of new facilities to improve the mobility. The hilly nature of Santander makes it difficult for people to move in some transversal directions and easier in longitudinal ones. This special orography not only makes these movements difficult but also prevents the municipal bus transport service from adequately covering this demand. The impact on citizens is important but is logically greater for those who have special mobility difficulties such as the older adults.

In order to solve this problem, an important number of mechanical ramps, escalators and elevators have been installed in recent years that have been very well received by the citizens and specially, by the older ones. However, as it will be seen below, the concepts of age-friendliness and liveability in the city go beyond infrastructures that ease the physical difficulties of mobility.

These concepts are determined by an important set of factors, many of which are already well known from local government and public administration officials in general. In this context, the following needs have been identified:

- to contrast the existing knowledge of municipal decision-makers with the vision of the real users of the city, the citizens and, in particular, of those groups clearly most affected, the older people;
- to optimise new investments, once the clearest decisions on setting up new mobility facilities (escalators, etc.) have been taken, with the aim of fine-tuning the balance between impact and investment as much as possible, in an economic scenario with a significant limitation of resources;
- to increase transparency in decision-making, helping decision-makers to make informed decisions while stakeholders can gain a better understanding of the criteria that have been used and the results that have been achieved.

In order to meet these needs, it becomes clear that technologically advanced tools are needed to satisfy all stakeholders in a specific, customized and personalized way. As described above, the **citizens** have a strong demand for improved liveability in the city. The current context of the city and its characteristics have different degree of impact for each population segment. One of these segments is the **older adults** who, due, among others, to the process of ageing, have a diminished physical capacity to cope with the obstacles they face in their daily lives. However, there are others segments of the population, not directly associated with age, such as **people with reduced mobility**, which need to be considered. In this sense, it is worth highlighting the concept of degree of impact on the different segments of the population, a factor to be taken into account in the development of any action.

In contrast to the above, the needs of those involved in making decisions about the city and those who must implement those decisions must be considered. It is important to highlight that these needs are directly related to their professional responsibilities and this is a factor that impacts on their awareness and expectations on the results.

Indeed, two important stakeholder groups must be considered. The first of these would be **politicians** and **high-level civil servants**. The socio-economic context in which this group has to work creates new challenges and demands for them. First, decisions become more complex, and the optimisation of solutions becomes more and more important. Secondly, there is a challenge in the growing f accountability of their decisions, in a society that is becoming more knowledgeable and more willing to participate in decision-making.
To properly achieve the above-mentioned projects and initiatives, **civil servants** must have tools that allow them to carry out their responsibilities easily and more efficiently.
The expected outcomes pursued can be divided into three aspects:

- on the **social side**, it is important that public investments are made with the highest possible degree of optimisation, seeking for a fair and legitimate balance between the different stakeholders and areas of the city and with the greatest possible transparency in all processes, but mainly in decision-making.
- on the **political side**, having the capacity to make informed decisions, with adapted upcoming information and adapted values of parameters, to the level of responsibility of the civil servants. e.g. appropriate level of data abstraction allowing them to be more effective within the political agenda and timing.
- On the **communication side**, in addition to the transparency mentioned above, there are additional important aspects. The initiatives taken within the *Urbanage* project are other examples of the city council's commitment to improve municipal services and create new services adapted to the current innovative technological context, and particularly with the Smart City concept, to which Santander has been committed since 2010. The co-creation activities developed in the project make citizens aware not only that the city council takes their opinions into account on an ongoing basis and not only in specific situations, but also that a greater degree of participation is required on their part in the provision of their needs and their points of view, working to share responsibility in the development of the city and in the search for and implementation of solutions to the new challenges that arise. The activities and the general results of this project can set an example of the way to tackle new initiatives and also an example of good practice in the development of responsibilities of public administrations.

To achieve those expected outcomes, information like the number of impacted people, segmented by age groups or other features, is considered as one of the key elements. Then, different set of data should be gathered according to each case needs.

These datasets are very heterogeneous, both in terms of their characteristics and their degree of usefulness with the use cases to be implemented. Important aspects are related to their nature, to their temporality, whether there are static (not expected to vary in the medium or long term) or dynamic (data vary in short time, including those varying in real-time), their degree of privacy, their technicality, administrative and legal availability, etc.
Additionally, when addressing each use case, it is necessary to define the degree of importance of each dataset, considering the goodness (validity, accuracy, trustworthiness) and scope of the models to ensure proper performance of the digital twin as a whole.

Therefore, it is important from a technical point of view, in keeping with the requirements and with the availability of data, to elaborate a **data catalogue** that allows to analyse the current situation and to set the objectives to be achieved. Then, the gap that needs to be filled is clearer. This data catalogue, with the aforementioned characteristics, will make possible to establish priorities in the tasks to be carried out, evaluating the progress at any moment, and build a roadmap for the tasks to be carried out from now on.

Finally, concerning the data to be included in this catalogue, it is necessary to ensure the viability of the use case in accordance with the resources, the deadlines and the general objectives set. As Santander is starting the project without a digital twin, an approach has been chosen in which each dataset can have a different level of granularity. In this sense, 3 target urban areas have been identified in which the digital twin should gather as much information as possible, in at least one of them. There are the following:

- “Entrehuertas” at the southern slopes of “General Dávila” street (District 3), census sections from no. 03.002 to 03.009 and from 03.013 to 03.014;
- “Barrio del rey”, close to the downtown, full census sections no. 02.008, 02.009 and 02.013;
- “Arrabal de fuera” between “Vargas” and “Alta” streets (District 6), the full census section no. 01.011, and partially 06.004, 01.009 and 01.010.

These three areas have been chosen because their characteristics, especially for their need of urban regeneration. In fact, one of them is included in a specific action plan within the municipality and the other two are of great interest in the new urban planning action under development.

Figure 1: Santander pilot – areas of interest

3.1.1 Participation process approach

In the prior months of the elaboration of this document, an active stakeholder participation process has been developed, as described in D2.2 and D2.3. The main objective of this participation process has been to verify and/or enhance the definition and scope of the use cases proposed in the proposal stage through a set of systematic activities.

The use cases initially defined for this project are based on existing knowledge and experience of the municipality, which mainly comes from the civil servants. Therefore, these use cases have been considered with a high degree of interest and well refined. However, as knowledge and experience are more concrete, it becomes necessary to present it to the stakeholders for evaluation.

In this sense, a series of meetings have been held with representatives of the following stakeholder groups in a series of sessions:

- senior citizens;
- neighbourhood associations;
- associations identified as particularly relevant in the senior citizen's segment;
- civil servants with responsibility for or knowledge of services to citizens.

From July to October 2021, as part of the WP2 activities, and according to the designed approach reported in WP2 deliverables, the following meetings were held:

- Focus group with senior citizens and relevant associations within the older people segment (in particular, widows' association), held in July 2021, with 13 attendees and carried out according to the methodology elaborated in WP2. This activity aimed to identify the aspects of participants' daily life in the city that concern them the most, trying to identify f the municipal services and infrastructures they value the most and those where shortcomings need to be resolved or improved.
- Three co-creation activities:
  - Co-creation with senior citizens involving older people, neighbourhood, and widows' associations, carried out in September 2021, with a total of 9 attendees. In this activity, the aim was to identify participants' needs, challenges and opportunities in the defined use cases and their roles in tackling them.
  - Co-creation with civil servants, carried out in September 2021, involving 8 municipal workers. In this activity, the aim was to map existing initiatives, challenges, collaborations and data, in order to establish links between user requirements and data sources and models. The following services (as departments are named within the municipality) were involved:
    - citizen participation;
    - municipal health service;
    - urban planning;
    - municipal financial intervention;
    - police;
    - IT;
    - innovation.
  - Co-creation with a mixed group, consisting of senior citizens and civil servants, with a total of 8 participants and held in October 2021. In this activity, the aim was to achieve a close cooperation between pairs formed by senior citizens and civil servants by analysing common routes in the city and contrasting the different points of view.

A comprehensive report of the methodology, details of the activity and findings of these activities is provided in WP2 deliverables D2.2 and D2.3. Nevertheless, it is worth noting in this document that the objectives set for this participation have been achieved and the results obtained have been positive and have provided valuable inputs to the activities within the scope of WP6, as it will reported in this section.

During the activities carried out, it has been possible to confirm with stakeholders the general interest of the use cases, but also to enrich the use cases with elements that directly impact on their requirements. It also has been possible to identify important data such as the need for public toilets, benches or shaded areas or protection from rain, elements that will be incorporated into the data catalogue. Other important data identified is that the type of pavement and not only its condition is important for the mobility of senior citizens in cities.

On the other hand, although mobility by bicycle, linked to bicycle lanes, is not a matter of particular need for senior citizens as it is not their main means of transport, they have shown that they need to be safe from users of bicycles and, above all, electric scooters. The above outcomes are just a small set of examples of findings.

3.1.2 Pilot case 1 - Age-friendly -route planner

3.1.2.1 Description and goal

This scenario would be framed in what we can call the short term, insofar as the actions can be developed and the impact can be obtained and evaluated within a short period of time.

The initial approach of this use scenario is based on the fact that senior citizens are more sensitive than the rest of the population to any difficulty or barrier in the city. They are also the most affected by any temporary activity that may modify their mobility habits.

With this in mind, there are a number of actions that can be taken to improve the user experience in the city for senior citizens. All of them can be integrated into a planning and support tool for senior citizens in the city. This tool would integrate two fundamental elements.

On one side, it would be a **route planning tool** adapted to the particular needs of each citizen. It is well known that it is not possible to consider all **senior citizens** with common and standard characteristics. Certainly, in this segment of the population, age is a determining factor in their capacities and resources in aspects such as mobility, without undermining others, such as cognitive aspects. This produces an important diversity of needs, which need to be more refined when defining requirements by disaggregating needs to a greater degree. Examples in the area of mobility could be people who can move around but tire quickly, people who need assistive devices such as canes or those who move around in wheelchairs. We cannot forget, however, that there are more aspects in which citizens may have impaired abilities such as visual impairment, etc. The tool must integrate not only the ability to customise its functionality for different groups but also incorporate the precise data that allows for the correct performance for all of them.

On the other hand, we must be aware that people's routes through the city are often constant and related to habits maintained over significant periods of time. Recurring activities such as going to do the daily shopping, going to a medical centre or attending an activity in a civic centre, give rise to the definition of precise and constant routes, chosen at some point in the past, conditioned by citizens' abilities and city's infrastructures. If at some point, any of these parameters change, these routes will be modified. In the event that the capabilities of senior citizens change (e.g., they start using crutches temporarily or permanently), it is the user itself who can actively change his personal settings in the tool. However, when something changes in the city, such as the beginning of a construction work in a street, a breakdown in an escalator, a change of position of a bus stop or bus line service, etc., the user should receive this information in the form of an incident alert so that he/she can make a decision to take the alternative route offered, change his/her schedule or suspend the

activity he/she had planned. In this case, the tool must take an active attitude and provide interesting and adapted information as well as providing interesting information for the older people.

The use case includes the possibility for information to flow in both directions, so that users can also provide information about problems they encounter at certain points along their daily route as well as make suggestions.

Additionally, from **civil servants'** point of view and among them, those **responsible for municipal services**, information on the routes that are most popular or used by users together with the number of users on those routes is of great value in providing better services to the citizen. Indeed, this information together with infrastructure usage timing information, from hourly to annual, allows to better plan activities in the city producing a better service to the citizen.

For instance, if it is planned to carry out civil works in a street, the better time to do it can be analysed and the activities scheduled in order to minimize the number of citizens affected. Even more, if an activity can be carried out in a set of alternative places, the selection of the place can be done with least number of senior citizens affected. A deeper analysis can be made when planning these activities evaluating the alternative routes available for the senior citizens and, if they are not considered acceptable, give rise to put in place countermeasures to soften the impact. Clearly, a deep knowledge of the impact of any decision improves the quality of the decision.

During the **participation process** this use case has been validated and well received by all the participants. The main findings to improve the use case have been related to the elements to be considered when developing the tool. So, an **enhancement of the use case has taken place** mainly based on the elements and factors that affect the senior citizens. In this sense, numerous elements have emerged in the discussions, such as benches, public fountains, public baths, etc. As different meetings have been held with different participants, it has been possible to verify the repetition of some elements, which increases the significance of the results obtained despite the limited scope of these participation activities. This information serves not only to add additional data requirements to those initially identified, but also to establish priorities in their integration to the data catalogue and into the tool.

This widening of the scope of the use case has not only come from senior citizens but also from civil servants. During their specific meeting, the need to share data among different municipal services has been identified. This is not a new element because the silo approach that municipal services have in most cities is well known and that is something that all of them, including Santander, have been working on with specific activities and projects. However, the fundamental contribution that has been obtained is that specific elements and data have been revealed to transfer from some services to others and aimed at the use case target citizen's segment. This is particularly important for being transferred into requirements.

3.1.2.2 Involved personas

Although the civil society can be considered the main stakeholder for this use case as the final recipient of the benefits it can bring, there are others that are worth highlighting. In the following paragraphs a review of the involved stakeholders giving some insights about their involvement is included.

- **The older people´s community:**
  The main target of the use case is the **older people´s community**. However, categories can be expanded to those with reduced mobility or, in general, with any of their physical or social capacities permanently or temporarily reduced.
  Furthermore, it cannot be forgotten that, although senior citizens are considered the main objective because they are the most impacted by the problems raised and the benefits that the use case can bring, in general, the use case benefits the entire community. For example, it is clear that a breakdown in an escalator affects all citizens who use it differently, but what is certain is that it affects everyone to some degree.
  The main objective is to improve the user experience in the city. Citizens must perceive those municipal services are attentive to their needs and take care of them.

- **Municipal civil servants:**
  We consider within this group municipal workers who are in charge of the daily operations of municipal services, including from technical staff to senior officials who have responsibility for decision-making.
  It is known that the demand of citizens for better municipal services is increasing and unfortunately it is not possible to grow public resources in accordance with these needs. In this context, sustainability and efficiency are paramount. Any tool that facilitates decision-making in the shortest time possible for a public official is of benefit to citizens. In addition, the greater knowledge of the civil society' needs will lead to better service and better use of available resources.

- **Politicians/Decision Makers:**
  Politicians have the responsibility to make the more significant / largest decisions in the development of the city. These decisions have a major impact as they affect both citizens in their daily lives and municipal civil servants in their work. This impact has a great impact in the city but they are usually made for the medium-term perspective, whereas some decisions have larger scale effects. In this context, the availability of information on the daily functioning of the infrastructure and the activities of the citizens in the city are of particular importance to be able to make the right decisions to match both aspects: resources with needs. In addition, accountability to citizens is more appropriate when informed decisions are made and the data that led to those decisions can be shown. In that sense, citizens can better understand the decisions made by being more aware of the difficulty of those decisions and those responsible for executing those decisions can be better aligned with them by having a more technical component.

3.1.2.3 Expected outcomes

Studies show that a regular physical activity helps older people to stay fit, prevent common diseases and loneliness. In addition, daily activities and obligations prevent frailty and social isolation. Hence the importance of seniors getting out and continuing their daily activities.

In this context, a system that facilitates mobility within the city is expected, mainly on foot, thanks to a planning tool that will include incident alerts. The system should provide the following functions:

- find routes between specific places in the city minimizing mobility difficulties and take into account the particular needs of citizens, in particular those related to mobility, and provide additional information about the reasons a particular route is recommended to the user;
- integrate an input communication channel that rely on incidents warning municipality system, out of the scope of this project, in urban infrastructures that hinder or impede paths/trajectories in the city, either in global city mobility (e.g. an incidence at the main entrance of the city) or for certain identified movements (e.g. a breakdown in an escalator). The flow of information of incidents will be bidirectional between City Council and the users;
- simulate incidents on certain infrastructures in order to evaluate their impact on citizens. Selecting the infrastructures according to the schedules and the nature of incidents will facilitate the measure of the impact, with the aim to minimize it., e.g., to delay the execution of a work in a street until a certain date, to schedule maintenance operations on a specific day of the week or at specific hours, etc.;
- produce reports with information about the demand and utilization of the different infrastructures based on the effective use of the system.

Regarding the different outcomes categories:

- **Social goal-related**
  An improvement in the transparency and efficiency of the functioning of the municipal services that influence citizens' mobility on foot, establishing a channel of communication adapted to the day-to-day needs of citizens and in particular of those particularly affected by changes and incidents in the city's infrastructures. This will increase daily outings in the city and the perception that the city is attentive to their needs and problems.

- **Policy related**
  From the point of view of public officials better and more efficient management of municipal and citizen-oriented resources and faster decision making. From the point of view of politicians, a progress in the development of Santander as a Smart City and an example of a good practice in the use of technology at the service of citizens and public officials.

- **Communication/co-creation/co-design related (storytelling, gamification)**
  Although many activities related to the use of technology for the improvement of public services have been developed and the city of Santander is committed to its development as Smart City, it is necessary for all stakeholders that a real impact can be seen in the city. This has been achieved previously with other initiatives, but it is necessary to develop new scenarios in the definition of a process of continuous improvement and expansion of municipal services under improvement.
  This use case is one of those examples of improving public services to citizens in one of the aspects that can have the greatest transcendence such as mobility. Mobility is an area that has a great impact because it multiplies the effect of the number of citizens affected by the daily frequency of actions. Furthermore, as mentioned above, although the improvement of mobility affects citizens in general, the use case has been oriented to a segment of the population with an even greater sensitivity, demonstrating that it is possible to carry out actions for certain groups with bigger vulnerability.
  In addition, the use case will reinforce the communication channels with citizens based on the technology to be used. Besides the usual channels of communication in line with today's society (social networks, web, etc.,) the City of Santander is currently developing a city App oriented to the service of citizens and visitors of the city. The use case can become part of this tool if it has the right features establishing synergies with other parallel activities that are being carried out. This App has a very broad set of components with which bidirectional communication links can be established. These results will improve the co-creation processes with citizens based on the information they provide.

3.1.3 Pilot case 2 - Simulation tool for long-term urban planning

3.1.3.1 Description and goal

The Santander City Council is currently developing the new general urban development plan. This plan will govern the development of the city in the long term. One of its objectives is to provide a solution to current problems and define, with concrete elements, the main lines on which the evolution of the city will be based in the coming years. It must also be a harmonious and flexible instrument of development that will also address the problems that are currently known and will affect the city in the coming years, but also the ones that are still unknown or with no major impact.
This plan will address a set of challenges that are common to cities of the same scale as Santander such as sustainability, the strong growth in demand for better and new municipal services in a context in which resources are not growing proportionally, etc. Additionally, it should emphasize those problems that are particular to the city or that have a higher-than-average incidence and that, therefore, must be solved at the local level. In the case of Santander, the two particular elements of importance have already been mentioned: the complicated orography and the aging of the population above the average of its surroundings.

For all these reasons, urban planning is something complex, of great impact (in terms of time and depth) and in which a multitude of general factors coexist (e.g., what will be the areas of urban expansion of the city and the new road networks needed) and particular factors (e.g., where the playgrounds, benches and other street

furniture will be located). To perform this task correctly, it is essential to have an in-depth knowledge of the current situation, not only from existing technical data but also from the point of view and ideas provided by the citizens who are ultimately the users of the city. This provides the current needs and serves as a basis for defining future needs.

In addition, urban planning should be an instrument for shaping the intentions and policies for the future of the city, something that is the responsibility of politicians and senior officials. Although there are subjective elements in decision making by decision makers, there is one factor that can and should be substantially improved. This factor is the existence of objective information based on the most real and updated data of all the elements involved, which will make it possible to reliably establish the consequences of all the possible alternatives that may be chosen.

Currently, there is a significant amount of static information and also a wide range of data with a greater or lesser degree of frequency of updating. Besides the data available with greater reliability and a higher update frequency, it is necessary to it integrate in a common repository. This tool is currently under development in Santander and is called the Santander Smart City Platform. When completed, it will be a central information point for the city where information on the operation of municipal services will arrive and will provide the necessary information to all municipal services that need it, breaking with the traditional silo approach with which municipal services usually operate in cities. This Platform will have reporting systems and dashboards, adapted to all levels of responsibility and decision making to allow analysis and, if necessary, decision making, through a system that is as simplified as possible.

The development of the **digital twin** that is carried out in this project is the perfect complement to this Platform since it focuses on a fundamental aspect of the city context, such as urban planning, and through a system that allows to exploit the available data in the optimal way to provide the consequences of all those alternatives that are desired. The digital twin will be able to provide simulations that provide information on the segments of the population affected by each type of decision, in its multiple aspects, and on the degree of affection. This will make it possible to focus attention on those segments most in need or most vulnerable. The scope, reliability and detail of the outcome information provided by a digital twin goes beyond the tools currently available or in the pipeline as its simulations can incorporate real, live city data and can provide results with greater granularity.

During the participatory process that has been carried out within the URBANAGE project, it has been possible to contrast the vision of municipal officials, including those directly involved in the development of the new general urban plan with the real vision of citizens, especially that of senior citizens.
During the workshops and co-creation sessions, it became clear that in order to carry out high-level planning, the details of the citizen's day-to-day life must be taken into account. Many elements have been detected which, although not unknown to urban planners, confirm their vision or introduce a scale of priority in the actions and measures to be taken in the future. In this aspect, given that the population segment considered is around a quarter of the population of the city and with an upward trend, it has been very positive to make a special action with them, in addition to others that have been done with other stakeholders in the new urban planning.

3.1.3.2 Involved personas

As in the previous use case, citizens in general are again the main stakeholder in this use case since they are the final recipients of the benefits it may provide. However, the degree of interest of different segments of citizens in addition to other stakeholders where the use case has a significant impact can be analysed in more detail:

- **The older people´s community**

  As mentioned in previous paragraphs this stakeholder group is perhaps the most important because it is the largest and where the benefits will have the greatest impact. In general, we can cite as aspects to highlight the greater knowledge about the decision-making processes carried out in the city, the greater degree of transparency and trust in decision-makers, the improvement of infrastructures and in general of the experience in the city, and the optimization of public investment based on data and decisions with a greater objective component.

  As for the population segments affected, it is necessary to highlight that, given the long-term nature of the use case, the situation becomes more complex than in the previous case since the temporal component of the actions and their consequences must be considered. However, it can be intuited that in addition to the segment of the population of older adults that was of special importance in the previous case, now also takes prominence that of not so old adults who, with the evolution of time, will enter the segment of the population with greater sensitivity and affection.

  On the other hand, in addition to age, there is another factor worth analysing in order to segment the population, and that is the area of residence. Indeed, in this use case, related to urban planning, the areas of the city, and more specifically its neighbourhoods, will have different benefits depending on where they are located and, therefore, their interest in the results will be greater. In this aspect, neighbourhood associations take on a special role, as they are the instruments through which citizens have the greatest capacity to exert pressure on municipal policies.

- **Municipal civil servants**

  In general, civil servants are the ones in charge of executing the different actions and tasks associated with the high-level decisions made. It is very similar to what has been explained in use case 1 but now in a more medium-long term approach.

- **Politicians/Decision Makers**

  Their main interest is to have the ability to make decisions in a more **informed and objective manner** and greater technical support in their decision making. However, the availability of a tool where the process parameters are more adapted to their level of decision making is also important (technical ones can be more difficult to understand and more complicated to process in high-level decision making).

  Additionally, the decision-making process will have an increase in transparency, an increasingly important requirement in society and one that, moreover, is being supported by laws that progress in this aspect.

- **Companies**
  Acquiring knowledge of the city's strategies and objectives that allow them to align their businesses, establish longer-term plans for their businesses, and make investments early and accurately. Transparency in management provides them with greater security that decreases risk and thus encourages investment and economic growth.

- **Entrepreneurs**
  Increased knowledge of the environment for the medium and long term within its most direct environment allows the creation of business opportunities. In today's knowledge-based economy, structured, reliable and accessible information is of vital importance for the creation of new business models. Although the digital twin, in principle, will not be directly accessible outside the municipality, the data will be and this can foster the concept of the data economy, where each set of data can have a value and can be consumed or generated.

- **Other public and private administrations**
  Santander being the capital of the region of Cantabria, a good part of both regional and state public administrations are centralized in the city. The city, therefore, has the profile of a city of services and attraction of administrative and political activities not only for the citizens of Santander but also for all the citizens of the region. Likewise, the city has a university hospital called "Marqués de Valdecilla" which is a reference for its surroundings and constitutes an important part of the health-related activity of the city and the region. In addition to this, the city hosts the University of Cantabria, the European University of the Atlantic and the International University "Menéndez Pelayo", which organizes summer courses. These are just a few examples of the entities that may be affected by the decisions made in the context of this use case.

3.1.3.3 Expected outcomes

What is expected, in general, is a tool, which allows decision-makers and technicians to make **informed decisions** regarding the evolution of the city, both in urban planning, including infrastructure, furnishings and other elements such as civic centres.

In more details this tool is expected to:

- allows a **multi-criteria analysis** to perform a global qualification of each area of the city, with different degrees of grouping: district, neighbourhood, streets. The groups will be based on a series of objective and updated data in a way that allows an abstraction and an integration of the different aspects in a systematic and technical way;
- have the capacity to **simulate future scenarios**, making it possible to compare different alternatives on the basis of a set of specific or established parameters by means of a multi-criteria analysis. The multi-criteria analysis must be parameterized at a high level so that different levels of abstraction and generality can be established. This will allow each of the decision-makers to have decision-making capacity through the selection of the values of these parameters and within their scope. Technicians will have parameters adapted to their level of competence. Likewise, outputs must be established that

allow the scope of the results to be understood at all levels, for example, if a general plan is being made, the citizen can analyze, in a simple way, which parameters have been taken. This results in transparency and in a more global and less particular decision making;

- is aligned with national or international **reference indicators**, in particular, those indicators that are derived from the WHO Age friendly cities indicators and SDGs and from what has been established as friendliness with the older people. There should be a vocation for these indicators to be adapted or increased as national and international policies evolve. There should always be standardized references in order to be able to compare other cities and measure the current state and the state of progress.

With respect to the different points of view:

- **Social goal-related outputs**

  The use case will result in increased transparency and a higher degree of confidence in the decision-makers because this multi-criteria simulation tool will give decision-makers objective and well-founded data.

- **Policy related outcomes (evidence-based)**

  This use case, as mentioned above, will have an impact on urban policies in the medium to long term, as it coincides with the development of the Santander new General Urban Plan, the digital twin will help to simulate different scenarios, in a way that will help to make decisions that will have a direct impact on the citizens.

- **Communication/co-creation/co-design related outcomes (storytelling, gamification)**

  Promoting initiatives and best practices within the ecosystem of Santander and its Smart city strategy that the city started in 2010, in order to continue using technology as a tool for the improvement of public services.

3.2 Pilot case 1: age-friendly -route planner

3.2.1 Pilot case overview

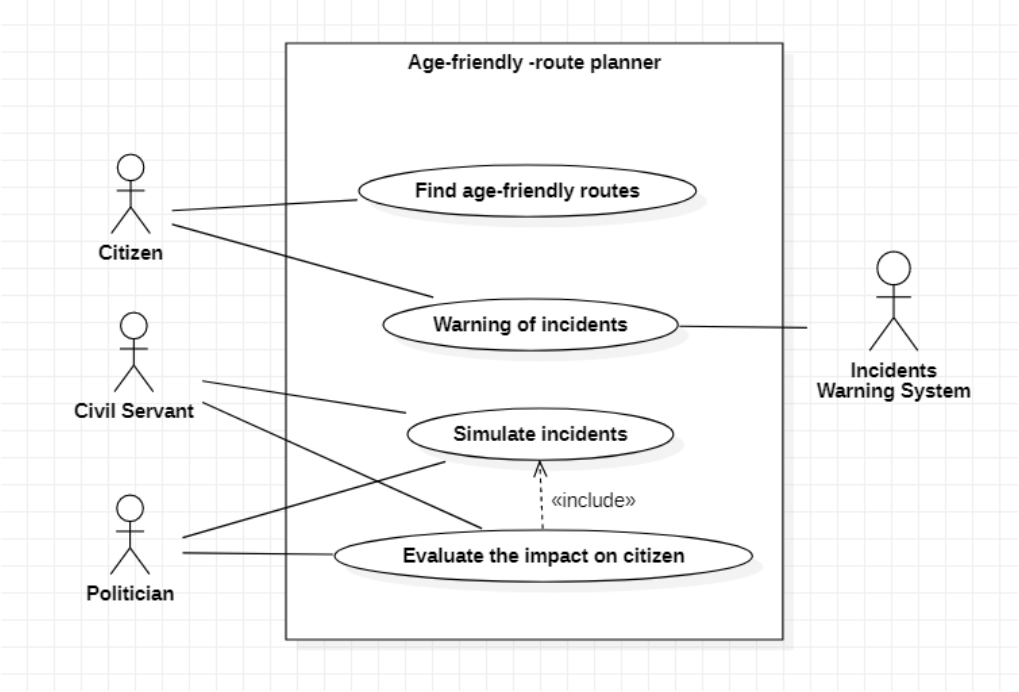


Figure 2: Santander pilot case 1 - age friendly route planner

3.2.2 User story details

3.2.2.1 User story 1: Age-friendly -Route planner

Nr + Name	UC1 - Age-friendly -route planner.
Goal	provide comfortable routes for ageing people.
Description functionalities	The comfortable route considers different variables, such as the conditions of the streets, obstacles, noise, temperature, urban furniture among others.
Actors involved	Citizens.
Pre-condition	User selects the use case via mobile app or external URL (to be defined).
Post-condition	None.

Table 1: Santander - Pilot case 1 - user story 1 - definition

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
Actor launches the Comfortable-route planner case via mobile app or external URL (to be defined).	System loads the system settings related to the different features considered in the use case for route planning.
	System shows the map based on the system settings.
Actor selects an origin and destiny and the features that must be considered for the route planning.	System shows the most comfortable route to go from origin to destiny considering the selected features.

Table 2: Santander - Pilot case 1 - user story 1 - main success path

Alternate Path	A1	
ACTOR ACTIONS	SYSTEM RESPONSE	
User want to edit its personal settings in the tool.	System provides a user form to edit their personal settings.	
User asks for additional information about the recommended route.	System provides additional information about the reasons a particular route is recommended to the user.	
User asks for information about the location of some elements in the route.	System provides interesting information for the older people, such as location of benches, toilets, fountains or shaded areas.	

Table 3: Santander - Pilot case 1 - user story 1 - alternative path A1

Functionalities	**Description**	**Role**
Features selection.	Select the variables that must be considered in the use case.	
Route planning.	Provide a route taken into account the selected features.	
Route visualization.	Visualize the optimal comfortable route.	

Table 4: Santander - Pilot case 1 - user story 1 - functionalities

3.2.2.2 User story 2: Warning of incidents

Nr + Name	UC2 - Warning of incidents.
Goal	To be informed about incidents in urban infrastructures that hinder or impede path/trajectories in the city.
Description functionalities	Older adults can be informed about incidents in urban infrastructure in their daily routes. Users should receive this information in the form of an incident alert. The functionality takes advantage of incidents warning municipality system, out of the scope of this project.
Actors involved	Older adults in particular and citizen in general.
Pre-condition	User has installed the required app and has configured his/her settings.
Post-condition	The user will be informed by the end of the use case.

Table 5: Santander - Pilot case 1 - user story 2 - definition

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
User presses enters the application.	System sends a notification to the users to confirm the subscription to receive alerts.

Table 6: Santander - Pilot case 1 - user story 2 - main success path

3.2.2.3 User story 3: Simulate incidents

Nr + Name	UC3 - Simulate incidents
Goal	To simulate different incidents in critical infrastructures of the city in order to minimize the impact in citizen in general and older adults in particular.
Description functionalities	Municipal civil servants and politicians can simulate the consequences of specific incidents in critical infrastructures.
Actors involved	Municipal servants, Politicians.
Pre-condition	The user is registered and logged with the required credentials to use this functionality.
Post-condition	The incident will be registered in the system by the end of the case study.

Table 7: Santander - Pilot case 1 - user story 3 - definition

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
User presses select the “simulate incidents” in the app.	System provides the user a form to collect data about the incident to simulate.
User provides information about the incident and its location (selection from a pre-defined list of incidents).	System provides the results of the simulation.

Table 8: Santander - Pilot case 1 - user story 3 - main success path

3.2.2.4 User story 4: Evaluate the Impact on Citizen

Nr + Name	UC4 – Evaluate the impact on citizen.
Goal	Minimize impacts on citizen due to incidents or maintenance operations in urban infrastructures.
Description functionalities	Identify priority days or hours to carry out maintenance operations.
Actors involved	Municipal servants, Politicians.

Pre-condition	The user is registered and logged with the required credentials to use this functionality. The simulation of the consequences of a specific incident in critical infrastructures has been performed.
Post-condition	None.

Table 9: Santander - Pilot case 1 - user story 4 - definition

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
User selects the functionality of "evaluate the impact of an incident".	System provides the user a form to collect data of the incident.
User selects the incident and the location where the incident take place.	System triggers the UC#3 Simulate incident.
User visualize the results and the impact of the simulated incidences.	

Table 10: Santander - Pilot case 1 - user story 4 - main success path

Alternate Path	A1	
ACTOR ACTIONS	SYSTEM RESPONSE	
User asks for information about most popular routes.	System provides a report with information on the routes that are most popular and the number of users using those routes.	

Table 11: Santander - Pilot case 1 - user story 4 - Alternate path A1

3.3 Pilot case 2: simulation tool for long-term urban planning

3.3.1 Pilot case overview

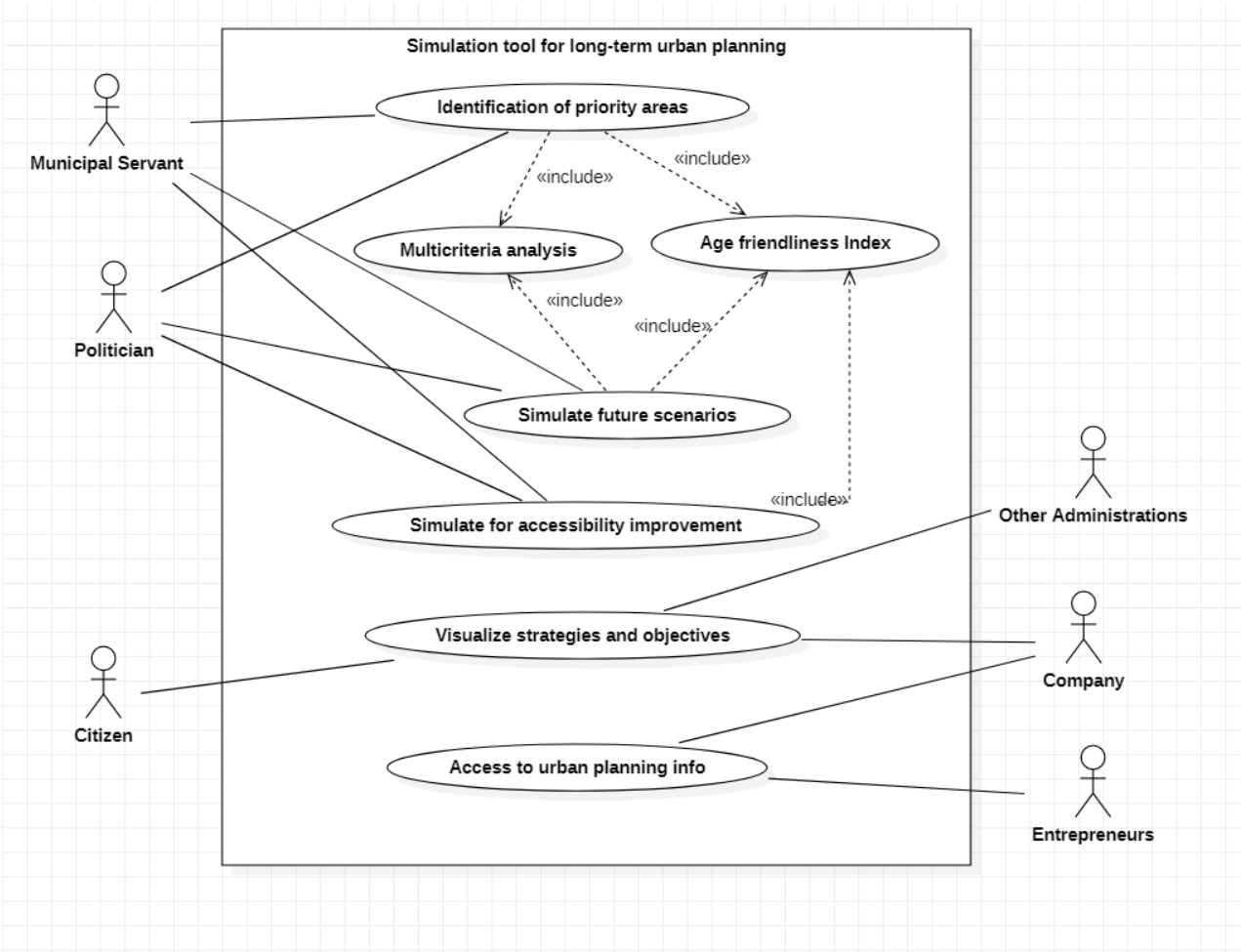


Figure 3: Santander pilot case 2 - simulation tool for long-term urban planning

3.3.2 User story details

3.3.2.1 User story 5: Simulate for accessibility improvement

Nr + Name	UC5 – Simulate for accessibility improvement.
Goal	To measure the age friendliness neighbourhood index and provide urban accessibility improvements.
Description functionalities	To measure the age friendliness neighbourhood index and provide optimal places to install a mechanical ramp or a lift in order to minimize the route time or maximize the comfort of the route for ageing people.
Actors involved	Public administration.
Pre-condition	User selects the use case via mobile app or external URL (to be defined).
Post-condition	None.

Table 12: Santander - Pilot case 2 - user story 5 - definition

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
Actor launches the simulation tool for long-term urban planning case via mobile app or external URL (to be defined).	System loads the system settings considered in the use case for long-term urban planning.
	System shows the map based on the system settings.
Actor selects a neighbourhood.	System calculates the age friendliness neighbourhood index. (UC#6)
Actor selects to improve the age friendliness neighbourhood index of a specific neighbourhood.	System provides the long-term urban needs in this neighbourhood to improve the age friendliness neighbourhood index.
Actor selects the option to install mechanical ramp or a lift in a neighbourhood.	System provides the optimal places to install mechanical ramp or a lift in order to minimize the route time or maximize the comfort of the route for ageing people.

Table 13: Santander - Pilot case 2 - user story 5 - main success path

Functionalities

Functionalities	Description	Role
Neighbourhood selection.	Select the neighbourhood that must be considered in the use case.	
Age friendliness neighbourhood index calculation.	Provide the age friendliness neighbourhood index.	
Long-term urban improvements of a neighbourhood.	Show the urban needs that must be cope with to improve the age friendliness neighbourhood index.	
Optimal places to install mechanical ramps or lifts.	Provide the optimal places to install mechanical ramp or a lift in order to minimize the route time or maximize the comfort of the route for ageing people.	

Table 14: Santander - Pilot case 2 - user story 5 - functionalities

3.3.2.2 User story 6: Age friendliness Index

Nr + Name	UC6- Age friendliness Index.
Goal	Evaluate the age-friendliness index of a selected area (municipality, district, etc.).
Description functionalities	Evaluate the age-friendliness index.
Actors involved	Municipal servants, Politicians.
Pre-condition	The user is registered and logged with the required credentials to use this functionality.
Post-condition	None.

Table 15: Santander - Pilot case 2 - user story 6 - definition

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
User or external system request for calculation of age-friendliness index.	System collects data for the calculation of the index.
User or external system provides details about the area for the calculations.	System calculates the age-friendliness index for the selected area.

Table 16: Santander - Pilot case 2 - user story 6 - main success path

3.3.2.3 User story 7: Multicriteria analysis

Nr + Name	UC7– Multicriteria analysis.
Goal	To Assess the effects, performance or impact of different alternatives with different criteria.
Description functionalities	Consult age friendliness index of the current situation in a parameterized way Compare the age friendliness index for different alternatives.
Actors involved	Municipal servants, Politicians.
Pre-condition	The user is registered and logged with the required credentials to use this functionality.
Post-condition	None.

Table 17: Santander - Pilot case 2 - user story 7 - definition

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
User selects the “multicriteria analysis” in the tool.	
User visualizes a map with the results of index and the scenario.	
User analyses the index through a multi-criteria analysis.	System performs the multi-criteria analysis according to the selected parameters and provided weights.

Table 18: Santander - Pilot case 2 - user story 7 - main success path

3.3.2.4 User story 8: Identification of priority areas

Nr + Name	UC8 - Identification of priority areas.
Goal	To identify the priority areas for transformation through qualification of the areas of the city.
Description functionalities	Visualize the age friendliness index for the different areas of the city. Consult the details of the different dimensions of the index. Multicriteria analysis.
Actors involved	Municipal servants, Politicians.
Pre-condition	The user is registered and logged with the required credentials to use this functionality.
Post-condition	An area of the city is selected for deeper analysis or scenario simulation.

Table 19: Santander - Pilot case 2 - user story 8 - definition

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
User selects the “identification of priority areas” in the tool.	System triggers UC#6 to evaluate the Age-friendliness index of the whole municipality.
User consult the details of the index for the different areas of the city.	System triggers UC#7 to perform a multicriteria analysis of the index.

Table 20: Santander - Pilot case 2 - user story 8 - main success path

3.3.2.5 User story 9: Simulate future scenarios

Nr + Name	UC9 – Simulate future scenarios.
Goal	Simulate alternatives for urban planning and compare them through a multicriteria analysis.
Description functionalities	Select alternatives for urban transformation. Compare the age friendliness index for different alternatives.
Actors involved	Municipal servants, Politicians.
Pre-condition	The user is registered and logged with the required credentials to use this functionality. The area has been selected as priority area for transformation.
Post-condition	Results of the simulation are analysed and considered for the definition of urban planning.

Table 21: Santander - Pilot case 2 - user story 9 - definition

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
User selects the “simulate future scenario” in the tool.	
User provides information about the scenario to simulate.	System triggers UC#6 to evaluate the Age-friendliness index for the selected area and the information of the scenario to be simulated.
User consult the details of the index and compares with the current situation.	System triggers UC#7 to perform a multicriteria analysis of the index.

Table 22: Santander - Pilot case 2 - user story 9 - main success path

3.3.2.6 User story 10: Visualise strategies and objectives

Nr + Name	UC10 – Visualise strategies and objectives.
Goal	Identify city's strategies and objectives to take into account and align personal or commercial plans for citizen and companies. Increase the transparency is also an additional and important goal.
Description functionalities	Acquiring knowledge of the city's strategies and objectives. Increase the degree of confidence in the decision makers. Contrast the vision of municipal officials with the citizens.
Actors involved	Older people community, Companies, Other public and private administrations.
Pre-condition	The user is registered and logged with the required credentials to use this functionality.
Post-condition	None.

Table 23: Santander - Pilot case 2 - user story 10 - definition

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
User selects the "visualize strategies and objectives" in the tool.	
User visualizes a map with the strategies and objectives defined in the urban planning.	
User provides feedback and comments about the strategies and objectives.	The system registers the inputs provided by the users

Table 24: Santander - Pilot case 2 - user story 10 - main success path

3.3.2.7 User story 11: Access to Urban planning info

Nr + Name	UC11 – Access to urban planning info.
Goal	Provide access to the intentions and policies for the future of the city.
Description functionalities	Acquiring knowledge of the city's strategies and objectives.
Actors involved	Companies, Entrepreneurs.
Pre-condition	Urban planning information is generated and made accessible through web service or similar.
Post-condition	None.

Table 25: Santander - Pilot case 2 - user story 11 - definition

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
User access to the service where the information is available.	System checks the requirements to access the information.
User provides details and credentials to access this information.	System provides the information about the urban planning.

Table 26: Santander - Pilot case 2 - user story 11 - main success path

3.3.3 Required datasets

For the efficient development of the above-mentioned functionalities, the AI algorithms developed will required the use of some specific data sources. Here we list some of the most important ones:

- *Cadaster (SHP file):* with the geometric representation and representative attributes of buildings and other urban elements of the city. The height of the building or the number of floors is a mandatory attribute to model the building in 3D. In case none of these attributes is available it will be derived from the elevation maps;
- *Elevation Maps*: Digital Surface Model (DSM) and Digital Terrain Model (DTM) can be processed and combined with building footprints in the *cadaster* map in order to calculate the height of the buildings;

- *Open Street Maps*: the OSM file is essential for building the street map of the city, and for building the graph that is used by the AI engine for calculating routes;
- *GTFS files*: these files are crucial to obtain information about public transportation routes, including information about the stops, services, and many other aspects. It is not clear if this concept will be considered, but in positive case, these GTFS files will be crucial;
- *Digital Mesh or LIDAR files for altitude calculation*[5]: these files obtained from an official public repository are used in order to calculate the altitude of the different points of the city. This information about the altitudes can also be obtained in Geotiff format[6].

Furthermore, the following information will be required to properly provide the functionalities listed in 3.3.1:

- *Active road works and calendar of maintenance works*: this information would be used to avoid users to go through streets or services that are impossible to cross or unusable;
- *Information about the urban furniture*: it is compulsory to count with a data source that informs about the placement of the whole urban furniture spread over the city (elevators, mechanical ramps…benches, public toilets);
- *Lighting of streets*: this information could be a perfect adding for planning safe routes;
- *Air quality* : this information will be crucial for planning routes that go through non-pollutant streets;
- *Paving type of streets*: the type of the pavements would be useful for accessibility purposes;
- *Street's occupancy*: this information could be useful for planning routes that avoid street without people (less safe) and prioritize going to semi-crowded streets (which feel much safer).

Lastly, we can find some preliminary data sources in the current version of the Santander's Open Data platform[7] that can provide some of the information described in this section. Here we list some of these data sources.

Data Source	Description	Comments
Induction loop data	This data contains the traffic information provided by the inductive loop sensors spread over the city.	This data could be useful for calculating the streets occupancy and for estimating the pollution. In any case, for contemplating this functionality the data source should be polished and amended.
Location of magnetic loops	This resource provides the exact location of the magnetic loops using the Control Center Municipal Traffic to regulate traffic and traffic lights programming.	This data could be useful for calculating the streets occupancy and for estimating the pollution. In any case, for contemplating this functionality the data source should be polished and amended.

[5] http://datos.santander.es/ - last visit: 4th October 2021.
[6] https://centrodedescargas.cnig.es/CentroDescargas/index.jsp - in modelos digitales de elevaciones
[7] http://dwtkns.com/srtm/

Historic – Induction loop data	This data set provides historical data from the last seven days of measurements carried out by the magnetic loops and using the Control Center Municipal Traffic to regulate traffic and traffic light programming.	This data could be useful for calculating the streets occupancy and for estimating the pollution. In any case, for contemplating this functionality the data source should be polished and amended.
Metereological Data	This dataset provides information about real time measurements from different sensors located in the city of Santander related to the environment, light, noise, temperature…	Usable for calculating the temperature of the streets, noise and air. In any case, if this data source will be used, it should be updated in real time.
Movil sensors_environmental measurements	This dataset shows real time information of the environmental measurements made by the sensors equipped in the Public Transport Vehicles, and maintenance of the city used by the Santander City Council for its daily management. The data is provided by Orion Context Broker, from the Fiware platform.	We can find here information about the CO, NO2 and temperature. It is interesting, but its update frequency makes it completely obsolete. It should be updated.
Waste Containers	This resource provides information about the waste containers operating in the Municipality of Santander. Among other data, it offers information on position, capacity, and even measurements of the built-in sensor.	This source should be further studied in order to know which containers are really usable. The frequency of update is acceptable.
Irrigation Sensors	This dataset provides information on measurements taken by sensors distributed in the city of Santander about soil humidity, relative humidity, wind speed…	In sense, this data could be very interesting, but it is currently obsolete, with only few data, and few measures.

Table 27: Santander pilot - required datasets

3.3.4 Requirements

3.3.4.1 Functional requirements

ID	Requirement	Related Use Cases
SANT_FUN_REQ#01	To find routes between points in the city that minimizes mobility difficulties	UC1
SANT_FUN_REQ#02	To allow customisation of the functionality for different groups and characteristics of the citizens	UC1
SANT_FUN_REQ#03	To incorporate the precise data that allows for the correct performance for all of the user types.	UC1
SANT_FUN_REQ#04	To provide additional information about the reasons a particular route is recommended to the user.	UC1
SANT_FUN_REQ#05	To change the personal settings of the user in the tool.	UC1
SANT_FUN_REQ#06	To provide to the user information when something changes in the city in form of an incident or alert	UC1, UC2
SANT_FUN_REQ#07	To provide interesting information for the older people, such as location of benches, toilets, fountains or shaded areas.	UC1
SANT_FUN_REQ#08	To integrate an input communication channel that takes advantage of incidents warning municipality system	UC2
SANT_FUN_REQ#09	To produce reports with information on the routes that are most popular and the number of users using those routes	UC4
SANT_FUN_REQ#10	To provide information on the times, from hourly to annual, when an infrastructure or a route is used	UC4
SANT_FUN_REQ#11	To simulate different incidents in urban infrastructures	UC3
SANT_FUN_REQ#12	To evaluate the impact on the citizens of the incidents or works in urban infrastructures	UC4
SANT_FUN_REQ#13	To provide the optimal places to install mechanical ramp or a lift to minimize the route time or maximize the comfort of the route.	UC5
SANT_FUN_REQ#14	To perform multi-criteria analysis for a global qualification of each area of the city (at different scales such as district, neighbourhood or street).	UC7, UC8, UC9

SANT_FUN_REQ#15	To calculate and visualize the age friendliness index at different scales	UC5, UC6, UC8, UC9
SANT_FUN_REQ#16	To simulate future scenarios	UC5, UC9
SANT_FUN_REQ#17	To compare different alternatives or scenarios by means of a multi-criteria analysis.	UC8, UC9
SANT_FUN_REQ#18	To select and modify the parameters for the multi-criteria analysis.	UC7
SANT_FUN_REQ#19	To analyse the results of the simulation in a simple way to be understand by citizen.	UC10
SANT_FUN_REQ#20	To allow external users (e.g. companies or entrepreneurs) to consume data about the urban planning.	UC11
SANT_FUN_REQ#21	To provide access to external users (e.g. companies, citizen or other administrations) to the strategies and objectives.	UC10

Table 28: Santander pilot – functional requirements

3.3.4.2 Non-functional requirements

No information is available for at this phase of the *Urbanage* project for the Santander pilot.

4 Flanders

4.1 Use case approach, goals and outcomes

4.1.1 Participation process approach

As part of the business analysis, a number of meetings were organized with representatives of:

- the care and health department;
- several Flemish towns and cities;
- and the older people[8] community.

Unfortunately, **public servants** active in the health domain were over questioned and occupied with the Covid-19 pandemic. They were very interested but have no time and resources to actively participate in this project. Nevertheless, they helped us to finetune the scope of the cases, especially for the case on *city services planning for older people*.

Flanders bears 300 towns and cities, spread over 5 provinces. 13 of them are defined as **central cities**. After a first prospection round with representatives of the central cities, 4 cities were selected to cooperate in the *Urbanage* project; Roeselare (1), Ghent (2), Turnhout (3) and Leuven (4), marked in dark green on the image below. Also, the non-central city of Tielt was selected (marked in blue).

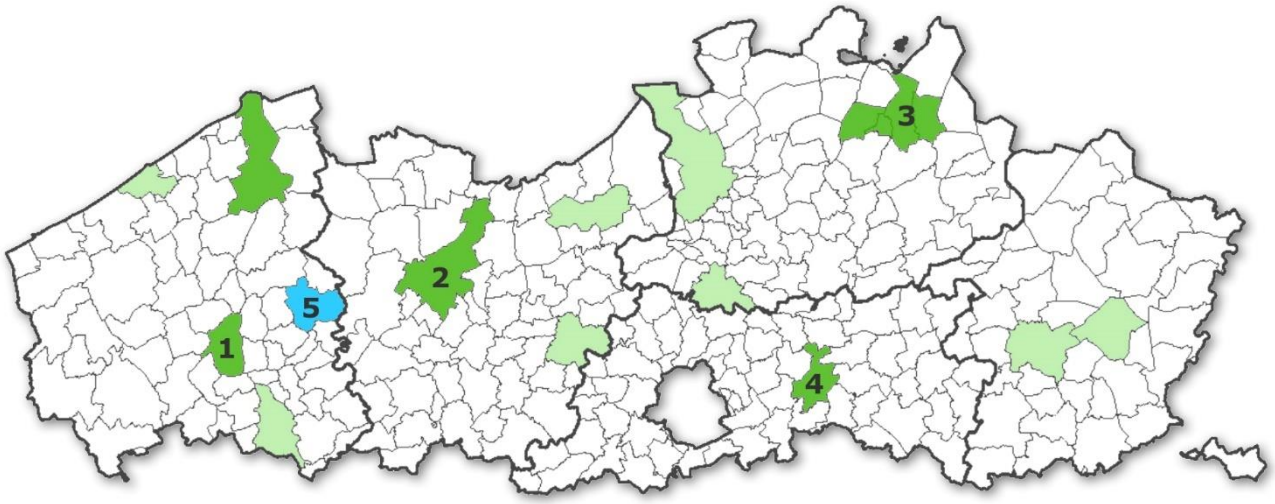


Figure 4: the 13 Flanders central cities in Flanders with highlight of the 5 cities participating in the Urbanage project

Also for **older people organisations**, there was quite some restraint to cooperate due to the Covid-19 pandemic, nevertheless we could organise some feedback sessions with some representatives.

[8] https://www.age-platform.eu/publications/short-guide-avoid-stereotypical-communication-when-talking-about-ageing-and-older

A series of meetings and workshop were organised in close cooperation with IMEC, as part of WP2. Twelve potential interesting high-impact scenarios, spread over 6 themes (health & wellbeing, physical accessibility, social experience, living and mobility) were defined and refined as a starting point. Twelve scenarios meeting the needs as addressed by field experts and being in line with the overall *Urbanage* philosophy.

During a **first workshop**, the twelve pre-set scenarios were presented, explained and discussed with representatives of the five selected central cities. As a result of the workshop, three scenarios were selected as most relevant.

1. The *heat stress* scenario;
2. The scenario of *city services planning for older people*;
3. The scenario of the *introduction of a mobility score* for older people.

After extensive internal analysis of the quality of available expertise & datasets and of feasibility of the roll-out, it was decided to only continue with the two first scenarios.

Both scenarios were worked out and concretised (based on personas) during a **second Miro interactive workshop** with the city representatives. This resulted in two well-defined cases. Also, a first fit-gap analysis exercise of desirable and available local and governmental datasets was done.

Finally, the two withheld mature cases were presented to the representatives of the older people community. Valuable feedback was gained and processed to optimise some aspects of both cases. The most important update is the broadening and redefinition of the *heat stress* case to a *green comfort* case.

4.1.2 Pilot case 1 - Green Comfort

4.1.2.1 Description and goal

Extreme heat is unhealthy for the human body and especially hazardous for older people as reported by the WHO [1]. Recommended actions to be taken in cases of extreme heat include [2]:

- keep out of the heat: Spend 2–3 hours of the day in a cool place. Avoid strenuous physical activity. Stay in the shade;
- keep the body cool and hydrated.

The impact of heat waves on daily hospitalisation and mortality rate was investigated in 24 Flemish care facilities [3]. As a main conclusion, heat waves seem to have an adverse effect on mortality. The impact of extreme heat events is expected to increase as a result of global warming and population ageing. Our attention must be directed to high-risk groups, including older people, anticipating the heat waves. Also, health protection strategies need to be developed to protect older people during extreme weather conditions.

Besides heat stress, another important element contributing to mental and physical health & comfort of older people was pinpointed by representatives of the older people community as a result of the interactive workshop organised by IMEC and Digital Flanders: the availability/proximity of relaxing & refreshing **green infrastructure zones and blue infrastructure elements** and the **accessibility** & **comfort** of these areas in a broad sense. We call the whole of all these measures: **green comfort**.

In the framework of the *Urbanage* project, we see a relevant contribution of digital twin technology to increase the green comfort of the minds and bodies of older people. We see the following digital twins' aspects to be relevant parameters in defining the green comfort :

- the identification of **shady places** (streets, squares, market places, parks, …) in the city, created by buildings as well as by trees. But also the identification of heat islands, to be avoided by older people;
- the availability of **green** (trees and other greenery, stand alone or organised in parks, forests, …) as well as **blue infrastructure** such as pools, ponds, rivers, canals but also fountains. Besides the relaxing effect, these elements are also refreshing factors [4];
- the availability of **street furniture** (benches, tables, toilets, lighting, fountains, drinking fountains), increasing the comfort/quality of relaxation zones;
- good **accessibility** of the green comfort zones. With qualitative walking routes, roads & sidewalks/pavements (with street furniture resting points) reachable and accessible for older people with limited mobility;
- the application of **artificial intelligence** to analyse satellite/aerial imagery (Open Access Hub - copernicus.eu + yearly Flanders high resolution aerial images) and Google Street View image analysis (mapping by IMEC). Helping to calibrate, improve and expand existing datasets.

Based on these parameters, a **green comfort index value** will be attributed to areas in the city. Defining the weight of each parameter and the interaction of all parameters will be a major challenge of the green comfort Flanders case.

Besides the automatic allocation of the green comfort index value, we plan to allow older people in the cities to make some adjustments of the index values. Based on their feedback, recalculations and factor weight updates can be performed (using artificial intelligence) to **optimise** the green comfort index value.

In the framework of policy participation and co-creation, we also plan to stimulate interaction between older people and policy makers by making use of **gamification elements**.

4.1.2.2 Involved persona's

For the green comfort case we see two main target groups.

- The **older people community:**
    - can find relaxing, refreshing and comfortable green zones in their city that are accessible/reachable using our *Urbanage* solution. This can be a digital map on a smartphone/tablet/laptop, as well as a printed poster in the common area of a residential care centre;
    - can give feedback to improve the determination of the green comfort quality index, making the *Urbanage* solution more accurate;
    - is invited to participate in policy decision making and co-creation, making use of various feedback and gamification techniques that will be introduced. The community can make suggestions to the placement of street furniture, they can vote on predefined scenarios, they can mark and comment places where green comfort is lacking, lagging or failing, and they can interact with each other by rating and commenting existing comments.

- **Policy- and decision makers:**
    - can consult *Urbanage* maps to find out:
        - where trees, shade and water elements are lacking;
        - where to plant new infrastructure that is accessible/reachable for (disabled) older people and increasing the green comfort;
        - what kind of infrastructure is needed;
        - where green comfort is missing.
    - can create scenarios and invite the older people to participate in decision making;
    - can consult the feedback of older people, helping them to take supported & democratic decisions.

4.1.2.3 Expected outcomes

Social

Older adults are at increased risk for **loneliness and social isolation** because they are more likely to face factors such as living alone, the loss of family or friends, chronic illness, hearing loss, and reduced mobility.
Also, studies have shown that maintaining regular physical activity helps older people to keep fit and to **prevent many common diseases**, such as heart disease and diabetes.

That is why it is important that the older people stay active, including by **going outside regularly**. As confirmed by the outcome of the workshop with the older people community, the availability and quality of walks in the neighbourhood is a major concern. The Flanders *Urbanage* green comfort case wants to address this concern,

by helping older adults not to suffer of loneliness and stay in shape mentally and physically, as well as by providing tools to stimulate and facilitate comfortable, refreshing and healthy mini-excursions into their neighbourhood.

Policy (evidence-based)

Older adults are not always well-organised groups, they are often isolated individuals who are hard to reach. That is why they are often insufficiently taken into account or simply forgotten at the level of policy and decision making.

The Flanders *Urbanage* green comfort case helps policy and decision makers to take measures to improve the green comfort of older adults. The *Urbanage* solution provides policy-related solutions from different angles:

- indirectly, the generated maps can help policy makers to make decisions to improve the green comfort for older people in their city;
- directly, but in a more passive way, policy makers can consult the suggestions and feedback, given by individual older people using the *Urbanage* solution;
- directly and actively, by offering the tools to create elaborate scenarios and to present these scenarios to the target group of older people. They can vote, they can give feedback/suggestions and they can react to ideas presented by others.

Communication/co-creation/co-design (storytelling, gamification)

The outcome of the Flanders green comfort case applications may inspire related projects & initiatives but also the whole society and older people in particular. That is why the integration of strong communication & dissemination tools will be important.

Also, communication is crucial when calling for action, when raising awareness is a goal and when feedback on pre-set scenarios is prerequisite. Older people need to be aware that they have a voice to change the green comfort in their own city, that their opinions matter & count in the city society and that they can make a difference improving the life quality of themselves and other older adults. Civil servants must be aware as well that older people have a role to play and make their opinion counted so they can take part of the decisions. Civil servants should understand how they can include older people in the process without ageist stereotypes, to achieve a real co-creation design.

Dissemination tools may include a website, social media channels but also existing storytelling tools that present *Urbanage* stories in a clear, fresh and compelling way.

4.1.3 Pilot case 2 - City services planning for older people

4.1.3.1 Description and goal

Based on the last workshop with the representatives of the older people community, we could pinpoint the focus of the second case.

For this case we want to offer a combination of two data layers we plan to create. These layers should be easily added to existing datasets or data driven applications:

- a first data layer shows the **age distribution** of citizens in a city. The datasets are bundled in statistical zones;
- a second data layer shows the distribution of people with a **physically reduced mobility**;
- the **combination of both layers** shows where older people with a reduced mobility are concentrated in the city.

With the use of the newly generated map layers, based on historic datasets of a city (source can be local or governmental data), it should be possible to predict how the local demographic distribution of older people with a reduced mobility will evolve in the future by using models. These models will take into account the demographic evolutions, as well as other environmental factors.

Our goal is to provide a set of data layers that help policy makers to decide where to plan new services that are of interest for older people, previously defined in WP2 activities, taking into account historic, actual and predicted data. This goal will be met by overlaying these layers on top of:

- the location of existing points of interests for older people (primary care, informal care, supermarkets, bakers, pharmacists, shops …);
- existing applications such as the "*Zorgatlas Vlaanderen*".[9]
  The *Zorgatlas Vlaanderen* (Care Atlas Flanders) provides an overview of Flanders' care, well-being, and health information.

4.1.3.2 Involved persona's

For the City services planning for older people case, we mainly focus on **policy- and decision makers** and **urban planners**.

Our envisioned *Urbanage* solution can be used to map the service needs for vulnerable older people with a reduced physically mobility. The outcome will help them in the evidence-based decision-making process to improve the actual situation (for instance by increasing the accessibility) or the future situation (for instance by suggesting the best places to plant/build new services).

[9] https://www.geopunt.be/catalogus/applicationfolder/zorgatlas

4.1.3.3 Expected outcomes

Social

Older people with a reduced mobility are very vulnerable for getting isolated. This group is not always taken into account when new city services are planned. The result can be that city services are not accessible for this particular group, that city services are not adapted to specific needs of people or a consultative process/design considering global population needs (including older people needs) is lacking.

This tool can help policymakers, decision makers and urban planners to also take into account older people needs with a reduced physical mobility when planning the integration new city services.

Policy (evidence-based)

By adding two layers, and combining them, (with historic, actual and predicted data) on top of the spatial distribution patterns of existing city services, the best solution of the implant of new older people related services can be determined.

This target group provides an extra point of view, enhancing the evidence-based decision making. The weight factor of the contribution of the target group will depend on the specificity of the service itself.

Communication/co-creation/co-design

The outcome of this case can be a starting point for co-creation as well. The best scenarios can be prepared and may be subject of online/offline communication campaigns and are a perfect source for co-creation and co-design. By presenting cases and scenarios, target groups can give feedback, they can vote or they can set priorities making the decision making even more proven.

4.1.4 Cooperation

4.1.4.1 Role of Digital Flanders

The main role of Digital Flanders in the *Urbanage* consortium is to provide data that can be interpreted by others.

The discussion about which data is needed is still ongoing but will mainly concern the age, gender, address and physical mobility of the person and the presence of facilities of all kinds. Perhaps, these data should be combined with geo-data.

The necessary personal data can be requested and aggregated via the MAGDA web service 'GeefPersoon'. In chapter 4.3.3. we handle the use of MAGDA in more detail. Since the data does not have to be traceable to a person, all data will be anonymized.

With the Open Standards for Linking Organizations (OSLO) programme, the Government of Flanders is committed to unambiguous standards for the exchange of information.

The OSLO Public Domain information model builds on the Basic Map of Flanders, also known as the Large-Scale Reference File (GRB), and is the topographical basic reference for all Flemish organizations that deal with large-scale basic data. It forms the logical reference file for all site management authorities in Flanders. These site management bodies need a wide range of site-related information (trees, green areas, pavements, etc.). The tables in chapter 3 indicate which OSLO data can be used.

The mere existence of Open Standards does not guarantee that the requested data on a specific subject is also available in a specific place. Participating municipalities will need to collect (additional) data on some subjects themselves.

A Digital Twin will be set up together with IMEC to make simulations of various subjects in order to get an impression of future developments. Usually, these simulations can be displayed as geo-data so that the result will be visible on a map.

Possible simulations are the growth and living place of the older people in a specific environment, the availability of care, places that protect against excessive heat, etc.

4.1.4.2 Role of IMEC (local implementation partner)

The following support is expected from IMEC:

- support in the co-creation process;
- support in the testing process with representatives of the target group;
- aggregation of data coming from the MAGDA platform;
- guarding the data interoperability and assisting Digital Flanders with the data integration process by the other technical partners;
- integration of external data sources, such as Google Street View and satellite/orthophoto imagery for the detection of greenery, street furniture and other POI's.

4.1.4.3 Role of other consortium partners

The following support is expected from the other consortium partners:

- the management of the implementation;
- technical designs;
- AI implementation:
    - for the calculation of the green comfort index with continuously updated datasets. For the self-learning updates of the green comfort index based on input from citizens and professionals/specialists;
    - for the identification of objects in the *Google Street View* landscape;
    - for identification of objects on orthophoto material.
- the implementation of Digital Twin visualisation;
- the realisation of an external application to score the green comfort index on a map.

4.1.4.4 Role of the customers

Based on the outcome of the co-creation workshops performed in the framework of WP2, a selection could be made of the collaborating cities and the topics best fitting in the *Urbanage* Flanders pilot project. The involved cities are listed in Chapter 4.1.1.

4.2 Pilot case 1 - Green Comfort

We worked out 10 user stories in detail for this particular case. The *Green Comfort* case was described in previous chapter.

4.2.1 Pilot case overview

Roles and functionalities

	Visitor without account	User with account	Expert with account
Explore the Urbanage case on https://citytwin.eu/. *See also user story 10.*	x	x	x
See 2D green comfort index map, update the opacity of this layer.	x	x	x
Click individual tiles on the 2D green comfort index map to see detailed information about the green comfort index calculations.	x	x	x
See + explore 2D base layers, heat stress & shadow maps, noise and air quality maps, POI-elements in the landscape, green & blue infrastructure maps, maps with accessibility info.	x	x	x
See + explore 2D user feedback layers.		x	x
Navigate through all maps. Change position, orientation, tilting level, panning, zoom level, …	x	x	x
Switch between 2D and 3D maps.	x	x	x
See + explore 3D base layers (*Open Street* map, terrain info, LOD2 buildings), positioning and size of trees, the POI locations and the shadow visualisation tool.	x	x	x
Switch 2D and 3D layers on/off.	x	x	x
Customise the green comfort index score **calculation method** on the 2D map. The different indicators can be switched on/off resulting in alternative calculations of the green comfort index.		x	x
Save/store green comfort calculation method updates on the 2D map.		x	x

Add/update/delete feedback to green comfort index scores automatically calculated by the *Urbanage solution*. The score can be **confirmed** or **corrected**. Also, **written comments** can be added.		x	x
Make a 2D simulations of a POI implant on a general accessible page.		x	x
Add/update/delete feedback on 2D simulations of a POI implants done by others on the general accessible map. Add a comment or like/dislike.		x	x
Localise and describe ideas and potential dangerous situations on a 2D map that is generally accessible to all visitors.		x	x
Add/update/delete feedback on 2D the ideas and potential dangers, posted by others. Add a comment or like/dislike.		x	x
Make a simulation in a private blank 2D-environment. Add POIs and see the green comfort index changing as a result. Load, save, update and delete simulations.			x
Export maps to a high resolution PDF-document that can be printed as a poster.	x	x	x
Make a free account	x	x	x
Log in to your account		x	x
Update your account – personal info and settings		x	x
Create/update/delete scenarios on https://citytwin.eu/ where ideas are presented to the visitors of the website.			x
Vote/rate scenarios presented on https://citytwin.eu/.		x	x
See voting/rating results for scenarios on https://citytwin.eu/.		x	x
Add/update/delete comment and like/dislike comments on scenarios.		x	x
Low level gamification. Create/update/delete a clickable map on https://citytwin.eu/ with a specific question to the visitors of the website. A location can be indicated by the visitors.			x

Mark a preferred location on a map on https://citytwin.eu/.		x	x
See the preferred location of others on a heatmap on https://city-twin.eu/.		x	x
Add/update/delete comments and like/dislike comments from others, connected to the clickable map on https://citytwin.eu/.		x	x
Export datasets.			x
Access and store/save dashboard. *See user story 7.*	x	x	x
Add/update own datasets by upload. Delete a dataset. Use the dataset in the determination of the green comfort index.			x

Table 29: Flanders pilot - roles and functionalities

Also, an **administrator** role is needed to:

- manage user profiles & roles;
- manage data sources & data layers;
- monitor the proper functioning of the server and application.

4.2.2 User stories details

4.2.2.1 User story 1: View map

Nr + Name	US1. View map.
Story	**As a** user/admin, **I want to** view 2D and 3D-maps on my phone/desktop/tablet PC.
Description functionalities	Depending on the objective, 2D or 3D maps will be presented to the users. Users can view the **2D-map**, they can navigate to a specific zone of interest in the public space to explore its green comfort aspects. The green comfort index is measured per city surface unit. Each unit is presented by a hexagon tile. The 2D-map is also the starting point for users to give feedback on the automatically calculated green comfort index, to mark potentially dangerous situations, to add suggestions/comments and to vote for a predefined scenario.

	Further, detailed information about the green comfort indicators is visualised by **3D-maps** where POI's and shadow projections can be explored in the zone of interest. The presented 2D- and 3D-maps and the added feedback and gamification functionalities should have a responsive design, so they function optimally for smartphones, tablets and laptop screens.
Actors involved	Citizens, professional advisor, policy maker, system expert.
Pre-condition	Starting from the DUET website on https://citytwin.eu/, the well documented green comfort case will be presented in detail. On the detail page, a link will be available to the map viewer, redirecting the users towards the 2D and 3D-maps in the *Cesium software*.
Post-condition	None.

Table 30: Flanders pilot case 1 - user story 1

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE

The actor consults the Digital Twin green comfort case via an external URL on https://citytwin.eu/. Part of the detailed case description will be the **hyperlinks** towards the map viewer showing 2D and 3D maps.
 	
The latter hyperlinks contains a unique case-id. This id triggers the loading of all needed and related data layers and pre-set settings.
 	
With this 2D or 3D map-visualisation as a starting point, the actor can now further explore the map view in more detail.
 	
The *Urbanage* technical partners take care of the citytwin.eu platform management and extension
	Based on the unique case-id of the hyperlink, the system loads the related data layers and settings.
	
	Grouped 2D map layers under investigation **limited to public space** include:
	• Green Comfort scores overlay (hexagon tiles with fixed dimensions);
	• base layers;
	  ○ Open Street map;
	  ○ orthophoto map;
	  ○ hybrid layer;
	• air quality & noise;
	  ○ air quality;
	  ○ noise;
	• heat stress & shadow;
	  ○ heat stress map;
	  ○ shadow map;
	• POIs;
	  ○ benches & picnic tables;
	  ○ public toilets;
	  ○ street lights;
	• green infrastructure;
	• blue infrastructure;

of the current DUET platform. The pilots and dissemination partner 21C deliver the content via the underlying CMS system.	• information about the accessibility;
	• actors feedback layers.
	
	Grouped 3D map layers include:
	
	• base layers;
	  ○ Open Street map;
	  ○ terrain data Flanders;
	  ○ LOD2 buildings;
	• POIs;
	  ○ tables & benches;
	  ○ public toilets;
	  ○ street lights;
	• green infrastructure;
	  ○ Trees.
	
	Pre-set settings include: the location, zoom-level, tilting level, angle of the view, shadow at a particular time of the day/season, selected layers, opacity of the layers, the legend explaining the used codes & colours…).

On the 2D-map, the actor selects a hexagon-zone in the city with a specific green comfort score.	System shows detailed information about the green comfort index of the hexagonal surface in a pop-up window or modal/lightbox: • the score itself; • a separate score of the indicators; • the number of views of a score; • the option to **approve** OR **update** the separate scores of the five indicators; • the average of the scores given by actors + the number of actors giving a score or approving the automatically calculated score; • the option to explain (in words) the update of a score.
On the https://citytwin.eu/ landing pages, **scenarios** can be **added** by a policy maker actor.	The actor needs access to the WordPress back-office of the https://citytwin.eu/ systems landing pages to implement the scenarios.
On the https://citytwin.eu/ landing pages, **scenarios** can be **assessed** by the actor.	The https://citytwin.eu/ scenario commenting and voting gamification tools of the system will be used to allow actors to vote/rate scenarios.
On the https://citytwin.eu/ landing pages, the shadow can be visualised in a 3D-map for each time of the year and for each moment of the day.	The https://citytwin.eu/ map viewer of the system shows the shadows precisely on the 3D-map, based on LOD2 information of the buildings and 3D trees simulations.

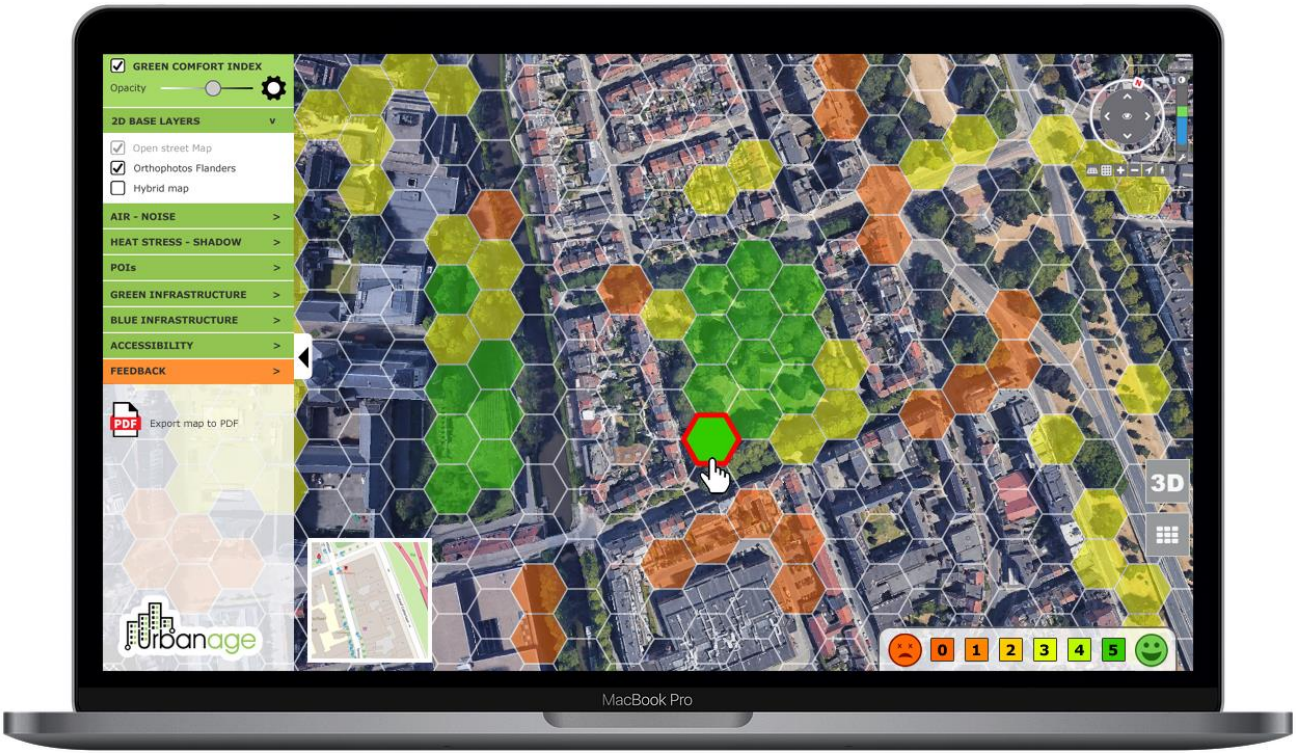
Table 31: Flanders pilot case 1 - user story 1 - main success path

Mock-ups

Mock-up 1: responsive views for smartphones, tablets and laptops.

Figure 5: Urbanage responsive design fitting smartphones, tablets and laptops

Mock-up 2a, b and c: visualisation of the green comfort index on a 2D-map.



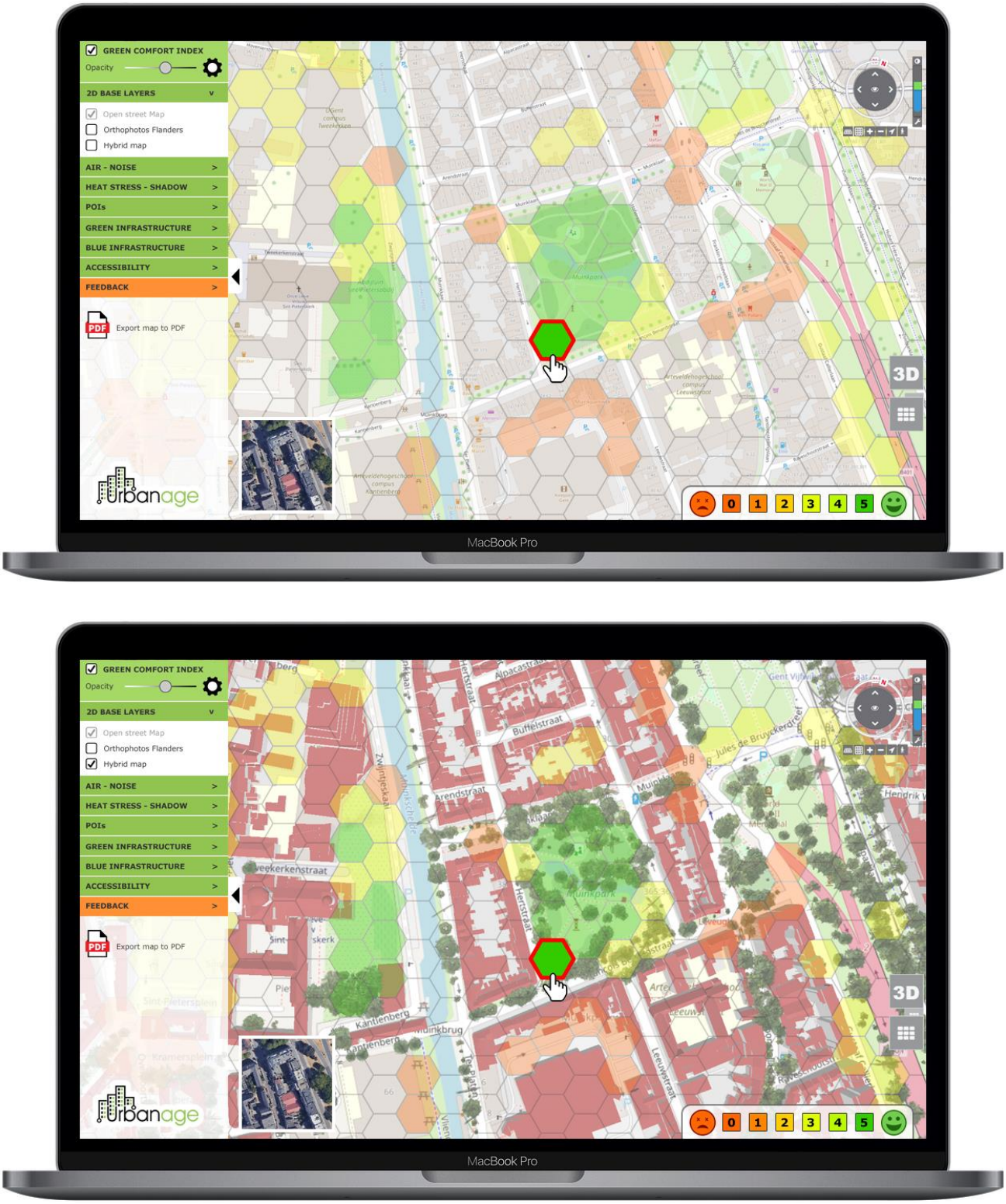


Figure 6: laptop mock-up of the overview of the green comfort scores in the city of Ghent. Views with Google Earth (or ortho photos, see top), Open Street map (middle) and a combination of both layers (bottom) as a basis.

Further elements include :

- *all information is restricted to the **public space**;*

- *the layer with the green comfort index scores on top. Mapped on a hexagon mesh with fixed dimensions. With a colour code, explained by a legend. Each tile is clickable, when clicked, detailed information about the green comfort calculations is presented. The score can be updated by visitors with an account (experts and non-experts). The opacity of this layer can be changed with a slider. The settings of the green comfort index calculations can be updated by visitors having an account. For instance; heat stress can be switched of as an indicator during winter time;*
- *base layers with an easy switch (Open Street map, Orthophotos and a hybrid visualisation);*
- *series of layers, ordered in groups. Option to switch layers on/off.*

Mock-up 3: 2D air quality overlay for the city of Ghent, Flanders, including the legend.

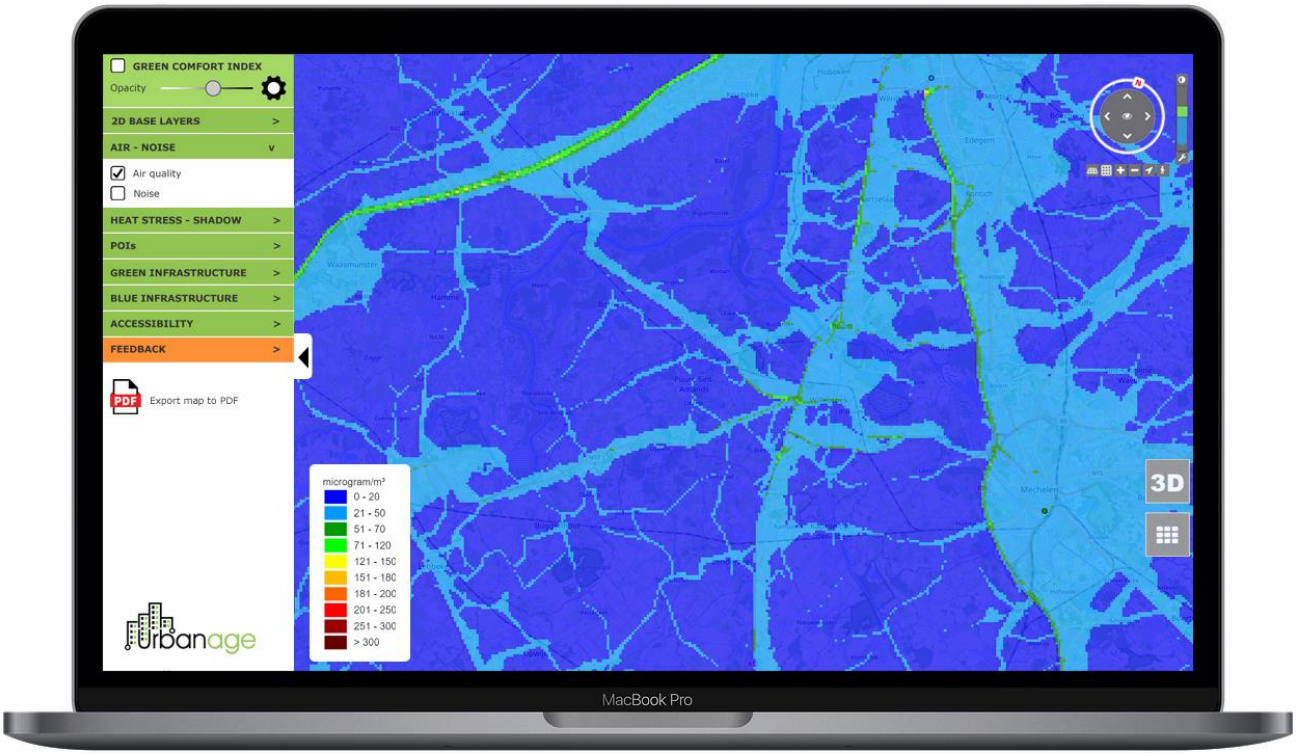


Figure 7: air quality map layer superimposed on the Urbanage base layers

Mock-up 4: 2D heat stress map for the city of Ghent, Flanders.

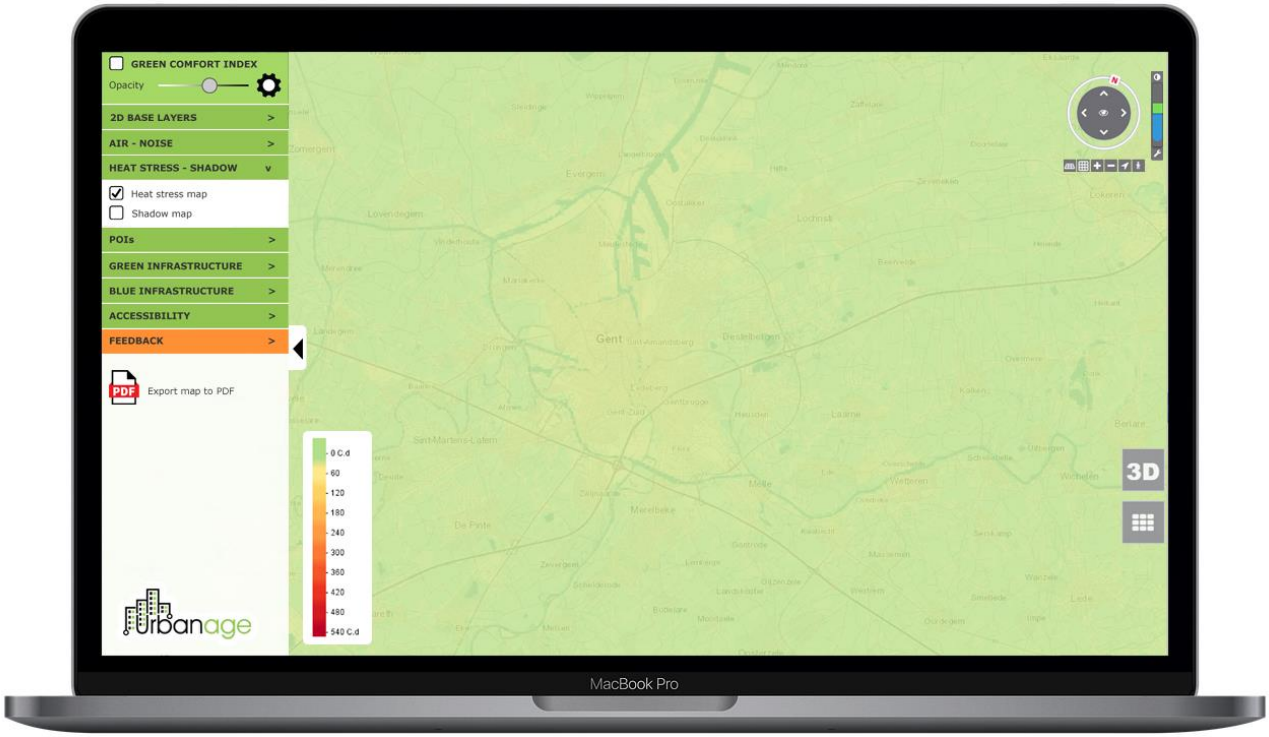


Figure 8: : heat stress map layer superimposed on the Urbanage base layers

Mock-up 5: visualisation of a selection of POIs (benches, tables and public toilets) on a 2D base map.

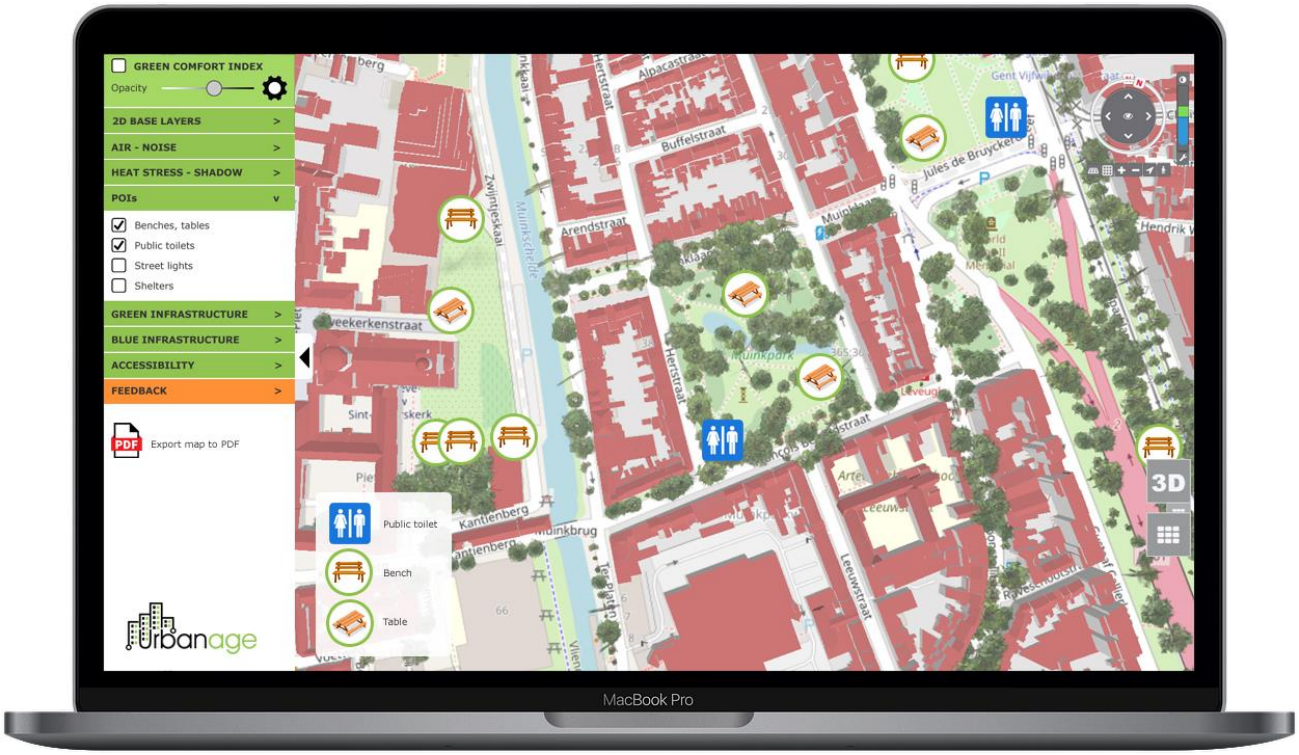


Figure 9: visualisation of POIs on a hybrid 2D base map

Mock-up 6: 3D visualisation of trees in the city.

Figure 10: visualisation of trees and their shadow impact in the city of Ghent, Flanders

Mock-up 7: 3D visualisation of street furniture in the city.

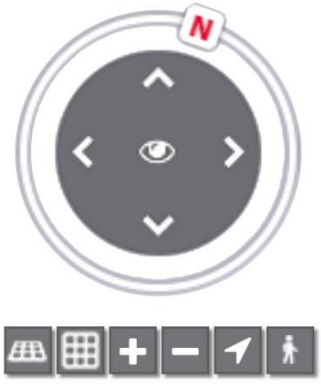
Figure 11: visualisation of the location of different types of street furniture in the city of Ghent, Flanders

Mock-up 8: 3D-visualisation of terrain data, LOD2 buildings and trees.

Figure 12: visualisation of shadow projection using terrain data, LOD-2 building information and tree data in the city of Ghent, Flanders.

The shadow projection can be simulated for each moment of the day with the tools at the right hand side, at any time of the year by using a slider element. Street furniture is visualised by pins. Different POI-layers are available, each data layer can be switched on/off.

Functionalities

Functionalities	Description	Role
Navigation. 	**Panning** Change the location on the map. **Zooming** Zoom on the map. **View angle** Toggle view angle. Horizontal (change the orientation) and vertical (change the tilting level of the point of view). **Shadow incursion**	All

	Toggle shadow of buildings and trees on the 3D-map at any time (hour of the day, day of the year) to see the effects of daytime and season on the shadow patterns.	
Toggle between 2D- and 3D views.	Easily switch between the 2D- and 3D views. 2D and 3D views have a different set of data layers.	All
Update the opacity of the 2D green comfort index layer.	Update the opacity of the 2D layer using a slider, to equilibrate the layers underneath.	All
Select / deselect 2D/3D layers.	Switch layers on/off (checkboxes) to better explore all aspects of the *Urbanage* solution. Layers are grouped and layer groups can be shown/hidden by one mouse click.	All
Click items on a 2D/3D map to get more information.	By clicking elements on a 2D/3D map, a popup window (lightbox, modal) appears showing detailed information about the item.	All
Update shadow patterns on a 3D map.	Update the pattern by using a slider for day of the year and hour of the day.	All
Select a 2D- or 3D-map item.	By clicking objects on the 2D or 3D-maps, extra information will pop-up by using pop-ups or modals/lightboxes. On the **2D map**, hexagons can be clicked on the green comfort index map to get background information about the score. Also, on the feedback map, hexagons can be clicked to add remarks and suggestions. On the **3D-map**, the POIs can be clicked to get extra information. Also on this map, feedback can be given in a separate layer.	All

Table 32: Flanders pilot case 1 - user story 1 - functionalities

Definition of done

Functionalities	Done test description	Priority (show stopper)
Navigation.	**Panning** I can easily change the map location on PC/laptop/smartphone. **Zooming** I can easily change the zoom level on PC/laptop/smartphone. **View angle** I can easily toggle the horizontal and vertical view angles on the 2D and 3D maps on a PC/laptop/smartphone.	YES

	Shadow incursion I can easily toggle the shadow of 3D-objects (hour of the day, day of the year) to see the effects of day time and season on the shadow patterns.	
Toggle between 2D- and 3D views.	I can easily switch between the 2D- and 3D views.	YES
Update the opacity of the 2D green comfort index layer.	I can update the opacity of the 2D layer using a slider, to equilibrate the layers underneath.	YES
Select / deselect 2D/3D layers.	I can easily switch layers on/off (checkboxes) to better explore all aspects of the *Urbanage* solution.	NO
Click items on a 2D/3D map to get more information.	I can click an element on a 2D/3D map, a popup window (lightbox, modal) appears showing detailed information about the item.	YES
Update shadow patterns on a 3D map.	I can update the pattern by using a slider for day of the year and hour of the day.	YES
Select a 2D- or 3D-map item.	I can easily click objects on the 2D or 3D-maps, extra information will pop-up by using pop-ups or modals/lightboxes.	YES

Table 33: Flanders pilot case 1 - user story 1 - definition of done

4.2.2.2 User story 2: Evaluate/update the green comfort index score

Nr + Name	US2. Evaluate/update the green comfort index score.
Story	**As a** logged in user/expert, **I can** evaluate/update the green comfort score of a 2D hexagon map segment on my tablet/PC or by using a smartphone app.
Description functionalities	A user can select a hexagon zone on the 2D map by clicking this specific tile. The user can also select the option "**use my actual location**" button, where the corresponding hexagon is automatically recognised. More information about the green comfort score appears in a pop-up window. The user can consult the details of the green comfort index calculation. If the user agrees with the score, he/she can confirm the automatically calculated score.

	If the user does not agree with the score, the user can make some updates. He/she can also give a brief explanation of the updated scores.
Actors involved	Citizen, older people community.
Pre-condition	User has opened the 2D-map on his/her PC, laptop or smart phone App.
Post-condition	None.

Table 34: Flanders pilot case 1 - user story 2

Main Success Path (primary flow)	Smartphone/tablet app - Android & IOS..
ACTOR ACTIONS	SYSTEM RESPONSE
Actor clicks on a hexagon tile on the green comfort index layer on the 2D-map.	The system opens a pop-up screen providing the calculated green comfort score with detailed information about the calculation itself. Also, information of manually corrected green comfort index scores is given, for the users and experts separately. The mean value is shown in the pop-up window, as well as the number of persons that evaluated the score. At the bottom of the pop-up screen, two buttons are added. The first button can be pressed when the visitor agrees with the score. By pressing the second button, an update can be given of the actual score by opening a new page in the pop-up.
Actor clicks on the “I AGREE” button.	System shows a thank you message. The pop-up window can be closed now.
Actor clicks on the “UPDATE SCORE” button.	System opens a wizard where the score can be updated. The individual parameter scores can be updated by using sliders. Also, an explanation can be added about why this score is precepted as being not correct. After clicking the “SEND” button, the user gets a thank you message and he/she can close the pop-up window. System stores the score and comments.
Actor clicks the close button of pop-up.	System closes pop-up window.
Actor clicks the settings button in the left menu for the green comfort index.	System opens pop-up window. System shows the list of all parameters used for the calculation of the green comfort score.
Actor toggle parameters on/off.	System will only use the parameters that are toggled on to calculate the green comfort index score.

	Calculations of the green comfort index are done by using AI. Manual corrections of users and experts will be taken into account to update the calculation procedure.

Table 35: Flanders pilot case 1 - user story 2 - main success path

Process flow scenario (including alternatives and exceptions) – **optional**

NONE

Mock-ups

Mock-up 1: detailed information about the green comfort index score of a specific zone in the city

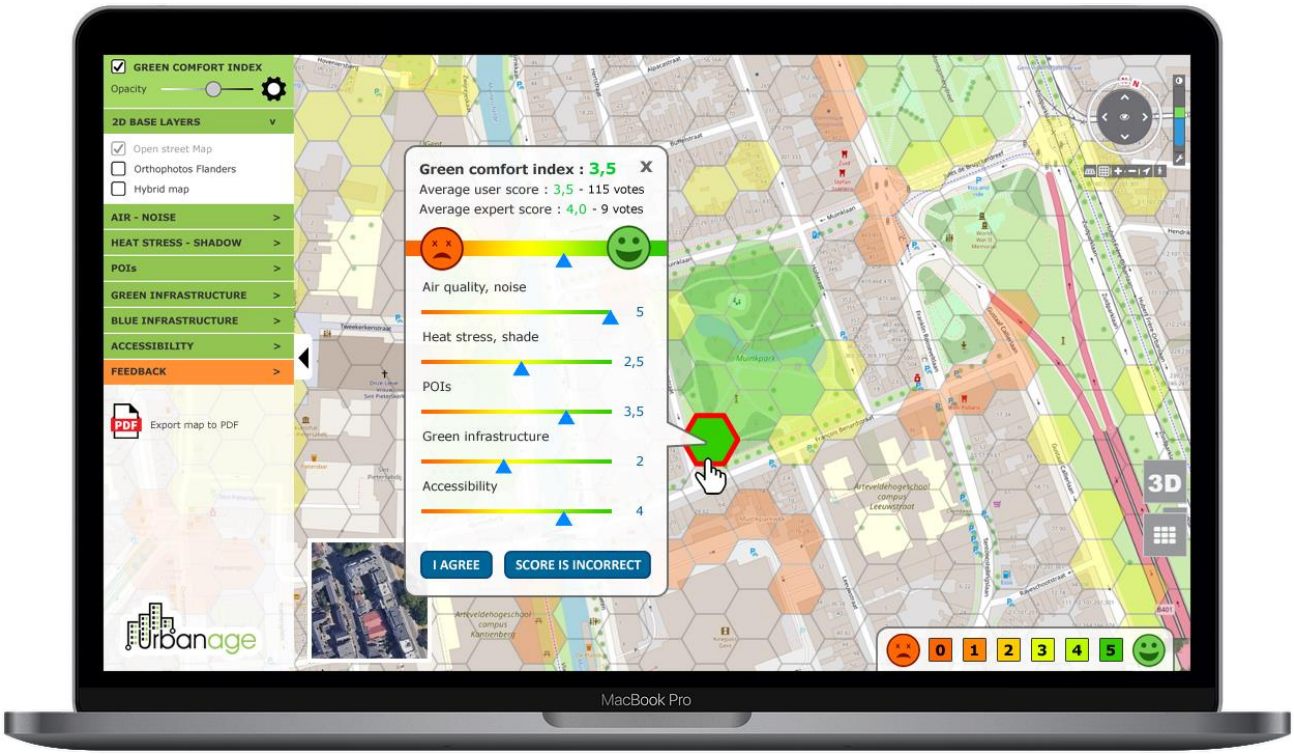


Figure 13: a specific hexagon tile is selected by clicking/tapping on it. The hexagon is highlighted and a pop-up window appears with detailed information about the green comfort index score.

Mock-up 2: pop-up, update a green comfort index score


Average expert score : 4,0
Air quality, noise
5
Heat stress, shade
2,5
POIs
3,5
Green infrastructure
2
Accessibility
4
I AGREE
SCORE IS INCORRECT
YOUR SCORE : 3
Move the sliders ...
Air quality, noise
5
Heat stress, shade
2,5
POIs
3,5
Green infrastructure
2
Accessibility
4
Your remark
Heat stress, shade
2,5
POIs
3,5
Green infrastructure
2
Accessibility
4
Your remark
SEND

Figure 14: the procedure of selecting a hexagon tile, consulting the green comfort index score and manually updating a automatically calculated score. Smartphone simulation

Functionalities

Functionalities	Description	Role
Select a location.	Click a hexagon tile, new information appears in a pop-up window. Modal or lightbox.	Citizen, expert
Rate the automatically generated green comfort index.	Click the "I agree" button if the score is correct according to you. Click the "the score is incorrect" button to update the score.	Citizen, expert
Score the automatically generated green comfort index.	Update the score for the main classes of parameters that are used to define the green comfort index. Use the sliders to update the score, the original scores are indicated as a reference.	Citizen, expert
Add a comment to a score.	Add a comment in the form (free text).	Citizen, expert
See comments and updated scores of others.	When consulting the green comfort information of a hexagon tile, the scores and comments of others will be shown.	Citizen, expert
Close a popup window.	When clicking the cross in the right upper corner, the pop-up window will be closed and the map layers are visible again.	Citizen, expert

Table 36: Flanders pilot case 1 - user story 2 - functionalities

Definition of done

Functionalities	Done test description	Priority (show stopper)
Select a location.	I can click a hexagon tile, new information appears in a pop-up window. Modal or lightbox.	YES
Rate the automatically generated green comfort index.	I can click the "I agree" button if the score is correct according to you. When I do so, I get a thank you and I can continue exploring the *Urbanage* solution. I can click the "the score is incorrect" button to update the score. When I do so, a new window will open where I can update the scores.	YES
Score the automatically generated green comfort index.	I can update the score for the main classes of parameters that are used to define the green comfort index. I use the sliders to update the score, the original scores are indicated as a reference.	YES

Add a comment to a score.	I can add a comment in the form (free text).	NO
See comments and updated scores of others.	When I consult the green comfort information of a hexagon tile, the scores and comments of others are shown. So I can have a good idea of what people think about the hexagon area.	NO
Close a popup window.	When I click the cross in the right upper corner, the pop-up window will be closed and the map layers are visible again.	YES

Table 37: Flanders pilot case 1 - user story 2 - definition of done

4.2.2.3 User story 3: Manage account and preferences

Nr + Name	US3. Manage account and preferences.
Story	As a user (citizen or expert), I can **apply for an account** and **manage** my preferences & account data.
Description functionalities	At various points in the *Urbanage* solution, users (with an account) can add information/feedback that will be stored and will be (partially) shown on the website. The allocation of the functionalities to the two user types, **citizen** and **expert**, is summarised in the table in chapter 4.2.1. To establish these (sometimes linked) functionalities, **user accounts** with information storage are a prerequisite. Also, the introduction of user accounts is a threshold for spam and other abuse (final account confirmation is done by a link sent by e-mail). When a visitor wants to access one of the functionalities listed in the table in chapter 4.2.1, an alert window appears with the message “for this action, you need a free account”. We keep the procedure to make an account as simple as possible. Only the information that is necessary for the correct functioning of the Urbanage solution will be stored. We also foresee a disclaimer where we describe why the login is needed and that the information will be used only for this purpose. Useful account information: • Name; • e-mail address (username, will be checked); • age (in years, so we can see specific input from the older people community. No day of birth needed);

	• password (needs to contain mix of characters/numbers + minimum length); • role: citizen or expert. Other information stored in the account: • settings of the green comfort index **calculation method**. Option to switch indicators on/off; • updates of green comfort index **scores**; • all written feedback, likes/dislikes; • simulations on the POI-map (different settings for citizens and experts); • creation of scenarios and gamification elements (experts); • evaluation of scenarios; • gamification input.
Actors involved	Citizens and experts
Pre-condition	None.
Post-condition	None.

Table 38: Flanders pilot case 1 - user story 3

Main Success Path (primary flow)	Create a user account - log in.
ACTOR ACTIONS	SYSTEM RESPONSE
User clicks on one of the functionalities that requires an account or clicks on the "LOG IN" button.	System shows a pop-up window. Message: *This action is reserved for (free) account holders only. We do this to store your feedback and to avoid abuse. Your account information will be only used for the Urbanage project, nothing else. We will not send you newsletters.* After, two buttons are shown: "LOG IN" and "MAKE A FREE ACCOUNT".
Actor clicks the "**LOG IN**" button on the main page.	System shows a pop-up. System offers the actor a choice: "LOG IN" or "MAKE A FREE ACCOUNT". On the same page two fields (username and password) are added to log in immediately. Submit button. Hyperlink: forgot my password. Hyperlink: I don't have an account yet.
Actor clicks the hyperlink "don't have an account yet".	System redirects actor to the "MAKE A FREE ACCOUNT" page.
Actor clicks the "forgot my password" hyperlink.	System sends the password to the account owner by e-mail.

Actor decides to log in with his/her existing account. Actor fills out credentials.	Credentials are checked by the system. If correct, the actor is logged in. If not correct, the actor gets error messages and can try 2 more times to log in. If he/she does not succeed after these extra trials, he/she is blocked for 10 minutes.
User clicks on the "**MAKE A FREE ACCOUNT**" button.	System shows information about the advantages/necessity of membership and comforts the visitor. The account is free and will not be abused. System asks actor to communicate his/her credentials via a form: • Name (will be shown) • E-mail (username, will not be shown at any part on the website) • Password • Age (will be shown on the website) • Preferences: put the 6 markers we use for determination of the green comfort index in order of importance. The form ends with a "SUBMIT" button.
Actor presses the "SUBMIT" button.	System checks the information entered.
Actor writes non existing e-mail address, wrong password or leaves questions blank when making an account or logging in.	System shows error alerts indicating what is missing and offer the opportunity to update the information.
Actor successfully made an account.	System thanks the actor for his/her confidence. System stores the information so user can login the next time. System starts a session, keeping the user logged in. System activates all functionalities that are reserved for members only. System sends an e-mail confirmation with the password to the actor.
When logged in.	Existing own comments can be updated or deleted. New comments can be added. *See table in chapter 4.2.1. for the full list of functionalities for logged in citizens and experts.*
Actor presses logs out button.	System ends the session, the actor has no longer access to personal information and to functionalities reserved for members only.

Table 39: Flanders pilot case 1 - user story 3 - main success path

Alternate Path	A1	CHANGE PREFERENCES
ACTOR ACTIONS		SYSTEM RESPONSE
Actor is logged in and clicks on the **My Account** button.		System opens the **My Account** screen, showing all filled-in information.
Actor changes the account settings (name, e-mail, password, age) and the updated list of parameters to take into account for the calculation of the green comfort index.		System stores the updated information.
Actor can update/delete all input entered into the system using the functionalities listed in chapter 4.2.1.		System stores the updated information. All individual information shown on the website is updated where applicable.
Actor presses logs out button.		System ends the session, the actor has no longer access to personal information and to functionalities reserved for members only.

Table 40: Flanders pilot case 1 - user story 3 - alternate path

Process flow scenario (including alternatives and exceptions) – **optional**

NONE

Mock-ups

Mock-up 1: alert pop-up with options LOGIN and MAKE A FREE ACCOUNT

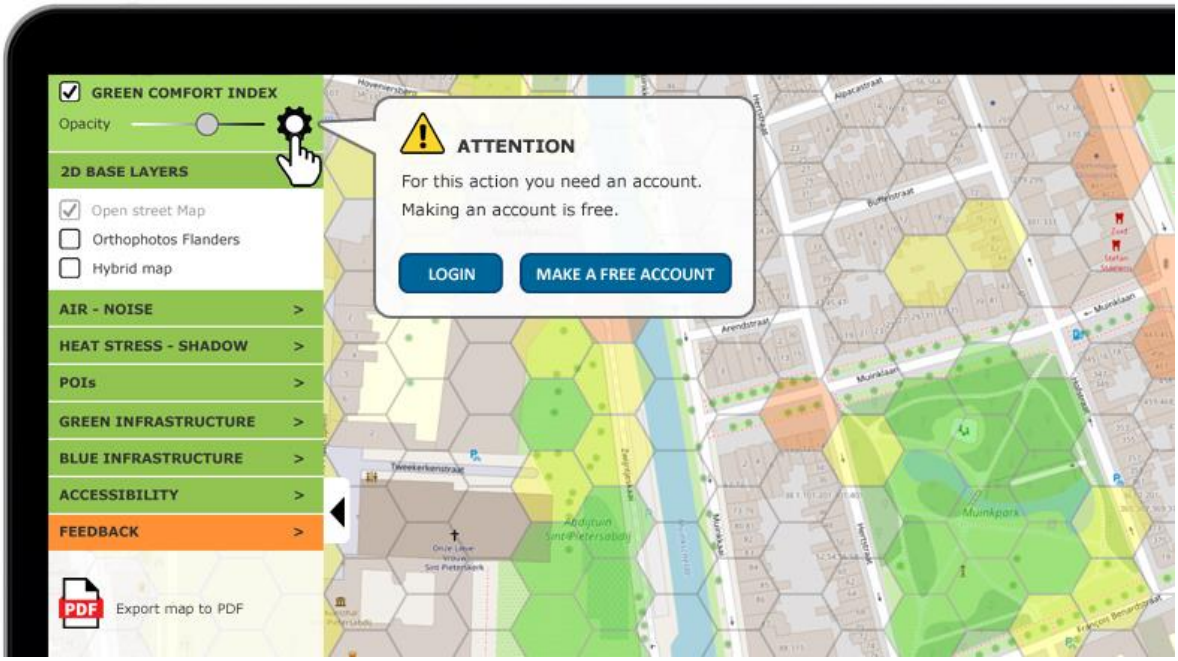


Figure 15: notification alert when an action is triggered that requires membership

Mock-up 2: create a free account

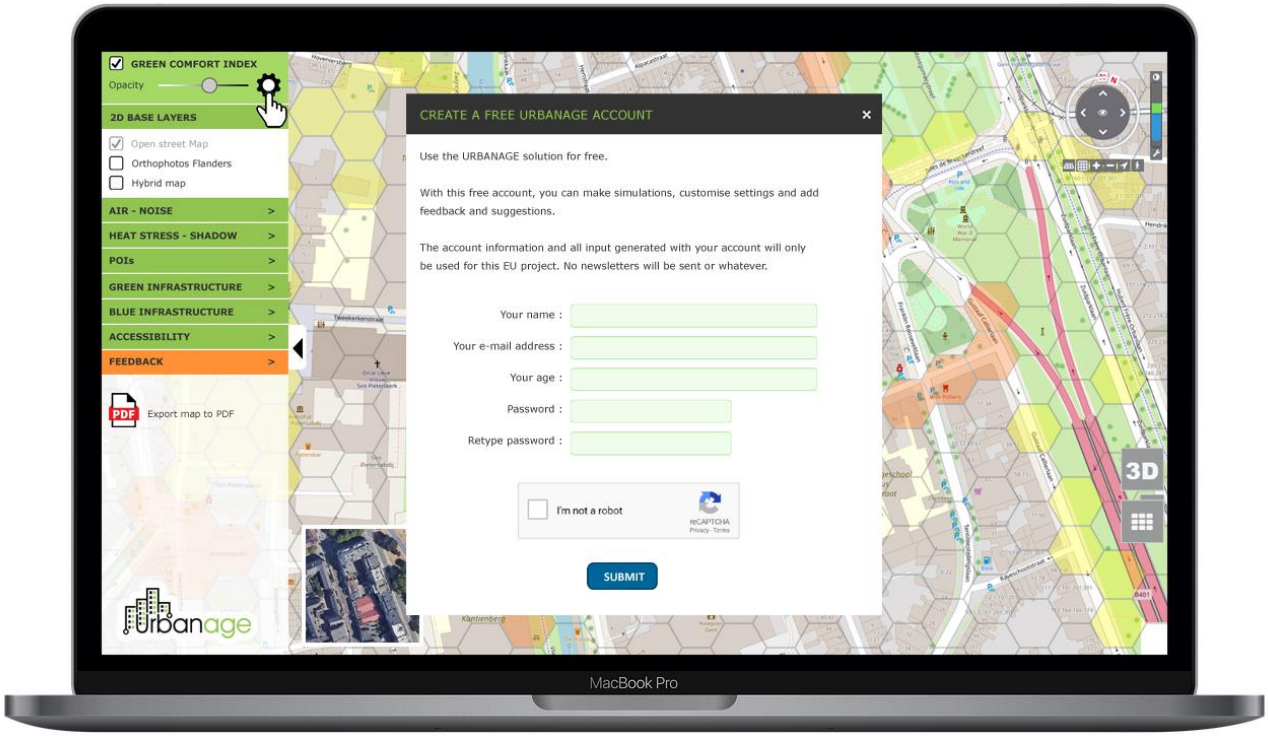


Figure 16: pop-up window for making a free account. Contains introduction, disclaimer, fields to be completed, RECAP-TCHA and submit button.

Mock-up 3: login pop-up window

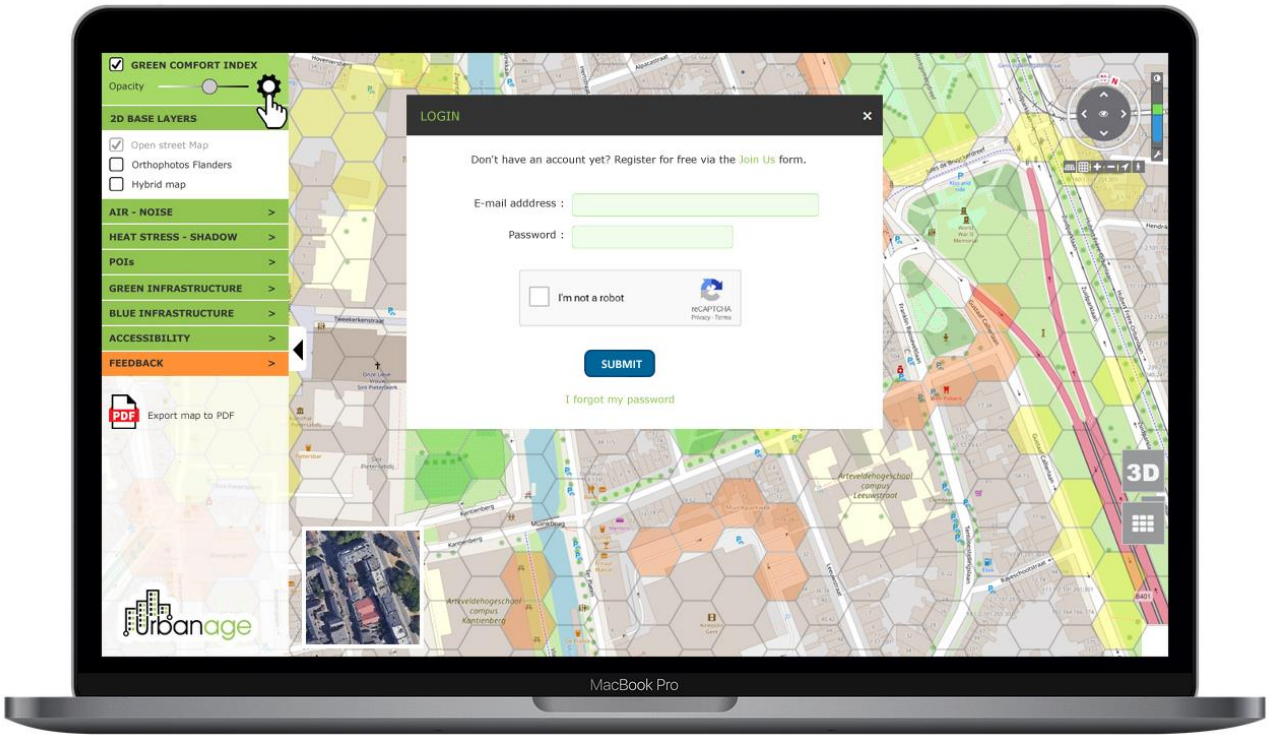


Figure 17: login pop-up window with link to the "MAKE AN ACCOUNT" page, request for username and password, RE-CAPTCHA and submit button.
Also, an option is added to retrieve the password in case the password is forgotten.

Functionalities

Functionalities	Description	Role
Alert pop-up.	• alert when accessing members only functionalities from the list in chapter 4.2.1: • *for this action, you need a (free) account;* • *buttons: LOG IN and MAKE A FREE ACCOUNT.*	Citizen, expert
Create a user account.	• create a user account by entering name, e-mail address, age, password; • two account types with different functionalities (listed in the table in chapter 4.2.1): citizen and expert; • input will be validated, error messages will be generated when applicable; • credentials + confirmation link are sent to the e-mail address of the user; • account is activated after confirmation via the link sent to the e-mail address;	Citizen, expert

	• the system administrator decides who is citizen/expert.	
Forgot my password.	By clicking this link, the user credentials are sent to the e-mail address of the user.	Citizen, expert
Add/show/**activate** functionalities and layers.	After being logged in, some menu items and functionalities (see list in chapter 4.2.1.) will become visible that remain invisible for visitors that are not logged in. Functionalities are different for citizens and experts	Citizen, expert
Update account information.	Option to update account information: name, age, password, e-mail address. After the update, the new info is sent to the e-mail address of the user.	Citizen, expert
Delete account.	Option to delete an account, all stored information will be deleted from the system, including all individual feedback.	Citizen, expert
Update settings of the green comfort index **calculation method**.	By switching the indicators that are used to calculate the green comfort index on/off, the green comfort index calculation itself will be updated.	Citizen, expert
Update green index scores.	Updated/delete the green index scores, the updates will be stored and linked to the account.	Citizen, expert
Update individual feedback given before.	Updated/delete all kinds of input (see list in chapter 4.2.1.), the updates will be stored and linked to the account.	Citizen, expert
Log out.	Change to basis mode.	Citizen, expert
Change preferences.	Allocate roles to users (make standard users experts) Delete accounts in case of abuse.	System expert

Table 41: Flanders pilot case 1 - user story 3 - functionalities

Definition of done

Functionalities	**Done test description**	**Priority (show stopper)**
Alert pop-up.	When I access members only functionalities from the list in chapter 4.2.1., I get a pop-up alert telling me I need a free account. I can click the buttons “LOG IN” or “MAKE A FREE ACCOUNT”.	YES
Create a user account.	When I click the “MAKE A FREE ACCOUNT” button, I can enter my credentials. When I enter a wrong e-mail address format, I get a notification and I can correct the information.	YES

	The credentials are sent to my e-mail address together with a confirmation link. When I click this link in the e-mail, my account is activated. The credentials are stored. Also my role is stored (citizen or expert).	
Forgot my password.	When I click this link, my user credentials are sent to my e-mail address.	NO
Add/show/**activate** functionalities and layers.	After logging in, all menu items and functionalities connected to the role I have (see list in chapter 4.2.1.) will be shown to me.	YES
Update account information.	When logged in, I can update my account information.	YES
Delete account.	When logged in, I can delete my account. All information that I have added into the Urbanage solution will be deleted irreversibly. I get a notice via pop-up: "are you sure you want to permanently delete your account?" Deleted information will include written feedback, votes, update green comfort index scores, …	YES
Update settings of the green comfort index **calculation method**.	I can switch parameters used for the calculation of the green comfort index score on/off.	YES
Update green index scores.	I can click on a hexagon in the 2D green comfort index layer and I can give an individual update of the score. This score will be used in the calculation of the average green index score by users/experts depending on the role I have.	YES
Update individual feedback given before.	I can updated/delete all kinds of input (see list in chapter 4.2.1.) I entered in the past.	NO
Log out.	I can log out, the system returns to the visitors non-member view.	YES
Change preferences.	As a system administrator, I can delete an account when I notice abuse. As a system administrator, I can upgrade the standard login role (citizen to expert) for all accounts.	NO

Table 42: Flanders pilot case 1 - user story 3 - definition of done

4.2.2.4 User story 4: Simulations of city adjustments by gamification

Nr + Name	US4. Simulation of city adjustments by gamification.
Story	As a logged in user, I can **simulate** the implant of street furniture into the city and I can react to suggestions of others.
Description functionalities	In the main menu of the 2D map, there is a set of layers bundled under the name FEEDBACK: 1. simulation - impact of street furniture & trees (citizens and experts); 2. simulation - organise a green comfort zone (experts only); 3. map your ideas/remarks (citizens and experts). By dragging and dropping, a limited selection of POIs can be virtually planted in the city environment. For each suggested virtual implanted POI, comments and likes/dislikes can be added by other logged in users. Besides feedback, extra information is shown when clicking a POI: • the impact of this implant on the green comfort index will be calculated and shown (with the actual situation as a reference); • the distance to the nearest POI of the same type; • the date of each virtual implant. **Experts** will be able to use the same simulation tool in a restricted environment. They can mark the area, they can add different POIs and they can see the resulting update of the green comfort index inside the marked area in reference to the actual situation. **Citizens and experts** can mark a spot on an empty map where they can add suggestions or point out dangerous situations.
Actors involved	Citizen, policy makers.
Pre-condition	User needs to be logged in.
Post-condition	None.

Table 43: Flanders pilot case 1 - user story 4

Alternate Path	A1	Simulation – citizen and expert actors.
ACTOR ACTIONS		SYSTEM RESPONSE
Actor (citizen or professional) logs in. Actor visits the 2D-map.		System gives access to extra set of data layers, the FEEDBACK set and shows them. Logged in **professionals** see one **extra** layer.
Actor clicks on the layer "**Simulation - impact of street furniture & trees**".		System shows gamification page. Overview all street furniture, virtually added by all citizens/professionals.
Actor clicks on an available POI.		System opens pop-up window with extra information. Time of post, name and age of the poster, impact on the green comfort index, distance towards closest street furniture item from the same kind. Also: feedback on this implant from other logged in users/professionals. Also: number of likes/dislikes for this suggestion.
Actor drags and drops a street furniture item onto the map.		System shows pop-up asking for a comment. System stores the comment and adds/stores the item on the map.
Actor clicks on the react button.		System opens pop-up asking for written reaction. After submission, the reaction is added to the thread of comments.
Actor clicks on the like or dislike button linked to the POI of interest.		System adds a like / dislike vote.
Actor clicks on own POIs.		System allows the actor to remove (but not replace) his/her POI. System makes that POI and linked comments are not visible any more.
Actor clicks on own remarks.		System allows the actor update/delete his/her remark. System deletes all comments connected to the remark when the remark is deleted.

Table 44: Flanders pilot case 1 - user story 4 - alternate path 1

Alternate Path	A1	Simulation & scenario creation - professional actor only.
ACTOR ACTIONS		SYSTEM RESPONSE
Actor (professional) logs in. Actor (professional) visits the 2D-map.		Logged in professionals see one extra layer: "**Simulation - organise a green comfort zone**".
Actor clicks the "**Simulation - organise a green comfort zone**" layer and navigates to an area of interest.		System shows gamification page (only visible for the individual expert actor). Empty map (new) or option to load saved layers.

With the provided toolset, the expert actor can mark a region he/she wants to investigate.	System restricts the green comfort index calculation to the marked area. The green comfort index before/after simulation is shown on top of the page for the whole marked region.
Expert actor clicks on an available POI that was added before.	System opens pop-up window with extra information. Time of post, individual impact/contribution on the green comfort index, distance towards closest POI item from the same kind.
Expert actor drags and drops POI items to the map.	System adds/stores the items on the map. System shows the improvement of the green comfort index for all added items in the area within the marked area. *As an alternative for an area marked by the expert actor, the zoom level can be used to restrict the test zone. Zooming in/out changes the values.*
Actor clicks on own POIs.	System allows the actor to remove (but not replace) his/her POI. System makes that removed POI is not visible any more.
Actor presses the save/update button.	System stores all items that are on the map as a **scenario**.
Actor clicks on a **scenario** to open it.	System loads all elements of the scenario and creates the corresponding green comfort index map.

Table 45: Flanders pilot case 1 - user story 4 - alternate path 2

Alternate Path	A1	Scenario export - professional actor only.
ACTOR ACTIONS		SYSTEM RESPONSE
Actor (professional) logs in. Actor (professional) visits the 2D-map.		Logged in professionals see one extra layer: "**Simulation - organise a green comfort zone**".
Actor sees all scenarios created. Actor clicks on a scenario.		System shows scenario details. System allows to make a visual snapshot of the case. System shows the read only URL version of the scenario.
Actor clicks on the "make snapshot" button.		System makes a snapshot (image export).
Actor clicks on the "save hyperlink" button.		The URL read only version of the scenario page is memorised and can be pasted into the www.digitaltwin.eu back-office of the landing pages.

Table 46: Flanders pilot case 1 - user story 4 - alternate path 3

Alternate Path	A1	Map your ideas and remarks – citizen and expert actors.
ACTOR ACTIONS		SYSTEM RESPONSE
Actor (citizen or professional) logs in. Actor visits the 2D-map.		System gives access to extra set of data layers, the FEEDBACK set and shows them.
Actor clicks on the layer "**Map your ideas and remarks**".		System shows gamification page. Overview all ideas and remarks and their specific location, virtually added by all citizens/professionals.
Actor clicks on an available idea/remark.		System opens pop-up window with extra information. Time of post & owner of the post (name, age) are shown. Also: feedback on this idea/remark from other logged in users/professionals and number of likes/dislikes.
Actor drags and drops an "idea" or "dangerous situation" icon on the map.		System shows pop-up asking for a comment. System stores the comment and adds/stores the item on correct location on the map.
Actor clicks on the react button.		System opens pop-up asking for written reaction. After submission, the reaction is added to the thread of comments.
Actor clicks on the like or dislike button linked to the POI of interest.		System adds a like / dislike vote.
Actor clicks on own ideas/suggestions.		System allows the actor update/delete his/her idea/suggestion. System deletes all comments connected to the remark when the remark is deleted.

Table 47: Flanders pilot case 1 - user story 4 - alternate path 4

Process flow scenario (including alternatives and exceptions) – **optional**

NONE

Mock-ups

Mock-up 1: simulation - impact of street furniture & trees on the green comfort index.

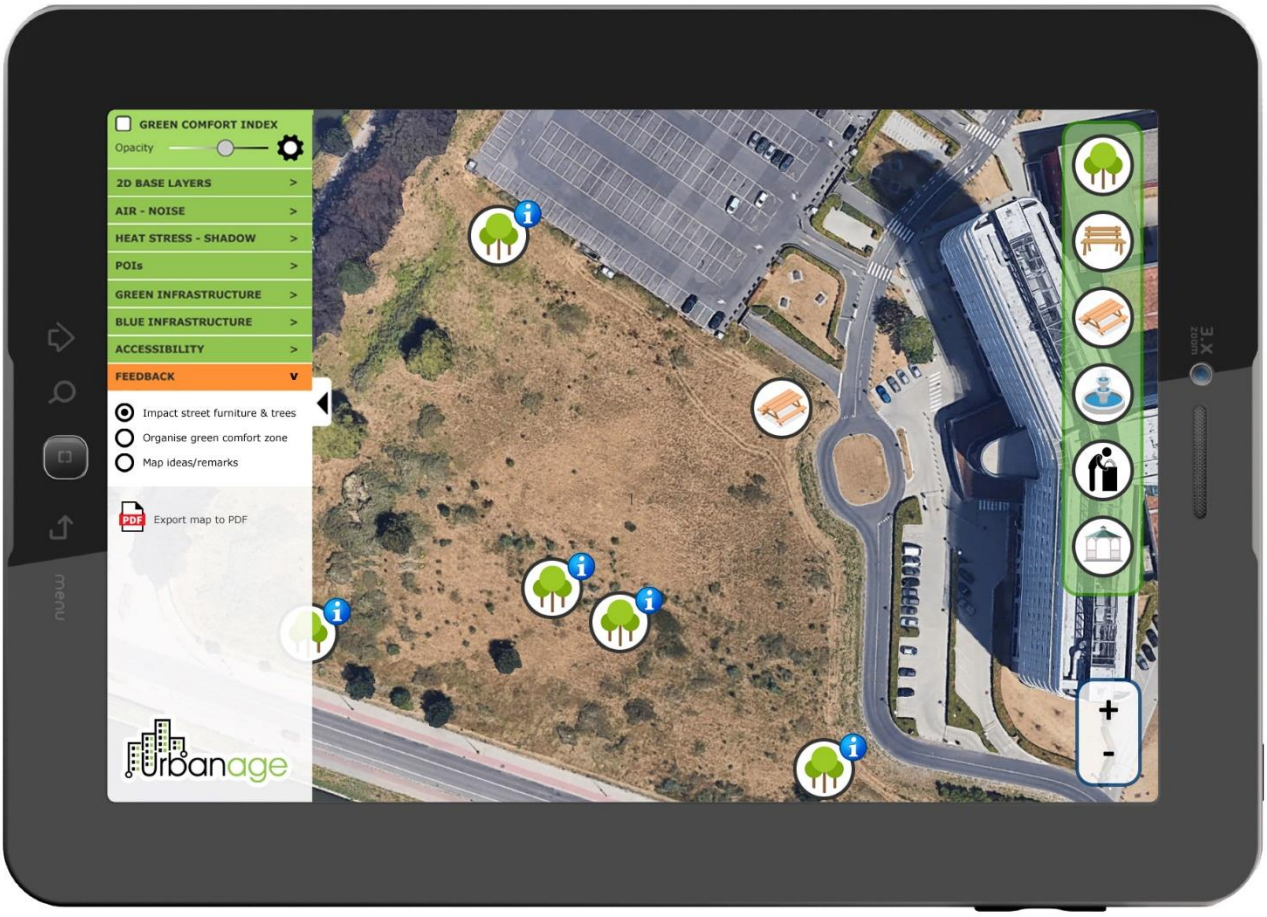


Figure 18: drag & drop simulation of the implant of POI elements into the city environment. Module for citizens and experts. POI elements are clickable.

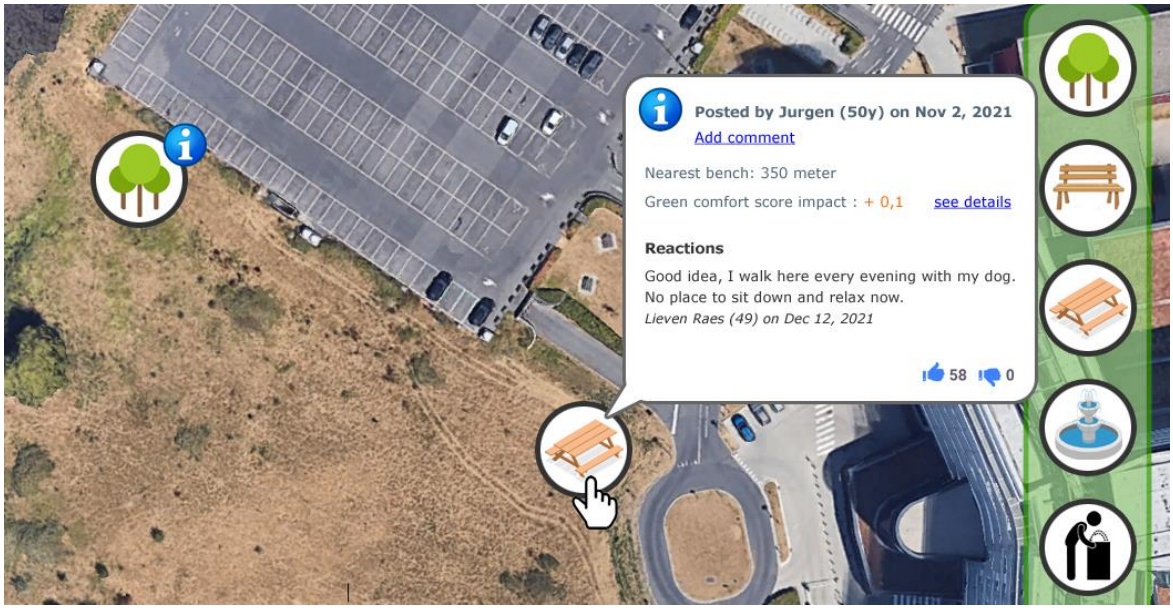


Figure 19: detailed information when a POI element is clicked/tapped. Information about the message owner, timestamp, nearest POI of the same type, the impact on the green comfort index, comments, likes/dislikes are added. Detailed information about the green comfort index score details is given when clicking the "see details" button.

Mock-up 3: simulation expert mode – study of POI-impact on green comfort index in a restricted area.

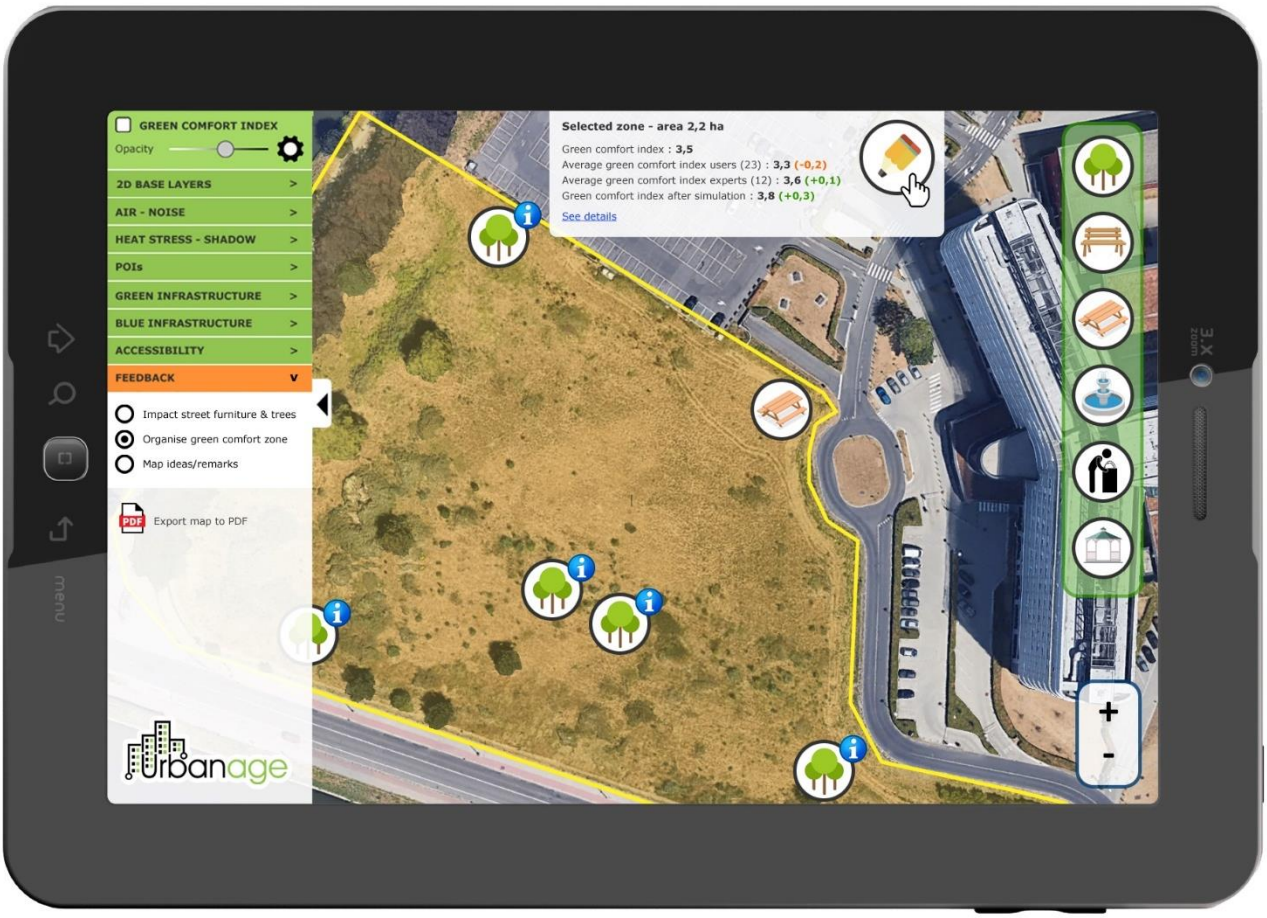


Figure 20: expert mode of the POI impact analysis tool. The expert can select a zone in the city (with the drawing tool -> polygon) where a simulation of POI additions & positioning can be made.
The effect on the green comfort is calculated and presented on top of the page. Detailed information about the score update (per indicator category) is shown when clicking/tapping the "see details" link.

Mock-up 4: gamification – map an idea or locate a potentially dangerous situation

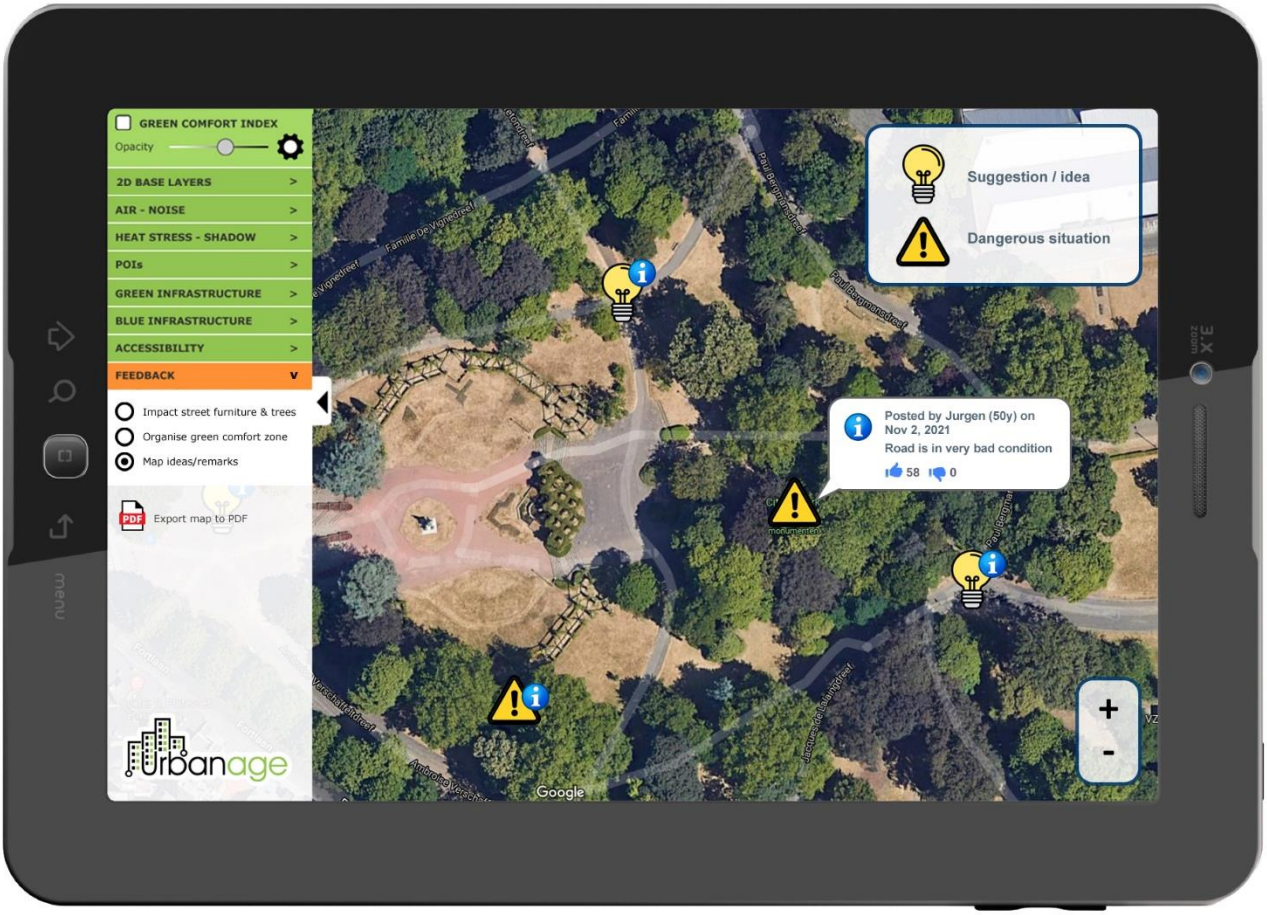


Figure 21: visualisation of the tool that used to add ideas, remarks and potential danger indications to specific locations in the city

Functionalities

Functionalities	Description	Role
Simulate the impact of the implant of extra street furniture and trees on the green comfort index.	Gamification tool with drag & drop functionalities. Recalculation of the green comfort index based on the updated situation.	Citizens, experts
Add ideas and notify potential dangerous situations on a 2D map.	Gamification tool with drag & drop functionalities.	Citizens, experts
Add simulation of the organisation of a green comfort zone in the city.	Drag and drop a POI element or feedback icon from the menu. Option to mark a region inside the city.	Experts

	Green comfort index calculations are based on the data available in this region only. Recalculation of the green comfort index based on the updated situation. Calculation of the area of the test zone.	
Save/store/update simulations.	Simulations can be named, saved and updated later.	Experts
Export simulations to create scenarios.	Simulations can be exported as images or as URLs showing a map with all added POIs or icons added. Includes information about the updated green comfort score.	Experts
Add POI elements or feedback icons on a map.	Drag and drop a POI element or feedback icon from the menu. The information/location is stored.	Citizens, experts
Select a POI element or feedback icons on the map.	The POI elements and feedback icons are clickable. Clicking a POI or icon triggers a pop-up showing information about the POI or topic that the icon represents. Information to include: name, age of the person who added the POI/icon, time of addition, number of likes/dislikes, the impact on the green comfort index, comments, distance to the nearest POI of the same type.	Citizens, experts
Add a comment on a POI or icon element, added by another user.	By clicking a POI or idea/remark icon, a popup appears. One of the items shown in the pop-up is the option to add a comment.	Citizens, experts
Like/dislike a comment added by another user.	By clicking the like/dislike icons, a logged in user can add a vote. Only one vote can be given per comment. Clicking another time on the same icon results in the withdrawal of the vote.	Citizens, experts
Update/delete POIs, feedback icons, comments, likes.	POIs that were added by the user as well as his/her posted comments, likes/dislikes can be updated or deleted at any time.	Citizens, experts

Table 48: Flanders pilot case 1 - user story 4 - functionalities

Definition of done

Functionalities	Done test description	Priority (show stopper)
Simulate the impact of the implant of extra street furniture and trees on the green comfort index.	I have access to the gamification tool with drag & drop functionalities. I can add items on a specific map location, the green comfort index will be recalculated for each added item.	YES
Add ideas and notify potentially dangerous situations on a 2D map.	I have access to the gamification tool with drag & drop functionalities. I can add items on a specific map location.	YES
Add simulation of the organisation of a green comfort zone in the city.	As an expert, I have access to the feedback layer with the gamification tool to evaluate the implant of POIs into a specific area. I can define this area myself by using the drawing option of the tool. The green comfort index is recalculated for the area I have marked. For this area, also information about the average score given by users and specialists is shown. The virtual addition of extra POIs I the landscape triggers the recalculation of the green comfort index, the results of the recalculation are shown and can be consulted in detail. When I click on the link “see details”, I see the individual scores for the indicators classes used to calculate the green comfort index. The surface area is calculated and shown as well.	YES
Save/store/update simulations.	As an expert, I can name and save my simulations, so I can continue working on them later.	YES
Export simulations to create **scenarios**.	As an expert, I can export the simulations I make to create images or URLs. The generated URLs link to a read only map with the POIs, their locations, and the updated green comfort index calculations included. The images and URLs can be used to introduce scenarios on the landing pages of the https://citytwin.eu/ pages. The gamification elements for scenarios (voting, rating) developed during the DUET project can be reused this way.	NO
Add POI elements or feedback icons on a map.	I can drag & drop POI element or feedback icon from the menu to the map. The information/location is stored.	YES
Select a POI element or feedback icons on the map.	I can click the POI elements and feedback icons. When I click an element, a pop-up appears, showing me information about the POI or topic that the icon represents.	YES

	Information that is included: name, age of the person who added the POI/icon, time of addition, number of likes/dislikes, the impact on the green comfort index, comments, distance to the nearest POI of the same type.	
Add a comment on a POI or icon element, added by another user.	I click a POI or idea/remark icon. A pop-up appears. One of the items shown in the pop-up is the option to add a comment. When I click the "add a comment" link, I can write a comment. My name and age are automatically added to be shown to the public.	NO
Like/dislike a comment added by another user.	I can click the like/dislike icons connected to a specific comment. When I click one of both icons, an anonymous vote is added. Only one vote can be given per comment. When I click the same icon again, the vote is withdrawn. After I can vote again (like or dislike).	NO
Update/delete POIs, feedback icons, comments, likes.	I can delete/update POIs and icon elements that I added myself. I can update/delete all feedback (written text, likes/dislikes) that I gave to other comments.	Citizens, experts

Table 49: Flanders pilot case 1 - user story 4 - definition of done

4.2.2.5 User story 5: Automated green comfort index updates

This user story can be seen as a supplement to user story 2. This user story focuses on the calculation method to determine the green comfort index.

Nr + Name	US5. Automated green comfort index updates.
Story	**As a** visitor or logged in user/expert, **I can** see the most recent green comfort scores.
Description functionalities	The green comfort index is a complex calculation, based on the measurement of indicators. • Indicator information may be dynamic, so the calculations need to be done on the fly at each request, **making use of the most recent datasets**. • Further, **corrections** can be made by logged in users and professionals/specialists. These calculations need to be taken into account as well. The weight of professional feedback must be stronger than the weight of the feedback given by non-professional citizens.

	• The availability of an indicator in a hexagon tile may influence surrounding hexagons. • The parameters included in the calculation of the green comfort index are not the same for all individual older persons. The relevance of the parameters may also fluctuate in time. That's why we offer the opportunity to visitors with an account to **switch parameters on/off**, presenting them an alternative calculation of the green comfort index. These aspects make the calculation of the green comfort index quite complex. Especially the integration of the user- and expert updates is something that needs to be continuously evaluated and updated depending on the results. This self-learning mechanism combined with the expert simulation results can be a basis for the introduction of **artificial intelligence** (AI). An AI solution corrects the green comfort scores, making them more reliable every day. With the continuous updating of the green comfort indexes by AI, also the resulting green comfort map will be updated.
Actors involved	Citizen, Professional.
Pre-condition	Logged in citizens and professionals. Citizens and professionals can update the scores.
Post-condition	None.

Table 50: Flanders pilot case 1 - user story 5

Main Success Path (primary flow)	PC MAP
ACTOR ACTIONS	SYSTEM RESPONSE
Citizen/professional actor logs in. Citizen/professional actor navigates to the 2D map and activates the layer green comfort index.	System shows the hexagon green comfort layer.
Actor clicks/taps on a hexagon on the map.	System launches a pop-up window showing the calculated score. System also shows averages of the corrections made by users and experts. System allows actor to update or confirm the score, see user story 2.
Actor updates the score, by updating the indicators, see user story 2.	System registers/stores the updates.

	System calculates green comfort index for each hexagon on the green comfort index map **using AI** and taking into account: • the most recent information on the 2D-map layers that are used to calculate the comfort green index; • the input of users and experts. The weight of the input will change in time by self-learning; • the individual settings of a user citizen/expert. Using the settings button, a selection can be made of the parameters taken into account to calculate the green comfort index. Nearby hexagon tiles will be influenced by an updated score, but also the calculation method can be reviewed based on repetitive updates. If possible, fake input should be detected by the system AI so this input will no longer be used to make calculations. The average scores of the users need to be recalculated but also the likes/dis-likes can be recalculated based on these results. The system shows an updated map. With the update of the hexagon green comfort index scores, also the colour code of the hexagon needs a review. *See also the AI implementation part.*

Table 51: Flanders pilot case 1 - user story 5 - main success path

Process flow scenario (including alternatives and exceptions) – **optional**

NONE

Mock-ups

Not applicable

Functionalities

Functionalities	Description	Role
Keep green comfort index up to date.	Update the green comfort index for each hexagon on the 2D map, based on: • the most recent values for the parameters used in the green comfort index calculations; • **corrections made by users** (with different weight factors used for citizens and experts). Weight factors are updated by AI self-learning. Of course, also the number of **user updates** for a hexagon tile affects the significance of the updates. *The goal is to update the automatically calculated green comfort scores to best fit the input from the users;* • detection of fake input by AI and resulting recalculations; • influences of values in nearby hexagons. Also here, weight factors for all parameters involved can be updated by self-learning AI; • the individual settings of users, since not all parameters will be selected as being relevant to them.	System
Show an updated map.	Based on the continuously recalculated green comfort indexes, a new map will be generated with an updated of the hexagon colours according to the legend scale.	System
Show updated averages of user input based on AI-output.	Fake records that are detected will not be taken into account. Also the connected likes/dislikes will be denied. Related written feedback will no longer be shown.	System
Storage of historic data and the AI evolution path.	This will be necessary for evaluation purposes.	System

Table 52: Flanders pilot case 1 - user story 5 - functionalities

Definition of done

Functionalities	Done test description	Priority (show stopper)
Keep green comfort index up to date.	• Evaluation of the green index score calculations and all sources used to make these calculations. • Evaluation of AI input and output. • Definition of parameters to determine the success of AI if possible. The evolution of these parameters will be closely monitored. • Analysis of the changes of weight factors. • Analysis of the records flagged as fake by the AI manually. Add corrections to help the AI evolving. • Analysis of the evolution of the influence of nearby hexagons as continuously updated by the AI. • If possible, manual analysis of samples and comparison with computed/corrected values. • Evaluation of the variables that are ignored by users to calculate the green comfort index. Consequent revision of the calculation procedure.	Statistician, analysts YES
Show an updated map.	Monitor all aspects of the map updates.	Statistician, analysts YES
Show updated averages of user input based on AI-output.	Monitor if the effects of exclusion of records are implemented correctly.	Statistician, analysts YES
Storage of historic data and the AI evolution path.	This will be necessary for evaluation purposes.	Statistician, analysts NO

Table 53: Flanders pilot case 1 - user story 5 - definition of done

4.2.2.6 User story 6: Export results

Nr + Name	US6. Export results.
Story	As an expert with an account, I can **export the results** of the green comfort index scoring (manually and automatically).
Description functionalities	The green comfort index scores should be exportable. The export dataset should contain: • Green Comfort Index values as automatically calculated by the system; • average green comfort index updates made by citizens and experts; • differences between the 3 measuring methods; • separate measured values for all parameters used in the calculation of the green comfort index. Exported datasets need to be anonymised. This exported information is a good basis for further investigations. Besides the export of data, a PDF-export option is needed to create high resolution maps. Hardcopy printed maps and posters can be presented to older people to help them to find cosy & comfortable green zones in their city. The workshops with older people learned that non digital communication is very important for them.
Actors involved	Professional advisor, policy maker.
Pre-condition	Experts are logged in.
Post-condition	None.

Table 54: Flanders pilot case 1 - user story 6

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
The expert actor clicks the “export results” button.	System opens the export window.
The expert actor uses the drawing tool to select a specific city region. The expert can also select predefined regions such as provinces or individual cities on a map of Flanders.	System registers the boundaries of the selected area and preselects all data within this zone.

The expert actor defines the export specifications: • the type of data (manual input or automatically calculated, delta's, maps, etc.); • the format of the data export (PDF, png, shape, XML, csv, …); • the timeframe or timestamp of data capture.	The system captures the requirements. The system prepares the datasets or creates a map. Maps are in high resolution and vector based. They can be printed as a A1 or A0 posters to inform older people that don't have access to digital communication devices.
The expert actor can request for an export of anonymised feedback (written feedback, liking/disliking votes) provided by users on the simulation maps (see user story 4).	System gathers anonymous information and sends it to the expert actor using the requested file format.

Table 55: Flanders pilot case 1 - user story 6 - main success path

Process flow scenario (including alternatives and exceptions) – **optional**

NONE

Mock-ups

Mock-up 1 – PDF-export option for 2D-maps.

Figure 22: PDF-export function on the 2D map of the Urbanage solution

Mock-up 2 – Urbanage poster in a care centre

Figure 23: PDF-posters in an older people care centre

Functionalities

Functionalities	Description	Role
Export datasets.	Export the results for a specific region to an output format that can be reused by other applications (e.g. CSV, XML, JSON). Export screen contains selection options for region, dataset type and file format.	Professional advisor, Policy maker
Export map.	Export maps that can be printed in high resolution or that can be easily integrated into a report/brochure.	Professional advisors, policy makers, older people

Table 56: Flanders pilot case 1 - user story 6 - functionalities

Definition of done

Functionalities	Done test description	Priority (show stopper)
Export datasets.	• I click the export button. • I can select predefined regions on a map of Flanders (provinces, cities) and I can select a zone on the map using a drawing tool (marking rectangles, circles). • I can choose what type of data I want to export for the selected zone (automatically calculated, averages of input by experts or citizens, the difference between both). • I can select for what period or what exact date I want to export data.	YES

	• I can choose the file format of the export.	
Export map.	I can set zoom level, location, layers, opacity and other visualisation settings of the 2D-map. When I press the export to PDF button, I get a high resolution vector-based PDF-file that I can use for printing, documentation and other dissemination purposes.	YES
Export feedback results.	I can download the feedback and likes/dislikes of comments from the *Urbanage* solution. I receive the information in an anonymised way.	NO

Table 57: Flanders pilot case 1 - user story 6 - definition of done

4.2.2.7 User story 7: Policy reporting dashboard

Nr + Name	US7. Policy reporting dashboard.
Story	As a policy maker (expert with an account), I can consult a **dashboard**, reporting the current situation and the impact of suggested changes, so I have a clear view on what is the best policy decision.
Description functionalities	For two of the user stories in particular, **dashboards** can be of great added value for graphically tracking, analysing, and displaying key performance indicators, metrics, and data points relevant to a particular objective: 1. overviewing (reporting) the current green comfort index (**see user stories 2 and 5**) and all its integrated parameters/indicators; 2. Reporting simulation results (**see user story 4**) to monitor the impact. Dashboards can be stored and a URL is created for stored dashboards. This way, the expert users can use the URL to present different scenario results to visitors of the https://citytwin.eu/ website which they can comment, evaluate, vote, like/dislike, … (see user stories 4 and 10, gamification & scenarios).
Actors involved	Policy maker, system manager.
Pre-condition	User is logged in. User stories 2, 4 and 5 results are available.
Post-condition	None.

Table 58: Flanders pilot case 1 - user story 7

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
Actor clicks the “create dashboard” option.	System opens the “create dashboard” wizard. The first step, selection of the location/region/zone, is set available to the actor.
Actor selects the location/region/zone by using the drawing tool or by selecting preset regions (cities in Flanders) in a layer.	System records the selection. System opens the “compose dashboard” screen.
Actor selects the “green index score” option or the “scenario simulation” option as the dashboard type.	System opens all specific sub options allowing to set the preferences of the selected dashboard type.
Actor sets the **green comfort index** preferences for the selected dashboard. Actor proceeds with the last step, “create dashboard”.	System creates the dashboard showing KPIs in a comprehensible way using graphic visualisation tools. Graphs include the visualisations of the green index score as calculated (using AI) by the system, the averages as suggested by the experts, the averages as suggested by citizens and the differences between the scores. Also, the values of the different parameters used to calculate the green comfort index score are visualised.
The actor selects the scenarios - stored in the actors account – that he/she wants to compare. Individual simulations can also be compared with the actual situation.	System creates the dashboard showing KPIs in a comprehensible way using graphic visualisation tools. Graphs include the visualisations of updated green comfort index as a result of the simulation, analyses of details of the simulation.
The actor stores the dashboard.	System creates a copy of the dashboard and creates a unique URL that can be accessed, showing exactly the same dashboard.
The actor clicks/taps the “export to PDF” button.	System creates an accessible PDF, neatly showing all graphs that are on the screen. Information about the selected area is added. A timestamp is added since dashboards change in time when datasets get updated.

Table 59: Flanders pilot case 1 - user story 7 - main success path

Process flow scenario (including alternatives and exceptions) – **optional**

NONE

Mock-ups

No mock-ups available.

Functionalities

Functionalities	Description	Role
Create dashboard.	Step 1: select a region (manually of select a city in Flanders).	Citizen, expert
Create dashboard.	Step 2: select dashboard type: • **Green Comfort Index;** • **simulations.**	Citizen, expert
Create **green comfort index** dashboard.	Step 3: set preferences to create the dashboard for the selected area.	Citizen, expert
Create **simulation** dashboard.	Step 3: set preferences to create the dashboard for the selected area. Stored simulations can be compared with each other or with the real situation at that moment.	Citizen, expert
Save/store a dashboard.	The dashboard and all its settings are stored. A timestamp is added and a URL is created. Visiting the URL afterwards will create exactly the same dashboard.	Citizen, expert
Export dashboard to PDF.	Create a PDF that is an exact copy of what is seen on the screen, add timestamp and info about the selected zone. Since dashboards change all the time when datasets are updated or when the green comfort index is updated by the AI.	Citizen, expert

Table 60: Flanders pilot case 1 - user story 7 - functionalities

Definition of done

Functionalities	Done test description	Priority (show stopper)
Create dashboard.	As a logged in citizen/expert, I can select a region (manually of select a city in Flanders).	YES
Create dashboard.	As a logged in citizen/expert, I can select dashboard type.	YES

Create **green comfort index** dashboard.	As a logged in citizen/expert, I can set preferences to create the dashboard for a selected area.	YES
Create **simulation** dashboard.	As a logged in citizen/expert, I can set preferences to create the dashboard for a selected area. Stored simulations can be compared with each other or with the real situation at that moment.	YES
Save/store a dashboard.	As a logged in citizen/expert, I can store a dashboard and all its settings. A timestamp is added and a URL is created. Visiting the URL afterwards will create exactly the same dashboard.	YES
Export dashboard to PDF.	As a logged in citizen/expert, I can create a PDF that is an exact copy of what is seen on the screen.	NO

Table 61: Flanders pilot case 1 - user story 7 - definition of done

4.2.2.8 User story 8: Add and update data sources

Nr + Name	US8. Add and update data sources.
Story	As a system administrator, I can add and update **extra data sources/data layers**.
Description functionalities	To make the *Urbanage* solution future proof, it is a good idea to foresee updates of the available datasets to determine the green index score. Since interesting extra indicators may become available in the future. With the introduction of new indicator data layers, also extra settings/weight factors will be needed to determine the updated green comfort index score. The AI behind the calculation of the green comfort index needs to be updates in order that the added layers are taken into account as well. Also, dashboards will need to be updated, taking into account the added indicators. As a result, green comfort index scores will not be comparable after addition of extra parameters included in the green comfort index calculations. Back-ups are needed where *deleted* layers are stored.
Actors involved	System expert.
Pre-condition	Expert user is logged.
Post-condition	None.

Table 62: Flanders pilot case 1 - user story 8

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
Logged in expert actor clicks on the data catalogue button.	System opens the data catalogue management screen.
Logged in expert actor performs CRUD actions.	System checks the validity of the dataset. System sends error messages when datasets are not valid. System requests the setting of parameters and preferences for the new data layer.
Actor sets preferences and settings.	• System stores/updates/deletes the dataset (file or service link). • System updates AI settings when applicable (inclusion of the layer in the green comfort index determination). • System updates the dashboards and other visualisations when applicable.

Table 63: Flanders pilot case 1 - user story 8 - main success path

Process flow scenario (including alternatives and exceptions) – **optional**

NONE

Mock-ups

Not available.

Functionalities

Functionalities	Description	Role
Add data source (file).	Upload a new data source file.	System expert
Delete data source (file).	Delete a data source file.	System expert
Edit data source (file).	Edit a data source file.	System expert

Table 64: Flanders pilot case 1 - user story 8 - functionalities

Definition of done

Functionalities	Done test description	Priority (show stopper)
Add data source (file).	As a system administrator, I can upload a new data source file and I can update the settings & preferences. The AI calculations of the green index, the dashboard compositions, and all other visualisations/calculations are updated accordingly.	NO
Delete data source (file).	As a system administrator, I can delete a data source file. The AI calculations of the green index, the dashboard compositions, and all other visualisations/calculations are updated accordingly.	NO
Edit data source (file).	As a system administrator, I can edit a data source file and I can update the settings & preferences. The AI calculations of the green index, the dashboard compositions, and all other visualisations/calculations are updated accordingly.	NO

Table 65: Flanders pilot case 1 - user story 8 - definition of done

4.2.2.9 User story 9: Statistics overview

Nr + Name	US9. Statistics overview.
Story	As a system administrator, I can consult the **status of the server**.
Description functionalities	For the online and interactive *Urbanage* solution, it is important to ensure a high uptime. Also, malfunctioning of the software needs to be closely monitored to ensure optimal user experiences. Further, informal user statistics are very welcome to the system administrator to see the relevance of the application and of the data that are inserted into *Urbanage* solution by all kinds of users. That is why the system administrator needs the necessary tools to **monitor** the server uptime/downtime, various aspects of the functioning of the application with an active

	automated warning system sending out alerts when the server or application is down or not working properly. Besides the automated notifications, all users (citizens and experts) need to be able to contact the system administrator with high priority when the *Urbanage* solution is not working properly.
Actors involved	System administrator (monitoring the application & its services). Citizen and expert users (sending a warning/error message to the system expert).
Pre-condition	System administrator and users need to be logged in.
Post-condition	None.

Table 66: Flanders pilot case 1 - user story 9

Main Success Path (primary flow)	(interface from an end-user perspective) – system expert uses his own expert back-office management tools (out of scope of US 10).
ACTOR ACTIONS	SYSTEM RESPONSE
Administrator actor clicks on the "report" button.	System opens the "report" wizard. System immediately shows alerts if there is a crucial problem. System immediately shows the logged malfunctioning of the last month, so the actor can notice recurrent problems.
Administrator actor selects an aspect of the *Urbanage* solution he/she wants to investigate.	System shows the most relevant numbers/graphs/tables needed to understand the actual status of the server and the application itself.
Administrator actor clicks/taps the history button.	System shows the recorded incidents. System shows extra information to help to understand the impact of these incidents.
User actor can report a bug or other malfunctioning of the *Urbanage* solution.	System shows a form asking the right questions. System stores the reported message and sends a push message to the system expert/admin.

Table 67: Flanders pilot case 1 - user story 9 - main success path

Process flow scenario (including alternatives and exceptions) – **optional**

NONE

Mock-ups

No mock-ups available.

Functionalities

Functionalities	Description	Role
Malfunctioning alert.	If a crucial incident occurs, the administrator receives an alert. The alerts are logged.	Administrator
Server & software actual status.	The administrator has access to a password protected dashboard showing the most relevant numbers/graphs/tables needed to understand the actual status of the server and the application itself.	Administrator
Server & software status history.	The administrator can consult the recorded incidents. Extra information is available to help to understand the impact of these incidents.	Administrator
Report malfunctioning.	All visitors of the website can report a bug or other malfunctioning of the *Urbanage* solution by filling out a form. Report messages are stored. A push message is sent to the administrator.	All

Table 68: Flanders pilot case 1 - user story 9 - functionalities

Definition of done

Functionalities	Done test description	Priority (show stopper)
Malfunctioning alert.	As a system administrator, I receive an alert when a crucial incident occurs. Alerts are logged.	NO
Server & software actual status.	As a system administrator, I have access to a password protected dashboard showing the most relevant numbers/graphs/tables needed to understand the actual status of the server and the application itself.	NO
Server & software status history.	As a system administrator, I can consult the recorded incidents. Extra information is available to help to understand the impact of these incidents.	NO
Report malfunctioning.	As a visitor of the *Urbanage* solution, I can report a bug or other malfunctioning of the *Urbanage* solution by filling out a form. Report messages are stored. A push message is sent to the administrator.	YES

Table 69: Flanders pilot case 1 - user story 9 - definition of done

4.2.2.10 User story 10: Create case on the https://citytwin.eu/ landing pages

Nr + Name	US10. Create case on the https://citytwin.eu/ landing pages.
Story	As a policy maker, I can **create cases** and gamification scenarios that can be accessed by users.
Description functionalities	A **professional user** has access to the WordPress back-office of the website https://citytwin.eu/. The user can create cases by filling out all required fields and by adding additional documentation and illustrations. The user can create scenarios, **based on the saved scenarios from user story 4** (images or URLs), **based on the dashboards** (user story 7), or made by another application like DUET. Scenarios can be presented to the visitor of the website by snapshots or by hyperlinks towards the read-only version of the created scenarios described in user story 4. The **two available gamification** elements of DUET can be used for **co-creation purposes**. Gamification – rate scenarios. The scenarios, presented by graphics, dashboards or by URLs can be explored by all users (see user story 4). Rating the scenarios is only available for users having an account. Each of the scenarios can be rated separately using a Likert scale. After rating, the logged in user can see the result of the rating. Professionals can see the results in the back-office of the https://citytwin.eu/ landing pages. Gamification - mark a spot. Based on snapshots made in user story 4, spots can be added by logged in visitors of the website to mark a specific location. The professional user, setting up the gamification session, can add a question like "Where would you install a new set of trees?". The result of all added transparent spots is shown to the public. The resulting heatmap makes preferred spots clear. All logged in users (citizens and professionals) can give feedback to a case. They can also react to the feedback of others and they can like/dislike comments. This can help the policy makers to evaluate different scenarios.
Actors involved	Policy makers.

Pre-condition	User is logged in (into the *WordPress* site or Digital Twin).
Post-condition	None.

Table 70: Flanders pilot case 1 - user story 10

Main Success Path (primary flow)	Create/update/delete a case
ACTOR ACTIONS	SYSTEM RESPONSE
Professional actor logs in in the back-office of the https://citytwin.eu/ landing pages.	System shows the options: • **add/update/delete a case**; • add/update/delete scenarios; • add/update/delete gamification elements; • see/analyse/download results of the gamification sessions.
Professional actor clicks on the "Add/update/delete a case" button.	System opens a form where case parameters can be added or updated.
Professional actor wants to add meta information (including URLs) about the case.	System shows text fields, dropdown boxes, radio buttons, checkboxes where all meta information can be inserted.
Professional actor wants to add images and movies to illustrate the case.	System includes upload functionalities to the case detail form. Images and movies can be uploaded and will be part of the case description.
Professional actor finishes the input of case details.	System shows a "save" button, when clicked the (updated) information is stored.
Visitor actor visits the https://citytwin.eu/ website homepage	System shows the *Urbanage* cases for the cooperating cities in Flanders.
Visitor actor clicks on a case	System shows case details on a separate page, including scenarios and gamification modules (if available and activated in the back-office by the professional user)
Visitor actor clicks an an image or movie	The images are shown in presentation modus lightbox. The movies can be played within the *Urbanage* pages.

Table 71: Flanders pilot case 1 - user story 10 - main success path 1

Main Success Path (primary flow)	Create/update/delete scenarios.
ACTOR ACTIONS	SYSTEM RESPONSE
Professional actor logs in in the back-office of the https://citytwin.eu/ landing pages.	System shows the options: • add/update/delete a case; • **add/update/delete scenarios**; • add/update/delete gamification elements; • see/analyse/download results of the gamification sessions.
Professional actor clicks on the "Add/update/delete scenarios" button.	System opens an overview of all scenarios related to the specific case. By clicking a scenario in the list, a form opens where scenario details can be added or updated: • scenario title; • scenario description; • URL to read only representation of the case (see US4); • URL to read only dashboard (see US7); • visual representing the scenario; • activate/inactivate scenario.
Visitor actor visits the case.	System automatically shows the active scenarios, if available.

Table 72: Flanders pilot case 1 - user story 10 - main success path 2

Main Success Path (primary flow)	Gamification – rate scenarios
ACTOR ACTIONS	SYSTEM RESPONSE
Professional actor logs in in the back-office of the https://citytwin.eu/ landing pages.	System shows the options: • add/update/delete a case; • add/update/delete scenarios; • **add/update/delete gamification elements**; • **see/analyse/download results of the gamification sessions**.
Professional actor clicks on the "Add/update/delete gamification elements" button.	System shows the available gamification tools: • **rate a scenario**; mMark a location.
Professional actor selects the "rate a scenario" type of gamification element.	System opens editor for the gamification tool, rate a scenario: • question to the visitors; • presentation mode of the scenarios (graphical, dashboard, URL); • rating mode: Likert scale, order the scenarios, select one of the scenarios; • activate/inactivate scenario.

Professional actor selects the "**see/analyse/download results of the gamification sessions"** option from the main menu.	System shows the voting results. The results can be downloaded.
Visitor actor visits the case	System automatically shows the active gamification elements (rate scenarios), if available.
Logged in citizen or professional actor clicks a button to activate the gamification element.	System launches the gamification element. System automatically shows the results when the actor finishes the gamification procedure.

Table 73: Flanders pilot case 1 - user story 10 - main success path 3

Main Success Path (primary flow)	Gamification – mark a location.
ACTOR ACTIONS	SYSTEM RESPONSE
Professional actor logs in in the back-office of the https://citytwin.eu/ landing pages.	System shows the options: • add/update/delete a case; • add/update/delete scenarios; • **add/update/delete gamification elements**; • **see/analyse/download results of the gamification sessions**.
Professional actor clicks on the "Add/update/delete gamification elements" button.	System shows the available gamification tools: • rate a scenario; • **mark a location**.
Professional actor selects the "mark al location" type of gamification element.	System opens editor for the gamification tool, mark a location: • question to the visitors, ex. where would you install a new drinking fountain? • upload of an image. Crop/pan the image; • set size of marking tool (circle diameter).
Professional actor selects the "**see/analyse/download results of the gamification sessions"** option from the main menu.	System shows the resulting heatmap. The results can be exported as an image or .xlsx document with x-y coordinates, and remarks for all inserted locations.
Visitor actor visits the case.	System automatically shows the active gamification elements (mark a location), if available.
Logged in citizen or professional actor clicks on a button to activate the gamification element.	System launches the gamification element. System automatically shows the results when the actor finishes the gamification procedure.

Table 74: Flanders pilot case 1 - user story 10 - main success path 4

Process flow scenario (including alternatives and exceptions) – **optional**

NONE

Mock-ups

Mock-up 1: landing pages DUET

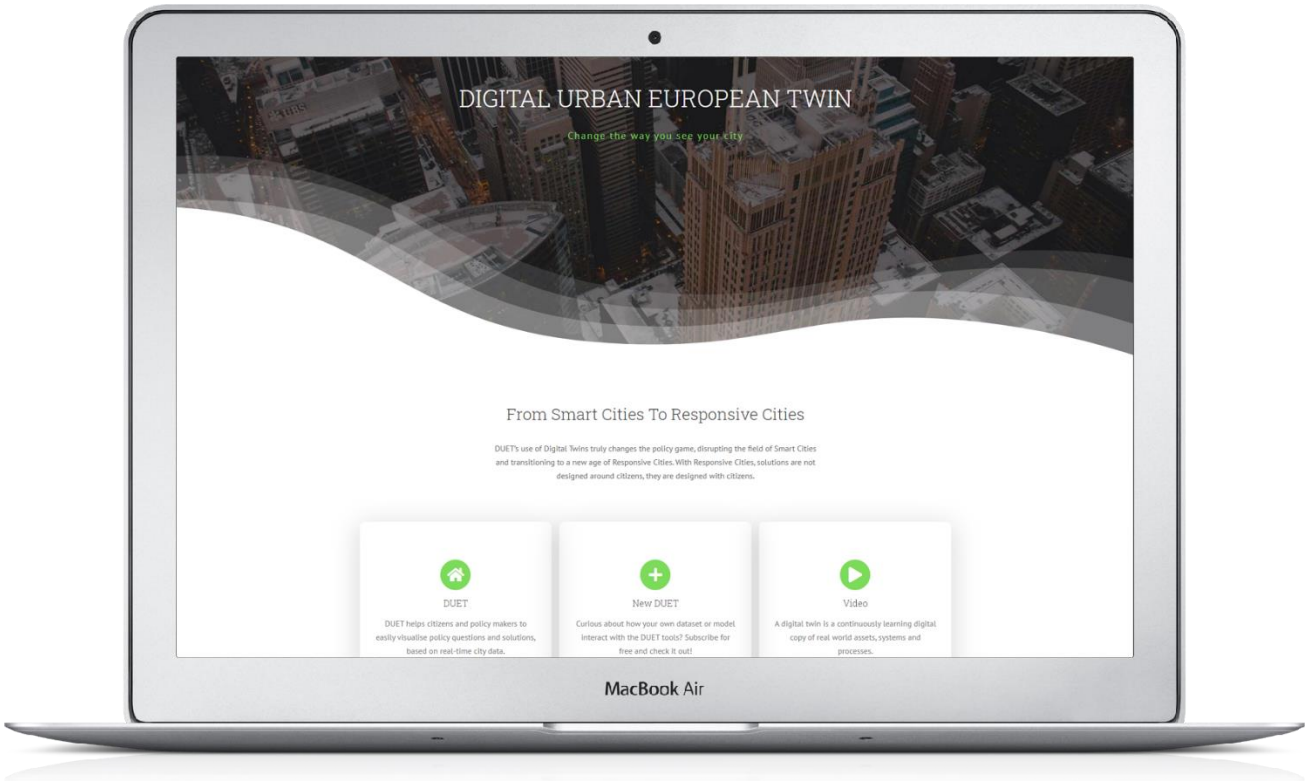


Figure 24: the https://citytwin.eu/ DUET landing pages homepage

Mock-up 2: detail of the *Urbanage case* in citytwin.eu.

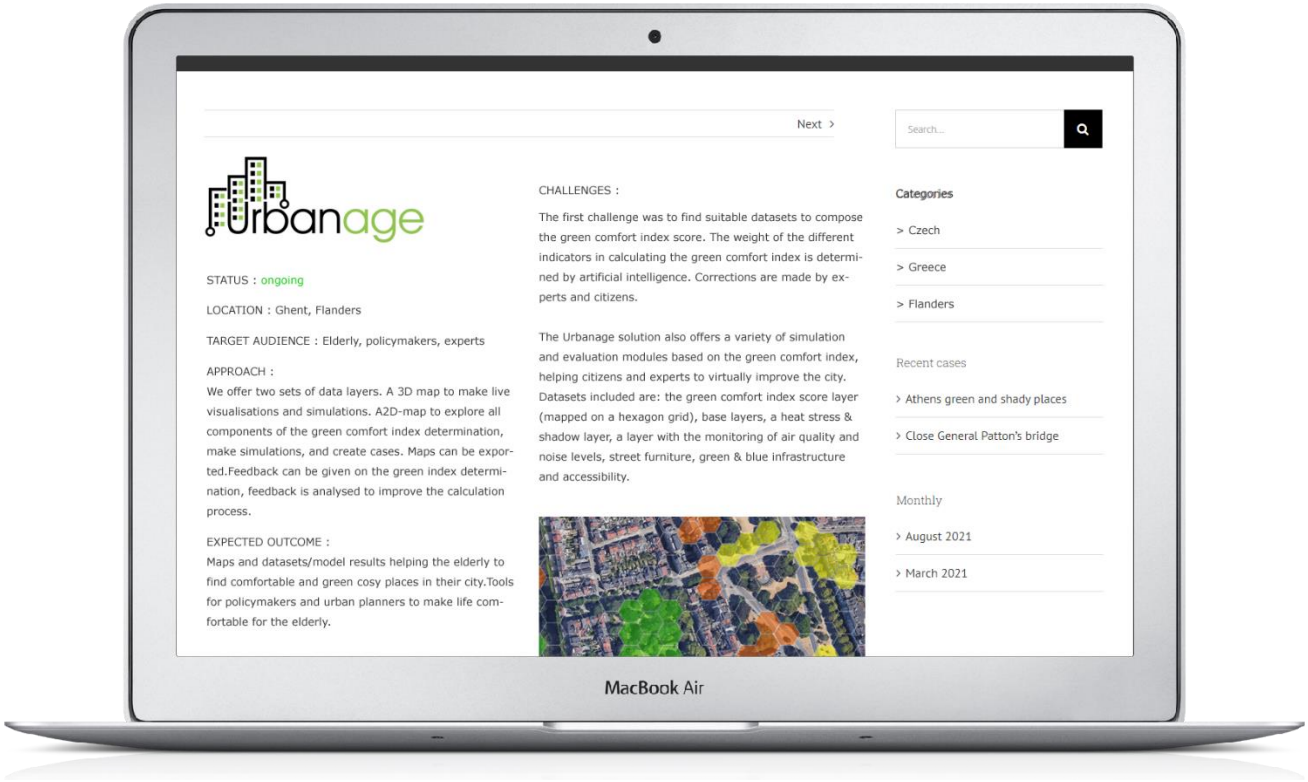


Figure 25: Urbanage case detail page on https://citytwin.eu/

Mock-up 3: detail of the *Urbanage case* in citytwin.eu.

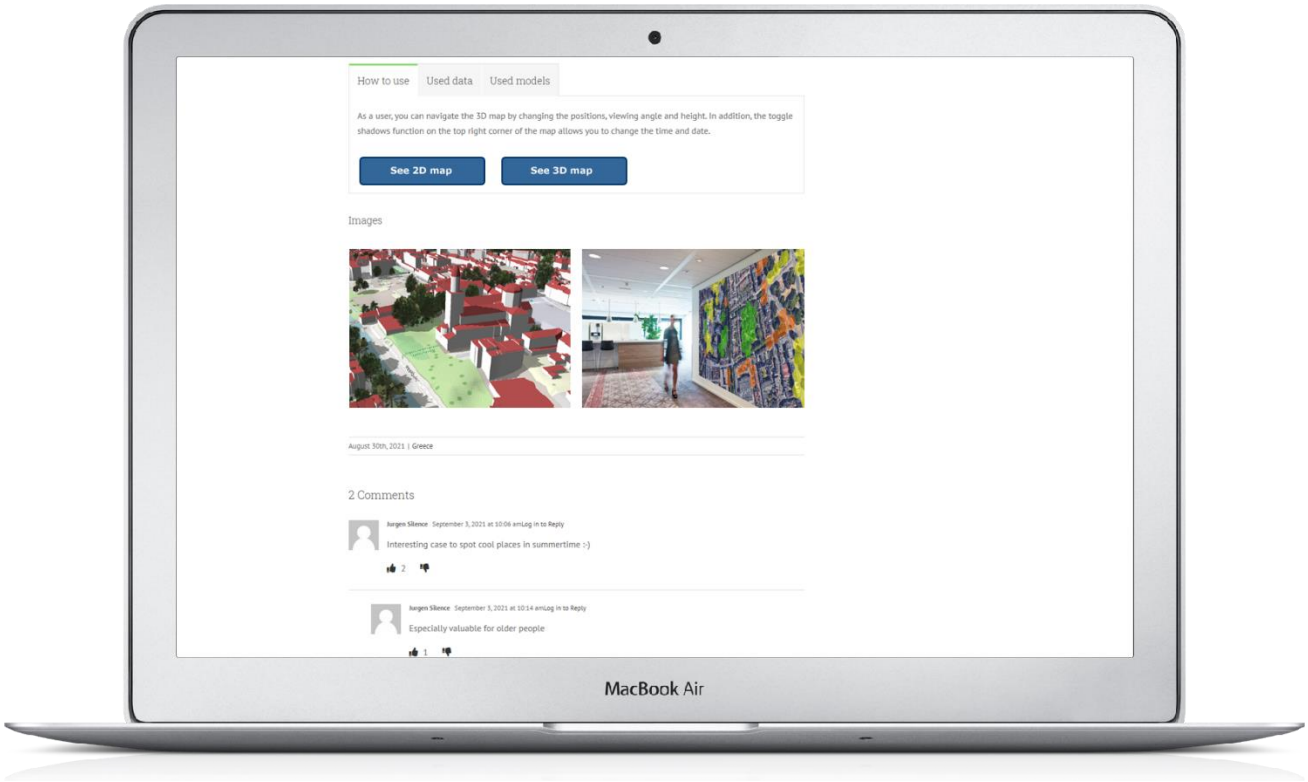


Figure 26: Urbanage case detail page on https://citytwin.eu/

Mock-up 4: presentation of scenarios in the https://citytwin.eu/ application + rating option

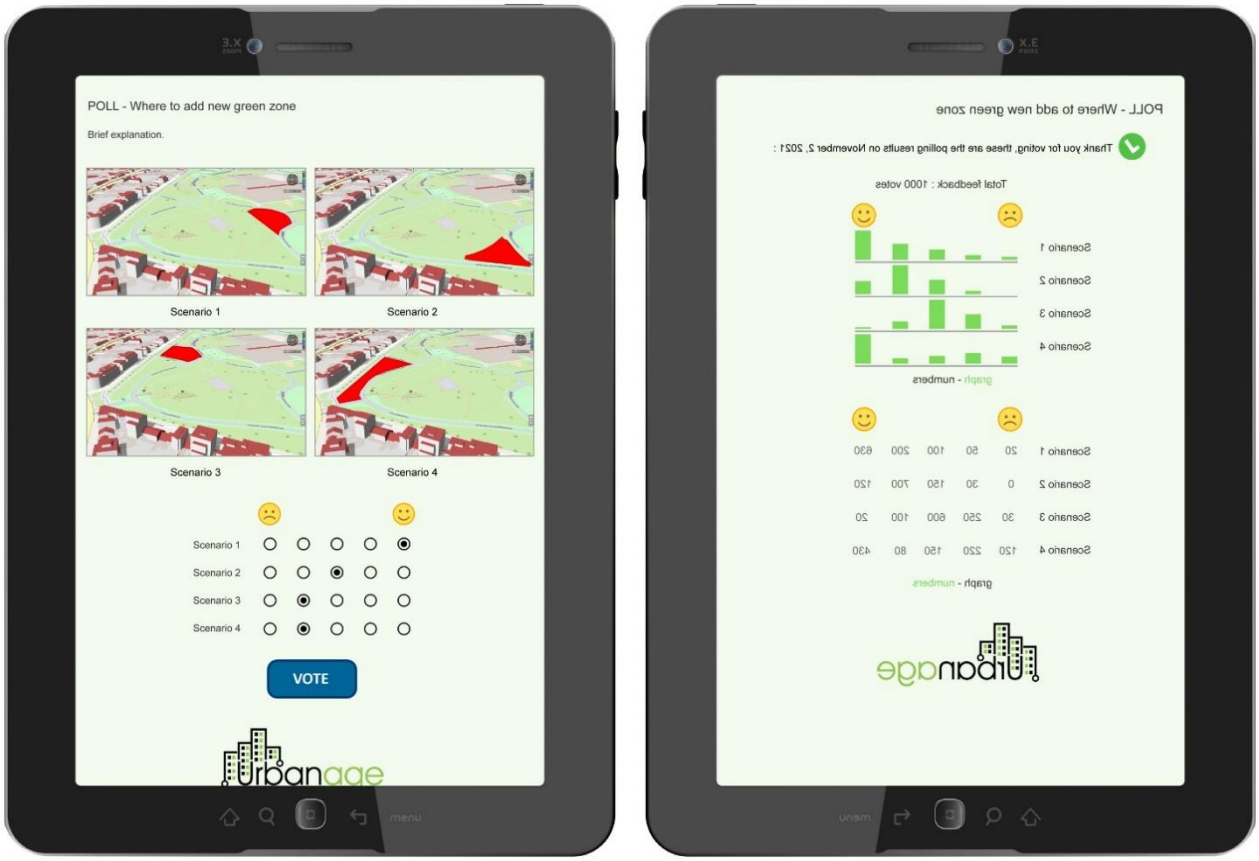


Figure 27: these screenshots represent the rating functionality of the https://citytwin.eu/ website, applied to a set of Urbanage scenarios described in User Story 4.
Four visual representations of scenarios (the implant of a new feature) are presented to the website visitor. Each scenario can be rated by means of a Likert scale. The image at the right shows the results of the rating.

Mock-up 5: using the gamification hot spotting tool of https://citytwin.eu/.

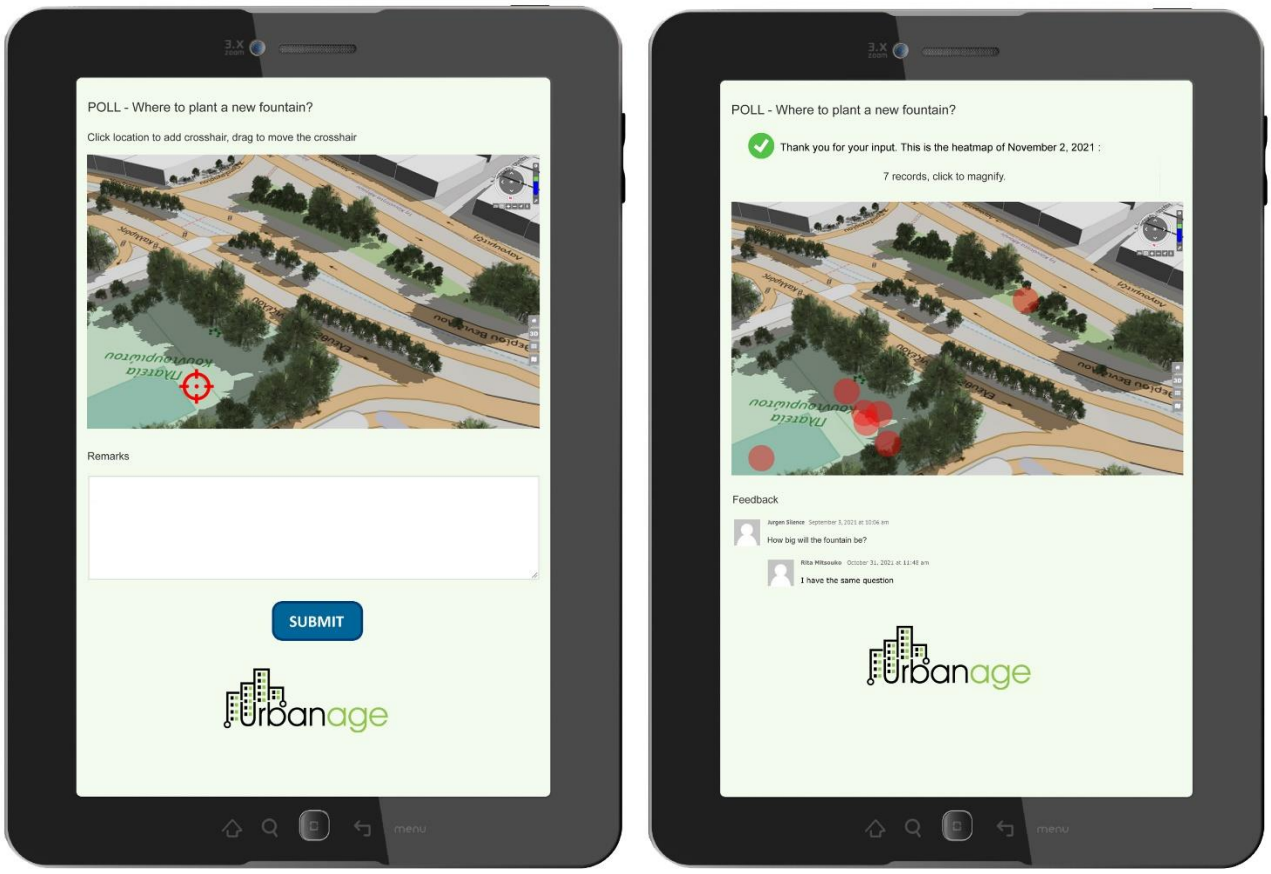


Figure 28: a snapshot made by logged in professional users (user story 4) can be used as a basis to start a survey. The screenshots above show the front end pop-up where citizens and professionals can mark a specific spot and leave a comment at the left. At the right, the result of all input is shown. All persons with an account can react to comments.

Functionalities

Functionalities	Description	Role
Add/update/delete a case.	Add/update/delete a case.	Logged in professional policy maker
Add/update/delete scenarios.	Add/update/delete scenarios.	Logged in professional policy maker
Add/update/delete gamification - rate scenarios.	Add/update/delete a gamification session, rate scenarios.	Logged in professional policy maker
Add/update/delete gamification - mark a location.	Add/update/delete gamification session, mark a location. The result will be a hotspot image.	Logged in professional policy maker
See/analyse/download results of the gamification elements.	See/analyse/download results of the gamification elements.	Logged in professional policy maker

Participate in the gamification/co-creation.	Participate in the rating of a scenario or in marking a location.	Logged in professional policy maker and citizens
Comment a case, like/unlike comments, react to comments.	Comment a case, like/unlike comments, react to comments.	Logged in professional policy maker and citizens
See all cases and scenarios.	See the cases and all scenarios related to a specific case.	All

Table 75: Flanders pilot case 1 - user story 10 - functionalities

Definition of done

Functionalities	Done test description	Priority (show stopper)
Add/update/delete a case.	As a user expert, I can add/update/delete a case.	YES
Add/update/delete scenarios.	As a user expert, I can add /update/delete scenarios.	NO
Add/update/delete gamification - rate scenarios.	As a user expert, I can add /update/delete a gamification session, rate scenarios.	NO
Add/update/delete gamification - mark a location.	As a user expert, I can add /update/delete gamification session, mark a location. The result will be a hotspot image.	NO
See/analyse/download results of the gamification elements.	As a user expert, I can see /analyse/download results of the gamification elements.	YES
Participate in the gamification/co-creation.	As a logged in user, I can participate in the rating of a scenario or in marking a location.	YES
Comment a case, like/unlike comments, react to comments.	As a logged in user, I can comment a case, like/unlike comments, react to comments.	NO
See all cases and scenarios.	As a visitor of the website, I can see the cases and all scenarios related to a specific case.	YES

Table 76: Flanders pilot case 1 - user story 10 - definition of done

4.2.3 Required datasets

During the co-creation workshops performed in the framework of WP2, the most relevant datasets were defined during a MIRO whiteboard exercise with the stakeholders involved in the different cities of Flanders pilot sites. In a next step, the availability of these datasets was checked on local and governmental level.

There is no uniform way to calculate green comfort. It is therefore necessary to develop an own methodology for this. Existing methodologies will be evaluated, updated and integrated for this case. Semantic standards (OSLO) (vocabulary and application profiles organised according to the Resource Description Framework – RDF) on the composition of different elements exist. These standards can be applied to measure the elements, but don't have data themselves. Uptake of the standards by Flemish cities and communities is growing but not enough advanced to cover all the required data. A global alternative is Open Street Map (OSM). Together with a worldwide comprehensive datamodel of the physical features on the ground the OSM initiative includes a public accessible database and several maps. The completeness and timeliness depends on the local communities of volunteers and is heterogeneous. The approach is to start with OSM-data and to complement or replace them with local data, where available. This approach can be applied, beyond the scope of this project, in any country or region.

Elements to be obtained from public sources are:

Element	Location	Description	2D/3D	Green comfort index indicator?
Base layers				
OSM.	DUET	OpenStreetMap (OSM) is a collaborative project to create a free editable geographic database of the world.	2D, 3D	No
Orthophoto & satellite imagery.	DUET	Sentinel satellite images & data from ESA is free & full Open Data through the EU Copernicus-programme, which offers not only earth observation data but also in-situ data about our planet & Europe. Open Access Hub (copernicus.eu). For the Flanders region we publish (yearly) aerial im-ages with higher resolution (25 cm) than the Sentinel images. These im-ages are already used 3-yearly - to extract greenery. Our previous results fit nicely, especially in urban areas.	2D	No
Public domain.	To be created	Important to set the boundaries of the field of interest.	2D	No

		Make a negative of the parcel plan and add green parcels owned by a public body.		
Terrain data.	DUET	Important to visualise shadows and for the implant of the LOD2 buildings and trees.	3D	No
Buildings.	DUET	LOD2 level for city of Ghent Shadows can be visualised (but not used in calculations) by using the combination of 3D map with buildings, terrain data and trees.	3D	No
Air quality.	DUET	Air quality index for Flanders.	2D	Yes
Noise.	DUET	Noise Flanders (based on traffic).	2D	Yes
Green comfort index.	URBANAGE	Hexagon tiles with actual green comfort index score as **automatically calculated**. Hexagon colours are related to the scale.	2D	-
Heat stress + shadow				
Heat stress map.	VMM	Helps to determine the green comfort index. The resolution of the map will be updated significantly in the near future. Data.	2D	Yes
Shadow map.	VMM	If available in high resolution in time (work in progress). Shadow is also included in the heat stress map.	2D	No
POIs – street furniture				
Benches & picnic tables, public toilets, street lights, drinking fountains.	OSM	Option to update the OSM data layer inside the city using the *MapComplete* functionality. OSM-data model includes street lamps (as point objects) and street lighting (as an attribute of a road segment - lit Y/N).	2D, 3D	Yes
Google street object detection analysis for benches.	IMEC	2D, used to check if additional data can be gained from Google Street on top of existing datasets. *We pick out one street furniture type and make the analysis to demonstrate the approach. It is not our intention to do this exercise for all POIs.*	2D, 3D	No
Green infrastructure				
Trees.	DUET	Will only be used to make a visual simulation of the shadow impact.	3D	No
Trees.	Local datasets	Depending on what parameters that are available, indicators will be: • presence of trees; • size canopy;	2D	Yes

		• tree height; • tree type.		
Green zones, greenery.	OSM Groenkaart 2018	OSM has a good mapping of greenery. Orthophoto-based green map (2018) can be used as well.	2D	Yes
Blue infrastructure				
Detailed water map includes all water elements.	GRB	All water parties, ranging from navigable waterways, rivers and lakes to ponds and small streams. All in one layer.	2D	Yes
Accessibility				
GIPOD database with information on road works.	GIPOD	Idea: visualise the accessibility of the green comfort zones with the highest scores.	2D	Yes
Accessibility of sidewalks.	Local?	Not a lot information from the government (Local datasets). Only in Turnhout and Gent (old). Texture/substrate (hard/soft), height/width of pavements.	2D	Yes
Roads and paths.	missing	Roads and paths for cyclists and pedestrians in recreational areas. Will be used as an indicator for the accessibility. Depends on measured parameters : • availability; • quality (texture hard/soft).	2D	Yes

Table 77: Flanders pilot - overview of usable datasets

The detailed analysis of the required datasets is illustrated by the slides in chapter 9.1.

4.2.4 Requirements

4.2.4.1 Functional requirements

The requirements table below contains additional requirements as mentioned in the definition of done of both pilot case.

Criteria	Requirement	Related pilot cases
Easy to use.	Providing an intuitive, easy to learn and easy to use interface for the Digital Twin and mobile app.	PC1, PC2
Interoperability.	Incorporating existing open data for further analysis and visualisations.	PC1, PC2
Responsiveness.	Responsive design of the Digital Twin on a PC and tablet (with a selection of functionalities). Responsive design of the app on different smart phones and a tablet.	PC1
Interoperability.	Providing data in an interoperable format to suit the Digital Twin (using the described data standards in D7.6 Standardisation plan and report – initial release).	PC1, PC2
Customizability.	Providing options to view particular datasets.	PC1, PC2
Historical data.	To collect and accumulate data over time (including timestamp).	PC1, PC2
Anonymity.	To not collect identifiable data or require registration from the user.	PC1, PC2
Accessibility.	To provide access to external users (e.g., companies, citizen or other administrations) to view and potentially download data.	PC1, PC2
Multiplatform.	Digital Twin runs on Windows and macOS – Digital Twin app runs on IOS and Android (most recent versions available at the end of the project).	PC1, PC2

Table 78: Flanders pilot - functional requirements

4.2.4.2 Non-functional requirements

No information is available for at this phase of the *Urbanage* project for the Flanders pilot.

4.2.5 Specific design (not use case related)

The use of AI is needed to create an interactive instrument tailored to the user's needs and preferences. AD1 AI implementation to spot green areas doesn't use any personal data or data to be anonymized since only available open data about the public domain will be used. The calculation and calibration of the Green Comfort index – AD2 - login data will be required. This will align with the GDPR rules and the upcoming AI directive as described in deliverable D2.7, "Legal and Ethics evaluation report – initial version".

4.2.5.1 Artificial intelligence implementation to spot green areas (AI)

This chapter of the D6.1 Flanders pilot section delivers input for future work in WP3, data and intelligence following the agile design and development principles. WP3.3 and WP3.4, task 3.2 (the implementation of Artificial Intelligence and Simulations) will detail the needs described below.

Artificial intelligence has an added value in three specific application domains:

1. measuring the public domain;
2. the calculation and calibration of the green comfort index;
3. the analysis of *Google Street View* & satellite/orthophoto imagery to detect elements in the landscape.

AD 1: measuring the public domain

Goal: finding comfortable, shadow-rich rest places on the public domain on a region-wide scale in an automated way by using techniques to recognize these places including their accessibility and other indicators listed in the table in chapter 4.2.3 (last column).

AI use: The use of AI as an automated detection technique help assessing effectively shadow-rich and accessible places.

Actions:

- select public domain locations;
- select semi-public domain locations (e.g. shopping centra, hospital gardens);
- measure various parameters of the indicators listed in the table in chapter 4.2.3 (last column);
- create an integrated data layer (3D, containing the relevant information);
- updating process based on improved data and improved machine learning outcomes.

AD 2: calculation and calibration of the Green Comfort index

Goal: once the comfortable, shadow-rich rest places on the public domain are detected as in AD 1, it is important to assess the suitability by calculating a suitability score.

AI use: AI can be used to calculate a heat stress score that matches the user's perception.

As explained in **user story 5**, the green comfort index is a calculation (to be performed for each **hexagon tile** on the map), based on the measurement of various indicators.

The indicators can be found in the table in chapter 4.2.3 (last column):

- indicator information may be dynamic, so the calculations need to be done on the fly at each request, **making use of the most recent datasets**;
- further, **corrections** can be made by logged in users and professionals/specialists. These calculations need to be taken into account as well. The weight of professional feedback must be stronger than the weight of the feedback given by non-professional citizens;
- the availability of an indicator in a hexagon tile may influence surrounding hexagons;
- the parameters included in the calculation of the green comfort index are not the same for all individual older persons. The relevance of the parameters may also fluctuate in time. That's why we offer the opportunity to visitors with an account to **switch parameters on/off**, presenting them an alternative calculation of the green comfort index.

These aspects make the calculation of the green comfort index quite complex. Especially the integration of the user- and expert updates is something that needs to be continuously evaluated and updated depending on the results. This self-learning mechanism combined with the expert simulation results can be a basis for the introduction of artificial intelligence (AI). An AI solution corrects the green comfort scores, making them more reliable every day.

The green comfort index can be determined in four steps.

Step1: Definition of the Public domain zones where the green comfort score will be calculated:

- create overview map of the public domain;
- define Hexagon zones (10*10 meter) on the public domain.

Step 2: Calculate a green comfort score for every hexagon:

- for each of the indicators listed in the table of chapter 4.2.3 (last column), a **weight factor** will be defined. When determining the green comfort index score for an individual hexagon on the map, the varying weight factors of all indicators will be taken into account;
- also, **surrounding hexagons will be influenced** when scoring the green comfort index of a hexagon. For example, when a map hexagon covers some trees, the weight factor for trees will count for 100% for this hexagon. Since also for the surrounding hexagons, the trees are nearby and reachable, the weight factor for trees will be taken into account as well, but in a lower degree (for instance 50%).
- indicators may have some properties that can influence the weight factor as well;
  As an example, tree height, width and density influence the amount of generated shadow and for benches, different degrees of comfort can be defined depending on its physical characteristics.

Step 3: Score the green comfort manually to provide a basis for comparison:

- logged in users and professionals/specialists can give a manual score for each hexagon. These scores will be taken into account with a certain weight factor as well. The weight factor for professionals/specialists will be higher;
- also, the weight factor will be influenced by the number of manual corrections and the standard deviation of the suggested corrections.

Step 4: Calculating the difference between the calculated and the perceived score:

Calculating the difference between the calculated score (adapted to max 100) and the perceived score (max. 100) for each hexagon. (using a different colour scale for higher and lower perceived scores compared to the calculated scores).

AD 3: analysis of *Google Street View* & satellite/orthophoto imagery to detect elements in the landscape

By using the *Google Street View API* & satellite/orthophoto imagery, benches, recognised by artificial intelligence, will be detected. The resulting locations will be projected to the *Urbanage* geographical base map and will be compared with the location of street furniture obtained by other sources.

If the *Google Street* & satellite/orthophoto imagery results are complementary and have an added value, this approach can also be followed for other indicators to improve the quality of existing datasets.

4.2.5.2 Anonymisation and pseudonymisation of data

This chapter of the D6.1 Flanders pilot section is worked out in more detail in WP3, data and intelligence. More specific, WP3.1. Check out this Deliverable to get more information.

There is no need to gather information with the name or registration number of the person, so the data will be completely anonymised and in compliance with the GDPR. If the address data is added as well, then the data should be pseudonymised.

4.3 Pilot case 2 - City services planning for older people

4.3.1 Pilot case overview

Through evidence-based policies for older people based on historical, current and predictive information in the social and geographic domain, we aim to inform decision-making bodies in public services to improve short- and medium-term decisions for older adults. Accessibility in a broad sense for the older people was later added to this case.

In order to improve the decision-making, the *Urbanage* project should result into two new map layers that can be easily combined with existing datasets and models or data driven applications.

- The first layer indicates the **age distribution** of the citizens throughout the city. This should help the policy makers to indicate the areas where older are living. Next figure shows an example.

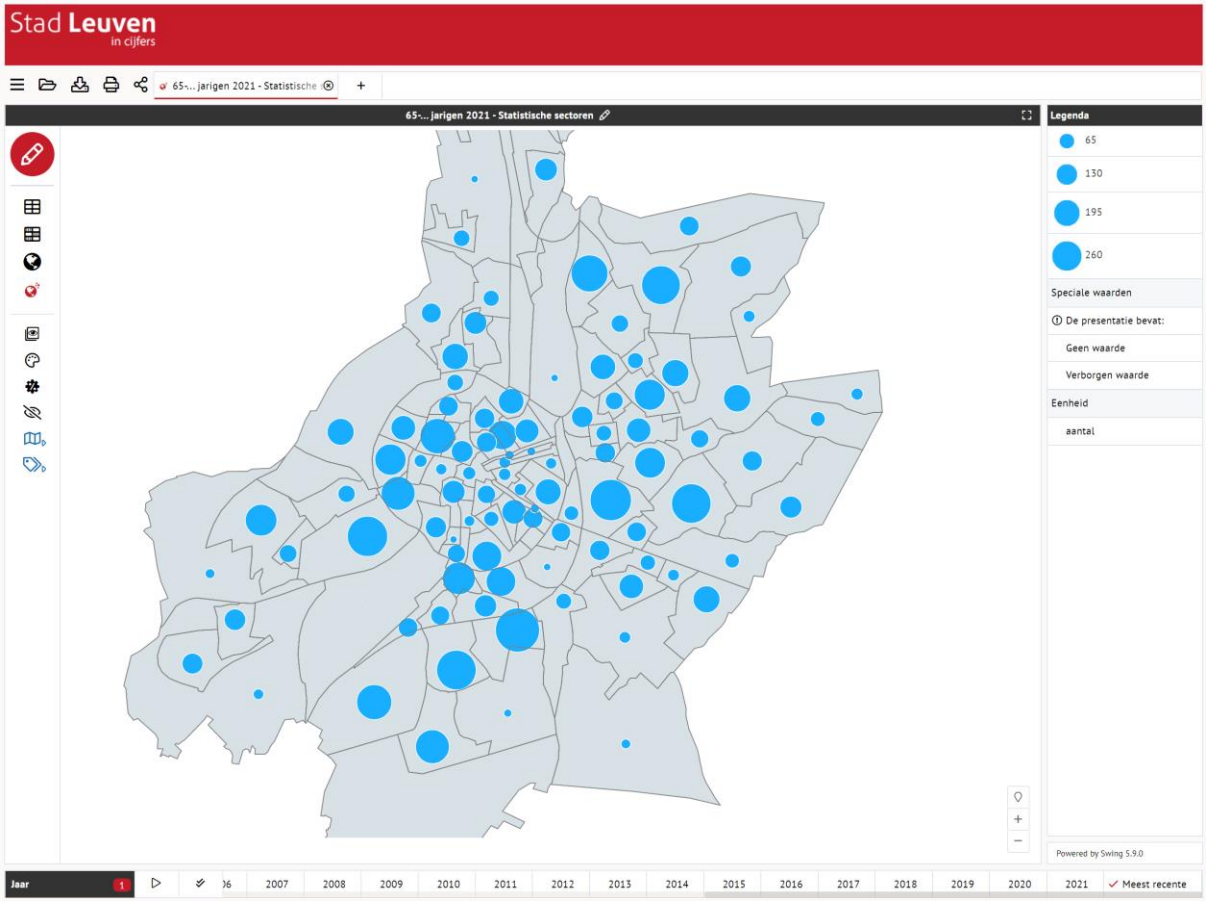


Figure 29: distribution of people with age of 65+ within the city of Leuven (statistical units)

- The second layer shows the distribution of people with a **reduced physical mobility** in the city. There are different sources of health information that can be explored. Next image shows how part of the data (integration allowance for 65+) is currently available per municipality. It is the aim to visualise the information in a more detailed but anonymized way.

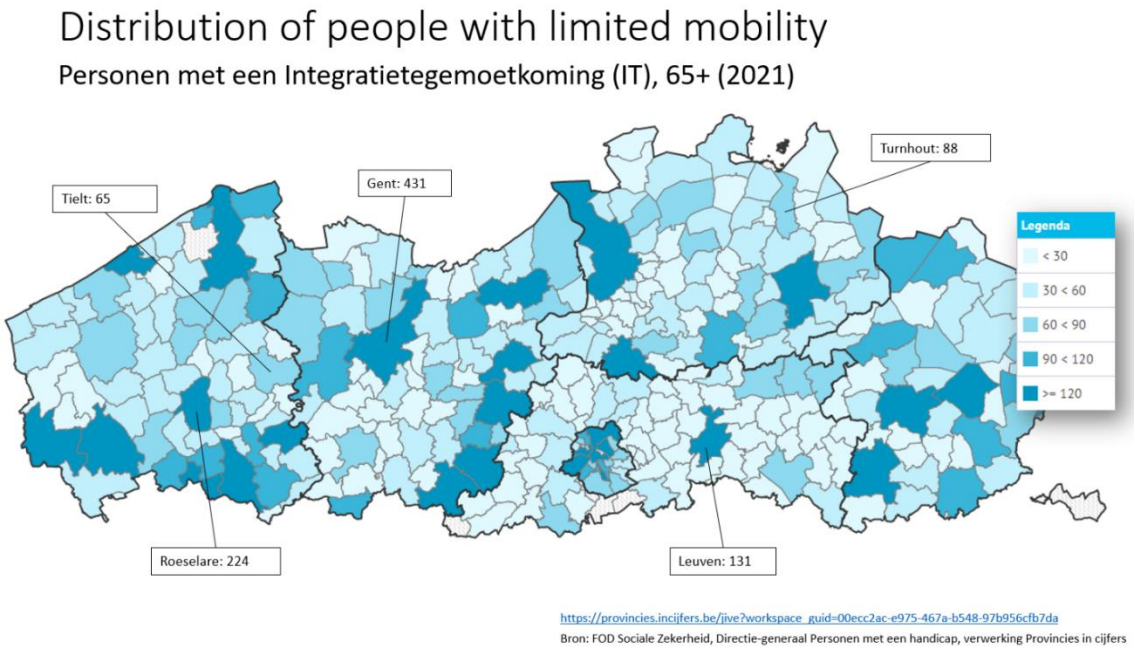


Figure 30: distribution of people with limited mobility in Flanders

When both are **combined**, it should be possible for policy makers to indicate the historic and present demographic distribution of older people with a reduced mobility as well as to make **predictions** (based on models analysing historic and current data) on how it will evolve in the future.

Roles and functionalities

This case focuses on policy/decision makers, they can:

- download/apply both data layers in the most commonly used formats;
- combine the data layers on top of existing/available data layers;
- integrate these datasets in existing models to predict future situations;
- test scenarios using both layers on top of existing layers.

By setting available combined datasets and scenarios, in a next step, **older citizens** can:

- consult maps to find nearby services such as dentists, pharmacies, etc.;
- suggest the location of the implant of new services based on demographic needs for older people;
- give feedback on the evidence-based policy making scenarios as assembled by the policy/decision makers.

4.3.2 User stories details

Nr + Name	US11. The usage of combined YTT data on historic and present demographic distribution of older people with a reduced mobility for policy making purposes.
Story	As a **policy maker**, I can access YTT data on historic and present demographic distribution of older people with a reduced mobility, so I can investigate data driven policy making, focused on older people.
Description functionalities	A policy maker can use and combine separate data layers with information on age distribution and distribution of citizens with limited physical mobility on top of existing datasets and/or applications in order to create policy making scenarios.
Actors involved	Policy maker.

Table 79: Flanders pilot case 2 - user story 11

4.3.3 Required data - city services planning for older people

Various existing base data layers are combined with information about the age and reduced physical mobility distribution of citizens.

Base **data** are available in the *Crossroads Bank Crossroads Bank for Enterprises* or in the *Crossroads Bank for Social Security managed* and maintained by the Federal government. Known elements related to older people care, as discussed during the design workshops, are listed in the following table.

Elements	Location	Comment
GP's	KSZ / RIZIV / De Sociale kaart	API planned (March 2022)
Hospitals, pharmacies, dentists	KSZ / RIZIV / De Sociale kaart	API planned (March 2022)
Informal care / home care	KBO / Provincies in cijfers	Cities uses a dataset from Locatus (biannual update)
Supermarkets	KBO / Provincies in cijfers	Cities uses a dataset from Locatus (biannual update)
Bakeries, butcheries, groceries	KBO / Provincies in cijfers	Cities uses a dataset from Locatus (biannual update)
Hairdressers	KBO / Provincies in cijfers	Cities uses a dataset from Locatus (biannual update)
Medical care centres	KSZ / RIZIV / De Sociale kaart	API planned (March 2022)

Table 80: Flanders pilot case 2 - user story 11 -available datasets type 1

On top of the available service-related datasets, the new map layers should be generated to monitor the **demographic distribution of older people and citizens with reduced mobility**. Access to personal data is therefore a prerequisite. In order to get these data, various methods can be used and will be discussed later in this document. It is important that these data are mapped on statistical area and that they are not traceable towards one individual. An overview of the most important data regarding the new map layers is given in the table below.

Elements	Location	Comment
Age	Provincies in cijfers	Number of inhabitants, split by age.
Gender	Provincies in cijfers	Number of inhabitants, split by gender.
Family	RR / KSZ	Information about the household composition.
Handicap (reduced mobility)	VAPH / NIC / DGPH / Vlaams Kadaster / Provincies in cijfers	Statistics regarding the amount of people, based on age and district (in Dutch: "arrondisement"), with the right for "income replacement and integration assistance" for the year 2020 can be found on this website and the dataset can be found on this link.

Table 81: Flanders pilot case 2 - user story 11 - available datasets type 2

Methods for data collection

Data can be collected via the use of *MAGDA services*. MAGDA is a product from the Flemish government that provides cities and towns with data that is stored in authentic sources owned by governments. In order to get access to this data, the cities and towns need to get an affiliation on the MAGDA service that provides the requested data. First of all, a legal ground is needed by the cities that give them the authorization to process personal data for a well-determined task. Additionally, a protocol has to be established with the authentic source or an existing general authorisation may be used. During the affiliation process on the MAGDA service, more information regarding the legal ground will be provided. For the *Urbanage* project one could use following MAGDA services to collect personal data:

- *Person.GetPerson-02.02 (in Dutch: "Persoon.GeefPersoon-02.02");*
- *Familiy.GetHealthCareAllowance (in Dutch: "Gezin.GeefZorgtoeslag-02.00;*
- *SocialSecurity.GetFullHandicapFile-03.00 (in Dutch: "SocZek.GeefVolledigDossierHandicap-03.00");*
- *SocialSecurity.GetHandicapFile-03.00 (in Dutch: "SocZek.GeefDossierHandicap-03.00")*
  (These services only exist with Dutch names. For the sake of clarity they were translated in this document.)

Alternatively, the required data can be obtained using Open Data from statistical bureaus. One could look at Statbel for the age distribution. Furthermore, the data from "Provincies in cijfers" can be used to give information about the age and gender distribution of citizens in specific cities as well as citizens with a handicap.

The detailed analysis of the required datasets is illustrated by the slides in chapter 9.2 (Annex & Templates).

5 Helsinki

5.1 Use case approach, goals and outcomes

5.1.1 Participatory process

As part of work of defining Helsinki use cases, several meetings were held with the city of Helsinki officials, alongside with three co-creation sessions designed in collaboration with WP2 and WP6. All co-creation workshops were organised online due to the existing situation with COVID-19 in fall 2021.

Vuosaari, an eastern neighbourhood in Helsinki [Figure 30], was selected as a target area for user recruitment for two reasons. Firstly, the area consists of a high proportion of older residents and, secondly, there has lately been significant amounts of urban redevelopment which have had an impact on accessibility. Thus, Vuosaari is also a suitable pilot site for the *Urbanage* use cases. The region currently has 39,961 inhabitants, of which 7,549 (19 %) are 65+ years old. 39,2 % of houses are owner-occupied housing, 46,1 % rental. In Vuosaari, there are private apartments specially designed for older people whose inhabitants are independent and mostly active. Inhabitants need of care vary according to the needs of the individual; in recruitments we targeted all senior citizens of Vuosaari. All co-creation workshops were designed with Vuosaari in mind but workshop participants acknowledged that emerging issues could be generalized to the whole city.

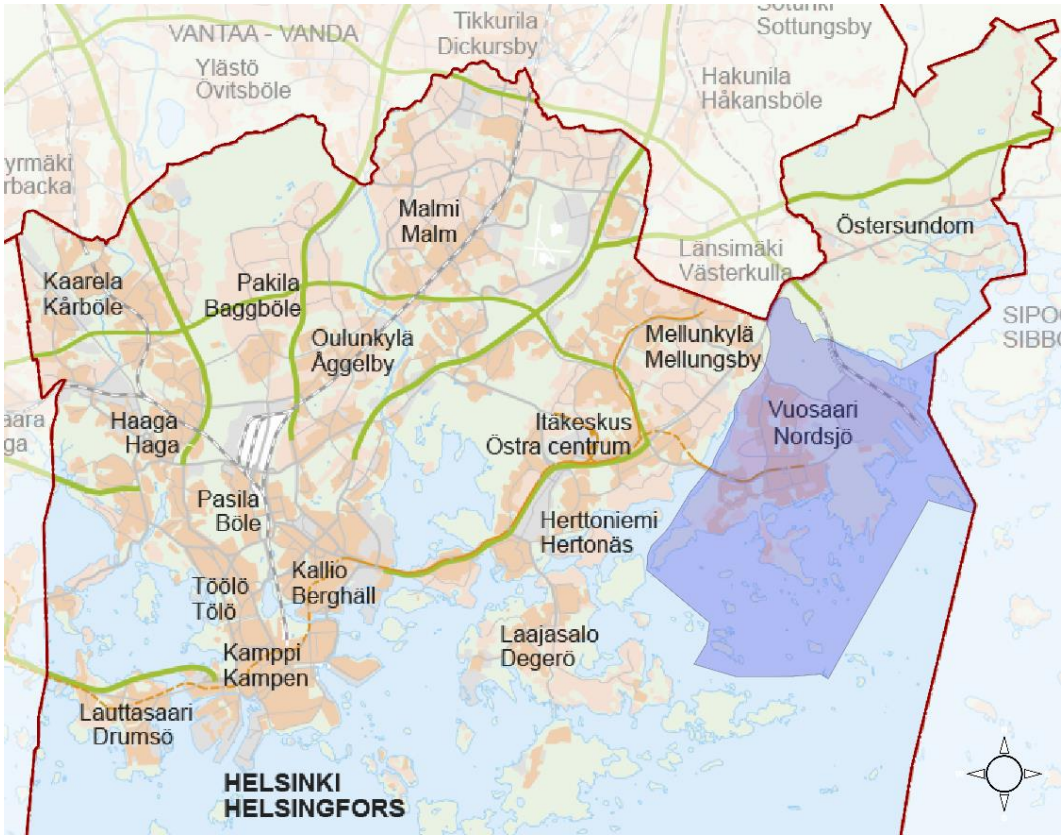


Figure 31: Vuosaari is located by the sea in East Helsinki

Co-creation workshop 1 was organised with the older adults residing in Vuosaari. In total 5 participants took part in the workshop. During this workshop, the older citizens mentioned a series of challenges, needs, desires and opportunities. The most pressing needs in terms of street infrastructure were often related to maintenance of streets, pedestrian walkways and access points (e.g., bus stops and entrances). Maintenance of walkways, especially during the winter, was considered as one of the main challenges for accessibility and mobility. The older citizens mentioned the need of proper surfaces to walk on during wintertime when roads tend to be slippery. In addition to walkability, workshop participants desired for more street signs which would give an indication of walking distances between relevant places. In combination with the needs for proper and safe transportation, the older inhabitants of Vuosaari desire a clean and safe environment where they can autonomously move from place to place with a clear estimation of moving time.

Co-creation workshop 2 was organised with the urban planners of the city of Helsinki. In total 4 participants took part in the workshop. In the workshop, civil servants from Helsinki mapped the existing initiatives, the challenges they are currently facing and finally the collaborations they consider relevant in addressing the needs of older people in the urban environment. Based on this workshop, there is a need for better and more accessible information regarding the needs of older citizens and issues they face in the urban environment to assist with better planning. Workshop participants also raised concerns about the lack of participation from older citizens in planning their city.

Co-creation workshop 3 was organised with both the older adults and urban planners of the city of Helsinki. In total 10 participants (7 older adults and 3 city officials) participated in the workshop. Based on the efforts conducted in previous workshops, 2 challenges were presented. The first challenge focused on mobility in the winter season. Older adults indicated in previous sessions that daily mobility was impeded in winter, for example because of snow piles (partially) blocking pavements. The second challenge put the emphasis on comfort and safety in certain areas participants identified in previous sessions. Based on the discussion, possible elements that contribute to this are e.g., lighting conditions on certain routes or a sufficient amount of greenery and resting places.

Based on the results of the co-creation sessions several accessibility issues and needs were identified (further explained in D2.3). Through Helsinki use cases we are focusing on the following topics:

- providing means for older adults to participate in urban planning;
- solve accessibility/mobility issues by collecting, visualising and sharing relevant, up to date and area specific data to inform decision making;
- create datasets of interesting and enjoyable places to assist in future planning efforts;
- measuring travel-time in Helsinki region considering needs of older citizens.

Solutions to these needs will be piloted with the following three use cases:

1. feedback on accessibility issues;
2. point of Interest;
3. travel-Time Matrix.

Use cases 1 and 2 will be piloted in Vuosaari, whereas use case 3 will cover the whole metropolitan area. The main objective for use cases 1 and 2 is to develop a tool and method for collecting citizens generated data regarding accessibility in the city to improve both the planning process and the overall outcome of urban planning. Developed IoT-device and feedback data collection and aggregation method might be useful for other pilot cities as well, e.g., Flanders could use a similar kind of device to collect heat perception data. Main idea of use case 3 is to provide information regarding the accessibility of services and a tool to measure travel-time considering older citizens' needs.

5.1.2 Use case 1: Feedback on accessibility issues

5.1.2.1 Description and goal

In use case 1 the main idea is to develop a new method to collect feedback from citizens and visualise the data on live map view. Through a physical IoT-device and virtual browser-based map service, citizens are enabled to send feedback about the issues related to accessibility in Helsinki. Issues will be collected with an IoT-device designed by Forum Virium Helsinki. In the planning of usability, the design takes into account the varying capacity of older people to adopt new technologies. Also, Forum Virium Helsinki will provide users training and information regarding the data collection and use of the device.

The aim is to build a small number of IoT devices which are handled as a proof of concept for future efforts to collect citizen generated data and enable wider public participation in urban planning and maintenance processes. Also, a browser-based mobile application is implemented alongside the IoT device to enable wider participation and to compare the user experiences and preferences. The web browser based "virtual IoT-device" will have all the same functionalities as non-virtual, however, this version is more flexible as it's functionalities can easily be modified based on users' preferences once the actual pilot has begun. Furthermore, the virtual version may have additional features, such as voice recording or add a photo function, compared to the physical IoT-device.

Collected data will be saved in a general format (e.g., GeoJSON) to secure FVH servers and transferred to the University of Helsinki DGL-servers (Digital Geography Labs) to add on existing map solutions. Citizens and civil servants will be able to view generated data on a browser map view.

5.1.2.2 Involved persona's

The participants of the co-creation workshops identified poor public lighting, lack of adequate amount of rest places (seating), proper signage and issues with winter maintenance of walkways, sidewalks and access points to public services and transport as the main issues affecting older citizens' mobility. This use case will develop a physical and virtual IoT-device that older adults can use to generate feedback on accessibility issues. The first prototype will focus on the following themes that were identified in the co-creation workshops:

- issues with walkways and roads (e.g., snow piles and slipperiness);
- safety;
- lighting;
- general unpleasantness.

For citizens, this use case provides a new mean to communicate with civil servants and provide feedback regarding accessibility. Easy to use interface empowers users to participate in creating more accessible neighbourhoods. A small number of physical IoT-devices are distributed to older adults in the Vuosaari neighbourhood to test the device functionalities and feed information regarding their accessibility issues. Physical devices are most likely handed to participants of WP2 co-creation workshops. Browser-based virtual IoT-device is communicated more widely to all older residents of Vuosaari neighbourhood.

For politicians and civil servants, e.g., urban planners, this use case generates a new data set of citizens' generated feedback data that can be used for making better informed decisions regarding accessibility and urban planning. The city of Helsinki will get access to feedback data that contains accurate location information and the data could be used for example to design better lighting for improving safety.

Also, regarding this use case Forum Virium Helsinki will explore opportunities to integrate and feed this new data to existing data platforms regarding city maintenance. Technical professionals in Forum Virium Helsinki and City of Helsinki are involved to provide guidance and expertise regarding the integration of collected data to Helsinki CIM and existing data platforms. For example, Helsinki City Construction Services (Stara) will be involved to discuss the potential to integrate relevant parts of generated feedback data to their information services (e.g., regarding maintenance requests) to improve efficiency of maintenance of public spaces.

5.1.2.3 Expected outcomes

Social

- City has a better understanding of the issues that older people face in their daily lives especially during the winter. FVH will discuss these issues with Helsinki City Construction Services (Stara) which is responsible for maintenance of public spaces in the city. The goal is to achieve instant improvements in the streets for example better and more precise prevention of slipperiness. This also motivates users to collect data which will support the long-term goals.
- Long term expected outcome is better urban planning in the perspective of older adults. One example could be re-designing the entrance of the metro station which was reported to be often slippery in winter.
- Receiving user generated information, collected through a wide scope of methods, and adding interactivity, moves the city towards a more proactive operational model in services and maintenance.

Policy (evidence-based)

- The approach in the Helsinki use case will enhance a true participatory process for city maintenance and routing services for the benefit of the older citizens.
- Existing city feedback channel can be difficult to use and access and requires both time and technical capabilities. This use case will focus on developing the method to collect feedback data from a specific user group (in this case older adults) and the results will be used to further develop and standardise collection of citizens generated data (e.g., the methods to collect, store and respond to user generated data), and help older citizens to participate in urban planning.

Communication/co-creation/co-design (storytelling, gamification)

- IoT-device provides means for older adults to actively participate and engage with city planning. Enabling and encouraging citizens to participate in improving their neighbourhood.
- A model to collect data from the citizens and how to automatically sort and redirect the feedback data to the appropriate city department for delivering and developing better services.

5.1.3 Use case 2: Point of Interest

5.1.3.1 Description and goal

Use case 2 follows the same data collection process but the main idea is to collect Point of Interest data about the most pleasant and enjoyable places and spaces in the Vuosaari neighbourhood. In use case 2 the main goal is to create a data collection method and visualisation on places older citizens enjoy, like to visit or spend their time in. Data will be collected in general format (e.g. GeoJSON) to secure FVH servers which will enable further utilisation and sharing among the city departments and *Urbanage* platform. Any potential data visualisations and integration to existing data management systems and service delivery will be designed in collaboration with city officials.

Point of interest (PoI) data will be collected with an IoT-device designed by Forum Virium Helsinki. In the planning of usability design takes into account the varying capacity of older people to adopt new technologies.

5.1.3.2 Involved persona's

This use case will generate a Point of Interest dataset which contains points of places and spaces that the senior citizens find interesting and particularly pleasant. Older adults will use IoT-device to generate Point of Interest data. Citizens feed information on:

- this is a pleasant place/This is a place I enjoy;
- I enjoy the greenery here;

These categories/functionalities can be changed during the implementation phase depending on the user feedback or rising needs.

Through the data collection in this use case, the city planners in Helsinki have access to Point of Interest data through map platform and can make better informed decisions to plan more accessible and enjoyable urban environments. For example, the social and wellbeing division can evaluate the network of points of interest and potentially make suggestions that could encourage and motivate older adults to exercise and explore their neighborhood. Users can also explore generated data through browser map view.

5.1.3.3 Expected outcomes

Social

- Citizens and civil servants are able to view generated data on a browser map view and can use the map view to explore points of interest. This potentially encourages citizens to explore their local area and creates a sense of place among the local community.
- Receiving user generated information, collected through a wide scope of methods, and adding interactivity, moves the city towards a more proactive operational model in services and maintenance.

Policy (evidence-based)

- City of Helsinki and civil servants in different departments have a better understanding of places and spaces that the older citizens enjoy in the city. Long term expected outcome is better urban planning in the perspective of older citizens. Points of Interest data could for example assist in placing new green areas and benches or in general could be used to evaluate the quality of public spaces.

Communication/co-creation/co-design (storytelling, gamification)

- The data set provides an interesting overview of points of interest and enjoyable places in the pilot area that users can view in browser map view.

5.1.4 Use case 3: Travel-time matrix

5.1.4.1 Description and goal

In use case 3 the main goal is to develop a tool for urban planners. This tool will serve:

- to better take into account older peoples' specific accessibility and mobility needs and restrictions (see below) when planning new urban development, when managing everyday processes in city government and administration, and during urban renewal;
- to identify neighbourhoods in which older people are faced with lower or inadequate access to everyday services or to opportunities of participation, and to learn from neighbourhoods that fare better;

- to provide quick access to city-wide operative figures on the state of accessibility and mobility for older people, and on equity between different groups of city-dwellers and neighbourhoods concerning accessibility and mobility.

To a lesser extent, the envisioned tool could also form the basis for a public tool to inform older people about the situation in their neighbourhood concerning a set of factors that restrict or enable their mobility and accessibility. Equally, the tool could potentially be used as an underlying data store for a routing tool that can help older people to find active mobility, public transport, and individual motorised transport routes that take into consideration the specific mobility needs and accessibility restrictions of older people. These two secondary goals will receive priority only after the primary goals (see above) have been met, and functionality targeted at urban planners and city officials has been implemented.

A travel time matrix is a spatial data set that records the travel costs (e.g., time, but also others, see below) between a complete set (fully-connected) of origins and destinations in, for instance, a grid of regular cells laid over a city [5]. Examples include the travel time matrices for car and public transport in Helsinki by Salonen & Toivonen [6], and for active travel modes, public transport, and individual motorised transport at different times of the day and for different types of destinations by Järv et al. [7]. The matrix is calculated with the door-to-door approach, which means that in addition to the time for driving, cycling, walking, or travelling on a public transport vehicle, the travel times also include the egress and ingress times that are spend at the beginning and at the end of the trip for example the walk to the parking lot or a bus stop and searching the parking lot as well as the waiting times in between the public transport trip. This approach ensures the true comparability of travel modes included in the matrix.

For this use case we want to take the concept of the travel time matrix further. We want to a) go beyond the 'average citizen' and include factors that are specific to older people, such as a higher variability in walking speeds, the need for a more accommodating urban environment with street furniture that allows frequent stops, a higher susceptibility to adverse weather conditions and (lack of) winter maintenance, a potentially more pronounced feeling of belonging (and thus distrust in undesired behaviour in public space). Further, we b) want to achieve a more dynamic travel-time matrix that improves the temporal sensitivity demonstrated by Järv et al. [7], and extends it to consider seasonal variation (including, e.g., the impact of weather). Finally, we will c) implement a travel time matrix that does not rely on travel time alone as a routing criteria, as it has been shown that factors such as environmental exposure (inc. greenery, air pollution and noise pollution), streetscape complexity (cf. Jan Gehl's walkability) among other things, have a stronger influence on mobility decisions of older people in comparison to the general public [8].

All of these improvements combined will enable urban planners to rely on easily accessible measures of accessibility for older people, both on a city-wide scale and on a neighbourhood scale. Interpretability of accessibility measures has been identified as one of the most important criteria for their use in urban and transportation planning [9]. The travel time matrix directly improves opportunities to plan the city to suit the needs of older people, and focus effort on neighbourhoods in which older peoples' accessibility has been sub-par.

The work going towards realising use case 3 will be carried out mostly by UH-DGL. The main output data set is a vector data set of origins and destinations in the metropolitan area of Helsinki (based on the 250x250m grid cells of the national population data issued by Statistics Finland), and an associated multi-dimensional matrix, e.g., in a database table format, that describes the travel cost, mobility costs, and accessibility in between each origin-destination pair, as well as at each origin or destination location. Another output will be a tool to compute such a travel-time matrix from input data that is contained in the Helsinki digital twin, such as demographic data in grid cells, information on the public transport network's schedule in GTFS format, and the layout, topology and quality of street and road networks. (for a more comprehensive list of data sets – also those not relevant for this use case – see also D4.1 CIM Structure definition, section 'Background Helsinki').

5.1.4.2 Involved persona's

The target audience of the resulting data set and tool are primarily:

- planners;
- transport planners (for public transport, individual active mobility and individual motorised transport);
- political decision makers;
- an informed public, e.g., experts at NGOs or other advocacy organisations, interested citizens;
- other researchers who want to produce a travel-time matrix for another city, or reproduce our results.

During the development, we will rely on the expertise and knowledge of:

- technical professionals at the City of Helsinki and Forum Virium Helsinki (especially regarding the integration of the tools and results into the Helsinki CIM).

5.1.4.3 Expected outcomes

The main output data set is a vector data set of origins and destinations in the metropolitan area of Helsinki (based on the 250x250m grid cells of the national population data issued by Statistics Finland), and an associated multi-dimensional matrix, e.g., in a database table format, that describes the travel cost, mobility costs, and accessibility in between each origin-destination pair, as well as at each origin or destination location. Another output will be a tool to compute such a travel-time matrix from input data that is contained in the Helsinki digital twin (see also D4.1 CIM Structure definition, section 'Background Helsinki').

In line with UH-DGL's and FVH's general guidelines, the output data set will be published as open data, using (at least) the following two channels that address different audiences: 1) a data description paper in a scientific journal dedicated to spatial data sets, together with a Zenodo data record, 2) a suitable storage location within the Helsinki CIM/Digital Twin/Helsinki Region Infoshare ecosystem. The first channel clearly is directed towards an academic audience, the second channel to a local, city government and administration audience.

Social

- The travel-time matrix will inform city planners and other city government administrators of inequality and inequity concerning accessibility for older people and for other non-average citizens between different parts of the city. This can inform both their day-to-day work, and more strategic decision-making (see also *policy-related outcomes*)
- It can also be used to create an age-friendly trip planner that takes into consideration any potential accessibility issues or limitations, although this is not a priority outcome of this use case.

Policy related (evidence-based)

- Helps urban and transport planners to evaluate differences in accessibility in different parts of the city and to different groups of people, with a special focus on the restrictions and specific requirements of older people. The travel time matrix can be used for both a quick evaluation, and for a comprehensive assessment of potential improvements to the accessibility situation of older people in specific neighbourhoods and in the city in general.

Communication/co-creation/co-design (storytelling, gamification)

- We will work closely with the city's administration and their Council for older people to evaluate the routing algorithms and the outcomes of the travel-time matrix at a regular interval.

5.2 Use case overview

Currently the city does not have a tool to collect empirical feedback that also takes into account the varying abilities of older people to deal with different technologies.

Use cases will not collect or use any personal information. There is no need to gather personal information, e.g., names or any other data that would identify individuals, so the data will be completely anonyme and in compliance with the GDPR.

5.2.1 Use case descriptions

5.2.1.1 Use case 1: Feedback tool

Nr + Name	UC1 - Feedback tool.
Goal	To collect feedback about accessibility issues older adults face in the public space.
Description functionalities	Older adults use IoT-devices or virtual IoT-devices to give feedback data on predetermined accessibility issues.
Actors involved	Older adults, urban planners, Stara (Helsinki City Construction Services).
Pre-condition	Access to a physical or a virtual IoT-device (with internet connection and GPS).
Post-condition	None.

Table 82: Helsinki pilot - use case 1

Main Success Path (primary flow)	Physical IoT-device
ACTOR ACTIONS	SYSTEM RESPONSE
User turns on the IoT-device by pressing power button.	The device turns on.
User presses a button to give feedback on selected issue.	System collects the user generated feedback and connects it to geographic coordinates.
	Finally, the system will inform user that the feedback data has been saved to the server (light on the device).

Table 83: Helsinki pilot - use case 1 - main success path

Alternate Path	A1	Virtual IoT-device.
ACTOR ACTIONS		SYSTEM RESPONSE
User enters the URL on their smart device.		The web page loads the map view and asks permission for location information.
User selects the feedback from predetermined list and feeds the appropriate attributes.		
User presses a button to send feedback on selected issue.		System collects the user generated feedback and saves it alongside the geographic coordinates.
		Finally, the system will inform user that the feedback has been saved to the server.

Table 84: Helsinki pilot - use case 1 - alternate path

Process flow scenario (including alternatives and exceptions) – optional

Not available

Mock-up – optional

Not available

5.2.1.2 Use case 2: Point of Interest

Nr + Name	UC2 - Point of Interest (POI).
Goal	To collect Point of Interest data from the older adults on places and spaces which they see interesting, like to visit or enjoy.
Description functionalities	Data is collected with a physical and virtual IoT-device.
Actors involved	Older adults, urban planners.
Pre-condition	Access to physical or virtual IoT-device (with internet connection and GPS).
Post-condition	None.

Table 85: Helsinki pilot - use case 2

Main Success Path (primary flow)	Physical IoT-device.
ACTOR ACTIONS	SYSTEM RESPONSE
User presses power button on the IoT-device.	The device turns on and ready for a user command.
User presses a button to collect a Point of Interest.	System collects the user generated point and connects it to geo-graphic coordinates.
	Finally, the system will inform user that the PoI has been saved to the server (light on the device).

Table 86: Helsinki pilot - use case 2 - main success path

Alternate Path	Virtual IoT-device
ACTOR ACTIONS	SYSTEM RESPONSE
User enters the url on their smart device.	The web page loads the map view and asks permission for location in-formation.
User selects the feedback from predetermined list and feeds the appropriate attributes.	
User presses a button to send feedback on selected issue.	System collects the user generated feedback and saves it alongside the geographic coordinates.
	Finally, the system will inform user that the PoI has been saved to the server.

Table 87: Helsinki pilot - use case 2 - alternate path

Process flow scenario (including alternatives and exceptions) – optional
Not available

Mock-up – optional
Not available

5.2.1.3 Use case 3: Travel-time matrix

Nr + Name	UC3 - Travel-time matrix.
Goal	Provide to planners a travel-time matrix and accessibility model that takes into consideration the specific requirements, restrictions and preferences of older people as an example for non-average residents.
Description functionalities	A multidimensional data matrix representing different factors of travel cost between n:m origins and destinations (raster grid cells covering the entire city) that can be queried in a Geographical Information System (GIS) or similar to reveal the relative quality of accessibility for older people or other disadvantaged urban residents.
Actors involved	Data users (urban planners, transport planners, political decision makers, informed members of the public, other researchers)
Pre-condition	UH-DGL has computed such accessibility matrices for previous years (last iteration 2018), and added more sophisticated measures to it. The new iteration will be based on open data, or data available from the Helsinki CIM/Digital Twin (i.e., it should be more easily transferable to other cities), and take into specific consideration the restrictions, requirements, and preferences of older people, and compare the situation older residents find themselves in to the situation for the general public ('the average citizen') to highlight and mitigate structural disadvantages for older people.
Post-condition	Current version was created in 2018 and it doesn't take in account older people.

Table 88: Helsinki pilot - use case 3

Main Success Path (primary flow)	
ACTOR ACTIONS	SYSTEM RESPONSE
Data user loads matrix into a GIS or similar (e.g., from the city's WFS service).	File opens.
Data user queries the average accessibility index at a location.	The value is returned.
Data user queries the average accessibility index at a location for an older person.	The value is returned
Data user queries the mobility/accessibility measures between two locations.	An array of values representing different measures of accessibility and mobility between the two locations is returned.

Data user queries the mobility/accessibility measures between two locations, for older people.	An array of values representing different measures of accessibility and mobility between the two locations, for older people, is returned.

Table 89: Helsinki pilot - use case 3 - main success path

Process flow scenario (including alternatives and exceptions) – optional
Not available

Mock-up – optional
Not available

5.2.2 Required datasets

The city of Helsinki has an extensive catalogue of open data, Helsinki Region Infoshare, that can be combined with data generated in *Urbanage* project. Forum Virium Helsinki and stakeholders in Helsinki continue exploring opportunities to integrate the collected data to any existing data and map platforms to improve service delivery and accessibility for older citizens.

Dataset	Location	Relation to UC	Comment
City map services	https://kartta.hel.fi/?setlanguage=en		WMS, WMTS, WFS, TIFF
Semantic city information model & HQ reality mesh model.	https://hri.fi/data/en_GB/dataset/helsingin-3d-kaupunkimalli/resource/577f4286-7162-42e9-8ffe-52632228569e		GML
Helsinki Metropolitan Area Service Map (e.g., health care centres, public lighting, benches).	https://kartta.hel.fi/ws/geoserver/avoindata/wfs	UC1/2	WFS
Street/area under construction.	https://kartta.hel.fi/ws/geoserver/avoindata/wfs, see e.g., https://paikkatietoopas.maps.arcgis.com/apps/StoryMapBasic/index.html?appid=bd97f5cfbdac41cab0e6568ce25a419a	UC1	WFS
Traffic and warning lights.	https://hri.fi/data/dataset/helsingin-liikenne-ja-varoitusvaloliittymat	UC1	WFS
Interesting places, events and activities.	https://hri.fi/data/en_GB/dataset/myhelsinki-open-api-paikat-tapahtumat-ja-aktiviteetit, see e.g., http://open-api.myhelsinki.fi/map	UC2	API JSON

Street network.	https://kartta.hel.fi/ws/geoserver/avoindata/wfs?service=wfs&request=GetFeature&typeName=Seutukartta_liikenne_tiesto	UC1/2	WFS
Walkways/walking paths.	https://kartta.hel.fi/ws/geoserver/avoindata/wfs?service=wfs&request=GetFeature&typeName=YLRE_Katu_ja_viherosat_kevytliikenne_alue	UC1/2	WFS
Bicycle lanes.	https://kartta.hel.fi/ws/geoserver/avoindata/wfs?service=wfs&request=GetFeature&typeName=YLRE_Katu_ja_viherosat_kevytliikenne_alue	UC1/2	WFS
Travel time matrix (2018).	https://blogs.helsinki.fi/accessibility/helsinki-region-travel-time-matrix/	UC3	Covers the whole metropolitan area
Population data, in grid cells.	For computing a travel time matrix; Data available from Statistics Finland (eoserver/vaestoruutu/wfs?request=GetFeature&typeName=vaestoruutu.vaki2020_1km), and from the city's SDI/Digital Twin (https://kartta.hsy.fi/geoserver/wfs?request=GetFeature&typeName=asuminen_ja_maankaytto:Vaestotietorudukko_2020); In order to evaluate how easily the method can be transferred to other cities, we will also benchmark the usefulness of openly available datasets, such as the Gridded Population of The World (GPTW) [10]	UC 3	WFS, TIFF
Street network.	For computing a travel time matrix; Data available from the city's SDI/Digital Twin (see above). In addition, we will evaluate using data directly from OpenStreetMap (which the city also contributes to; https://osm.org/), to test how easily the methods can be transferred to use data that is openly available anywhere.	UC 3	WFS/.osm.pbf
Public transport network and schedule.	For computing a travel time matrix; Data is available from HSL, the regional public transport provider, in GTFS format (https://www.hsl.fi/en/hsl/open-data#public-	UC 3	GTFS

	transport-network-and-timetables-gtfs). Similarly, we want to test whether we can use syndicated open data, e.g., from TransitLand (https://transit.land/). This would make transferring our toolchain to other cities easier.		

Table 90: Helsinki pilot - required datasets

5.2.3 Requirements

5.2.3.1 Functional requirements

Criteria	Requirement	Related Use Cases
Easy to use.	To provide intuitive, easy to learn and easy to use user interface.	UC1/2
Customizability.	To provide an interface to adjust location and add attribute data.	UC1/2
Interoperability.	To incorporate existing open data for further analysis and visualisations.	UC1/2/3
Control.	To provide an admin view for exploring, removing and processing collected data.	UC1/2
Responsiveness.	To inform user about data submission (e.g., pop-up or other visual response).	UC1/2
Interoperability.	To provide data in an interoperable format to suit the Digital Twin	UC1/2/3
Customizability.	To provide options to view particular datasets (e.g., option to view only particular feedback).	UC1/2
Historical data.	To collect and accumulate data over time (including time stamp).	UC1/2
Anonymity.	To not collect identifiable data or require registration from the user.	UC1/2/3
Accessibility.	To provide access to external users (e.g., companies, citizen or other administrations) to view and potentially download data.	UC1/2/3

Table 91: Helsinki pilot - functional requirements

5.2.3.2 Non-functional requirements

No information is available at this phase of the *Urbanage* project for the Helsinki pilots.

5.2.4 Specific design (not use case related)

Forum Virium Helsinki and UH Digital Geography Lab will continue working together with relevant stakeholders in Helsinki and with the technical work packages to explore opportunities to include Artificial Intelligence algorithms to the design of use cases, e.g., to further utilize collected data and to assist in the development of Helsinki use cases.

6 Validation framework

Deliverable 6.2 in month 24 will contain the initial results of the validation framework as a result of task 6.3 “Technical Validation” and the description of implementation activities from task 6.2 “Implementation”. The framework itself containing functional and technical validation is described below.

The objective of task 6.3, partially covered in D6.1 is “*to validate from the technical point of view the implementation of the URBANAGE Ecosystem in the 3 use-cases, during the whole implementation process (3 iterations), to extract lessons for replication in other cities and regions (end-users' evaluation of results is carried out in WP2).*
To ensure that this task is carried out properly, technical stakeholders will be involved throughout the development of the use case. The parameters and aspects on which the technical validation will be carried out will be determined at the beginning. The validation methodology will consist of both quantitative and qualitative measures (i.e., a questionnaire and interviews).
Coordination activities between all the cities implementing the use cases will be carried out in order to homogenize the results and allow them to be comparable as much as possible. We will obtain those common elements and the particulars of each case that logically will depend on both the concrete implementation and the characteristics of the scenarios where the pilots are developed. By means of different methods such as objective assessments, interviews with interested parties, simple surveys, etc., the benefits, difficulties, barriers, etc. will be collected.”

The Task 6.3 Validation framework will link the functional design, functional and non-functional requirements and the technical validation approach.

In the next part, based on a technical validation checklist - 1 to 3 use cases (for example 1 per pilot) will be defined to test the proposed checklist and to provide a planning aligned with the iterative design process.

6.1 Validation methodology

*The **validation methodology** can be described as a common methodology, to ensure results of the different use cases can be compared and lessons can be extracted for replication. By means of different methods such as objective assessments, interviews with interested parties, simple surveys, etc., the benefits, difficulties, barriers, etc. will be collected.*

The validation methodology will be twofold and cover a combination of the users' internal and external testing. The validation activity contains several interrelated aspects and stands not on its own.

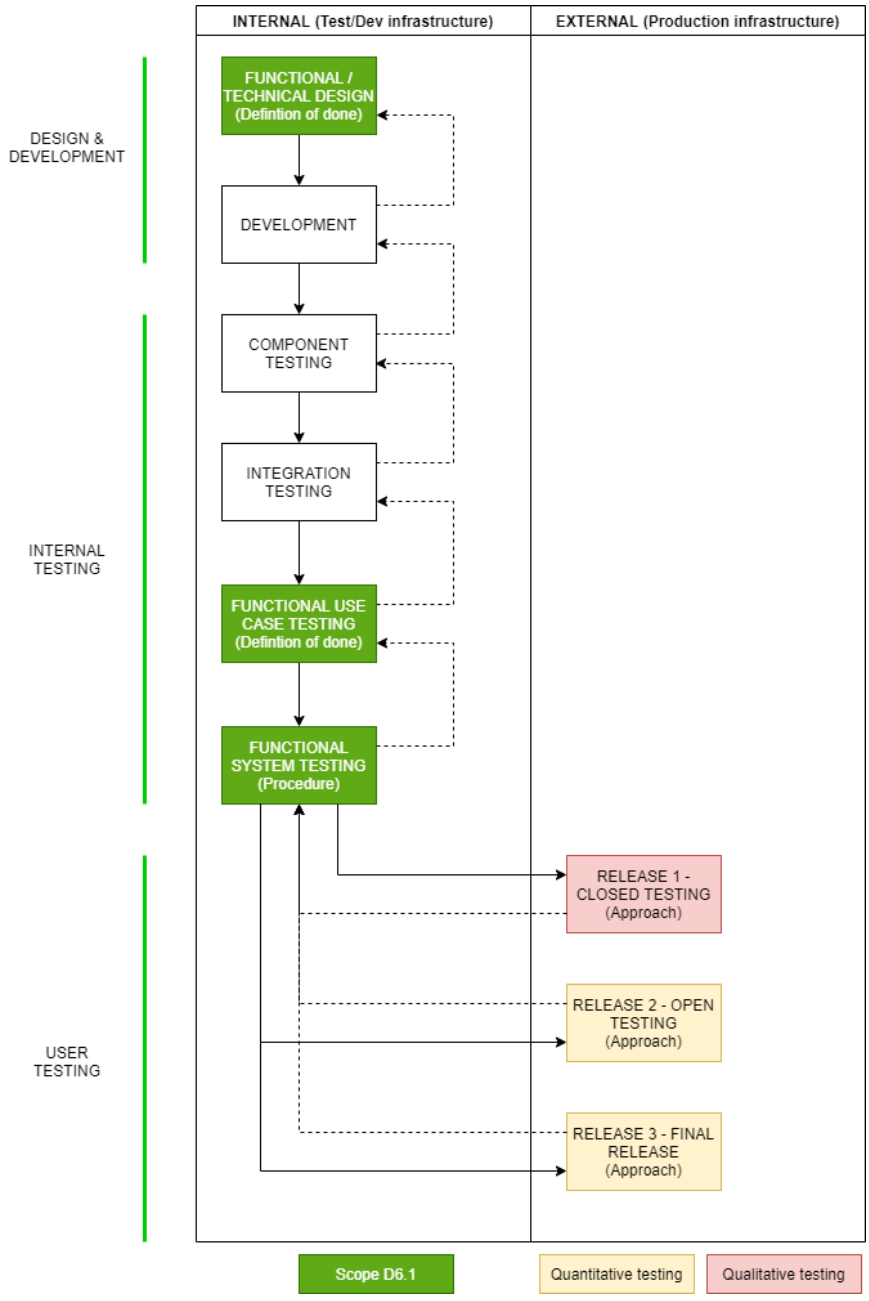


Figure 32: Urbanage Validation framework - validation methodology

6.1.1 Design and development

The input for the validation and testing is directly related to the user stories descriptions in this report. During the agile development cycles, the validation and testing will be further refined. The basic input can be found in the functionality description and the definition of the done table explaining the functionality, the results (done test description), and each user story's priority. A second important input is the human (actor) /machine (system response) interaction description.

6.1.2 Internal validation and testing

The internal validation and testing comprise technical testing (components and integration testing) and functional testing. The first validation steps are the component testing and the integration testing covered by WP3 and WP5. The input of the definition of done is the basis for the functional use case testing. The human (actor) /machine (system response) is the starting point for the functional system testing where the interaction between the different user stories is central.

6.1.3 User validation and testing

The user validation testing will be applied to the three planned software releases. Release one, the closed testing release, will focus on qualitative testing. The second and third (open testing and final release) will combine qualitative and quantitative techniques.

6.1.3.1 Qualitative indicators

Once the Digital Twins are available on an external (production infrastructure), a small group of people will be part of a closed testing round. Potential test users are selected on a case-by-case basis, depending on the key actors of particular use case.

The qualitative approach for the first testing cycle will follow the general principles of usability testing. A selected group of users will test the *Urbanage* Closed Testing prototype in a one-on-one setting with the testing facilitator. Depending on the functionalities, the users can for example be provided with a specific scenario and a range of tasks to complete. While completing the tasks, users are invited to share their thoughts, expectations and challenges with the prototype. The benefits of this approach are clear: usability testing helps to identify problems with the design and development in a stage where features can easily be added, changed, fixed or improved. The qualitative tests specifically allow us to[10]:

- determine whether test users can complete tasks successfully and independently;
- assess their performance and mental state as they try to complete tasks, to see how well prototype design works;
- see how much users enjoy using it;
- identify problems and their severity;
- find solutions.

6.1.3.2 Quantitative indicators

To evaluate the overall progress of the *Urbanage* development and its application in each pilot region, evaluation criteria will be formulated. These criteria relate to how a digital twin fits in the policymaking process; how stakeholders interact with the solution (especially policymakers and older people); how results are

[10] https://www.interaction-design.org/literature/topics/usability-testing

transferred to other cities; and the business potential of the solution. These topics are related to the key results in the DOA.

These indicators will be refined based on the input from task 6.3 “Technical Validation”, task 2.3 “Co-creation for challenges, user requirements and solutions identification” and task 2.4 “Impact assessment, evaluation, and paths for replication”.

ID	Outcome	Description/question	Method	Goal	Survey
DTs in the policymaking process					
D1	Acceptance of *Urbanage* pilot A as a solution	Is *Urbanage* perceived as tackling a real problem and providing a sufficient solution?	S/I	90%	Yes
D2	Usability of *Urbanage* pilot A	Is *Urbanage* easy to use for its target audience? (User experience)	S/I	0%	Yes
Business Value					
B1	Measure the impact of *Urbanage* pilot A	What is the added value of *Urbanage* over existing solutions, and how does it fit in existing policy processes? (Acceptance, satisfaction)	S/I	0%	Yes

Table 92: Urbanage validation methodology - user validation and testing - quantitative indicators

6.2 Validation planning

6.2.1 General approach

According to what is described in this document, the three different pilot sites, Helsinki, Flanders and Santander, each have their specific context and needs both in terms of technical implementation and in terms of their objectives. This heterogeneity, already foreseen since the project proposal, has an impact on the validation methodology and, consequently, on the planning. The validation planning is divided into two parts: one for internal validation and the other for user validation.

Internal validation activities, as described in the previous section, will be done by the *Urbanage* technical partners within WP3 and WP5. They will use their usual procedures for carrying out the involved tasks.

Regarding user validation, the following activities have been initiated:

- defining the necessary profiles appropriate for each of the iterations;
- defining the instruments (i.e., methodology) for collecting user feedback for each of the iterations.

During the user validation, the following subtasks will be repeated along the three iterations:

- identifying the specific users (e.g., older people, urban planners and civic servants);
- presenting the elements and functionalities to be tested and validated;
- executing selected tests by the users;
- gathering feedback using appropriate qualitative and quantitative methodology (depending on the needs of a particular use case);
- processing and synthesising the feedback;
- extracting the common parts and sharing of the information for the three pilot cities;
- elaborating on the iteration report to feed back the technical part with the common part and the specific part of the pilot.

6.2.2 Internal validation and testing plan

This plan, being a software development process, will follow an iterative scheme divided into a set of phases of component development and testing, as well as integration performing and testing. Testing may lead again to modification of the component development or integration approach.
The key element for the overall validation process of the pilots is the time constraints within the project planning framework. According to this planning, the most important milestones are the following:

- MS2: First release of *Urbanage* components, due to M12, producing the 1st iteration;
- MS3: First release of the *Urbanage* Ecosystem integrating first version of *Urbanage* components, due to M15.

6.2.3 User validation and testing plan

The user validation and testing plan should take into account that there will be three major interactions, each with aforementioned time restrictions according to the overall *Urbanage* project plan. Each interaction will be composed a set of tasks that have been described in the previous subsection.

6.2.3.1 Iteration no. 1 user validation and testing

The user validation and testing of iteration no. 1 will take place between the time constraints defined by the following elements:

- MS3: First release of the *Urbanage* Ecosystem integrating first version of *Urbanage* components, due to M15;
- MS4: First implementation and validation of the 1st release of *Urbanage* Ecosystem in the use cases and second release of *Urbanage* components, due to M24;

The results of validation and testing of 1st iteration will be included in the following deliverable:

- D6.2: Use case technical validation report. Initial, due to M24.

6.2.3.2 Iteration no. 2 user validation and testing

The user validation and testing of iteration no.2 will start after the following milestone is achieved:

- MS5: Second release of the *Urbanage* Ecosystem integrating second version of *Urbanage* components, due to M27.

The results of validation and testing of this 2nd iteration will be included in the following deliverable:

- D6.3: Use case technical validation report. Intermediate, due to M30.

6.2.3.3 Iteration no. 3 user validation and testing

The user validation and testing of iteration no. 3 will start after the following milestone is achieved:

- MS6: Final release and validation of the *Urbanage* components, due to M30.

The results of validation and testing of this 3rd iteration will be included in the following deliverable:

- D6.4: Use case technical validation report. Final, due to M36.

7 Conclusion

This deliverable presents the use cases for the three pilot sites. An overarching approach was followed during the business, and the functional design process and synergies between the pilot cases were detected. Of course, this is interesting for the technical partners who will work out the *Urbanage* solutions. And that's why inter-pilot approaches and communication are essential.

Overlapping case elements include:

- all cases look for the best solutions for older adults. The parameters taken into account to determine comfort for older people may largely overlap. It is a good idea to do some pilot-level ascending calibration;
- accessibility is a parameter taken into account in all three pilot sites. Santander will use accessibility information to define the most age-friendly routes, and the information is to be taken into account in calculating the age-friendliness index. Flanders will use this parameter to determine the green comfort index. Helsinki will monitor aspects of accessibility using IoT devices;
- the monitoring of incidents and accidents is a common feature for the three pilot sites. Incident reporting is included in the Santander and Flanders pilots;
- regarding the determination of the green comfort index and the age-friendliness index, parameters integrated into the calculations and the used weight factors will differ between the Flanders and Santander case (the cases have different approaches). Still, there will undoubtedly be some commonalities in the calculation procedure itself. The age-friendliness index also connects to the Helsinki case, where the index is one of the parameters taken into account to upgrade the existing Travel-time matrix determination;
- simulation solutions will be a substantial part of all three pilots. Therefore, some convergence is probable. Also, analyses, including the tools used for this purpose and export options, may overlap at various points;
- some solutions suggested by the pilot sites need the introduction of accounts and a certain accounts and settings management level. Also, using forms or other ways to collect feedback may be common features;
- since all pilots are under the URBANAGE project, the look & feel of the final products needs to be in common;
- Helsinki and Flanders share the mapping feature for Point of Interest data and the usage of Google Street image analysis to define elements/features in the landscape.

Following the work for this deliverable, the focus turns on the implementation of use cases (task 6.2). In this task, the *Urbanage* Ecosystem will be implemented in the use cases following an iterative approach:

- the first release of the *Urbanage* ecosystem integrating the first version of *Urbanage* components (M15);
- start with implementation and technical validation of the first release of *Urbanage* Ecosystem in the use cases and second release of URBANAGE components (M24);
- the second release of the *Urbanage* Ecosystem integrating the second version of *Urbanage* components (M27);
- the final release and technical validation of the *Urbanage* components (M30);
- the final release of *Urbanage* Ecosystem (M33).

The next step will be to focus more on implementing different use cases based on all partners' input. The timeline for implementation and validation of use cases will vary on a case-by-case basis. Thus, for successful implementation and iteration of use cases, there is a need for continuous collaboration and open communication between the three pilot sites and technical partners of the project to share findings and development stages. This will ensure maintaining congruence between use cases when possible and will increase the project's benefits for the partners and wider replication purposes. Customization of the generic tools for decision-making will also be carried out as part of task 6.2.

8 References

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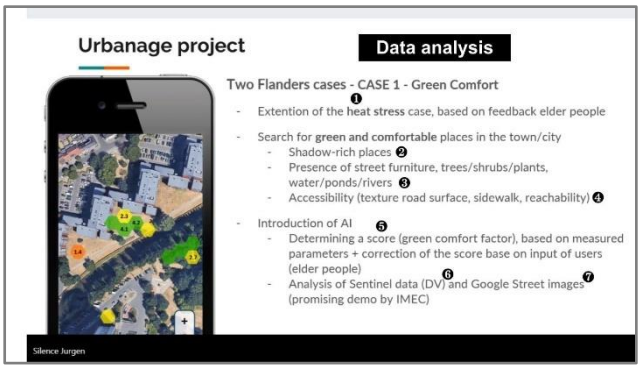
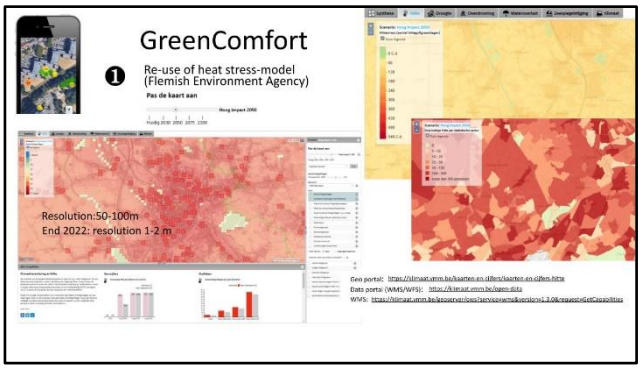
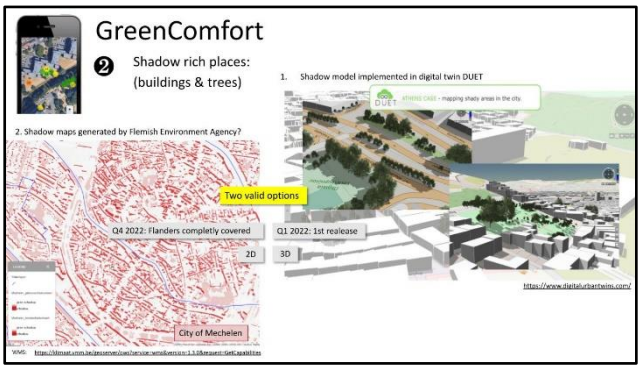
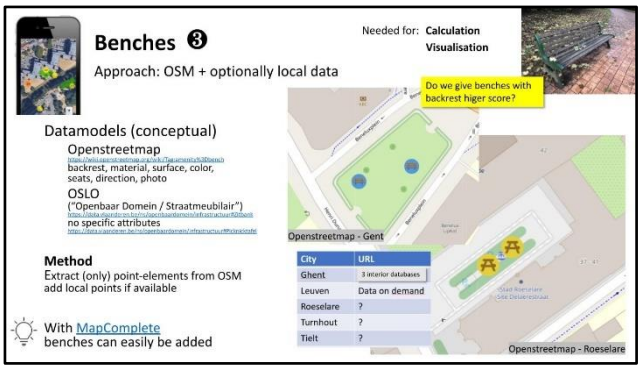
9 Annex & Templates

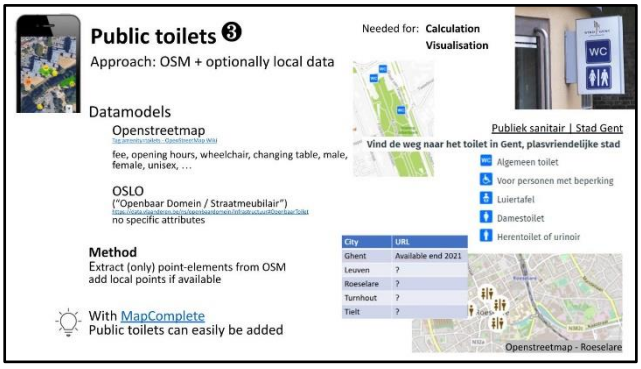
9.1. Data analysis Flanders case 1

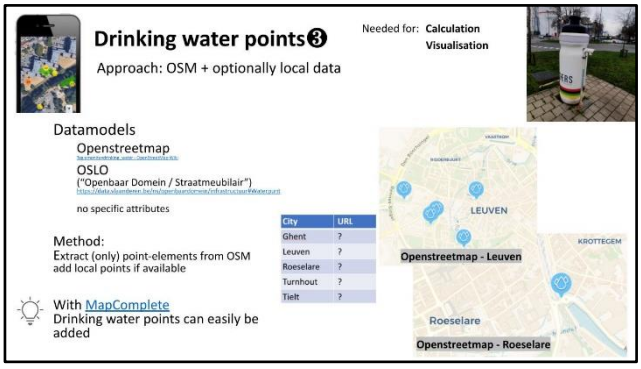


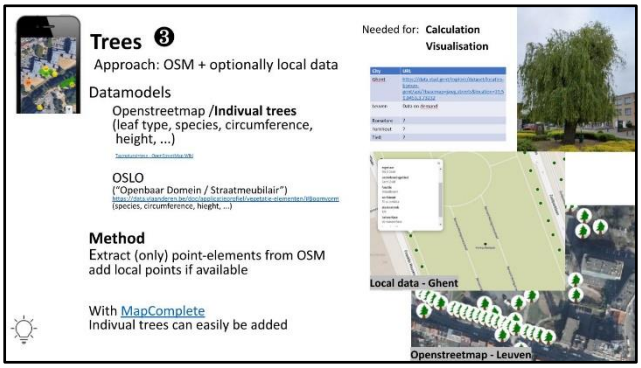


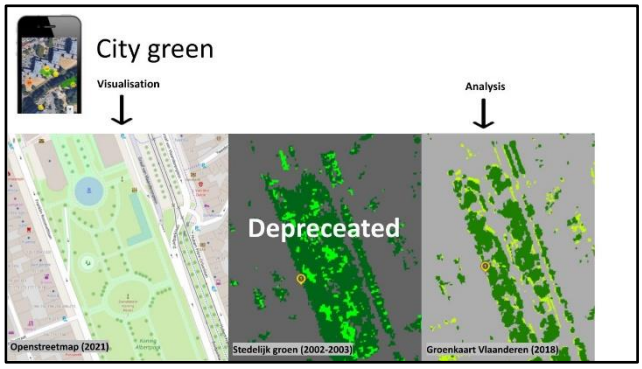


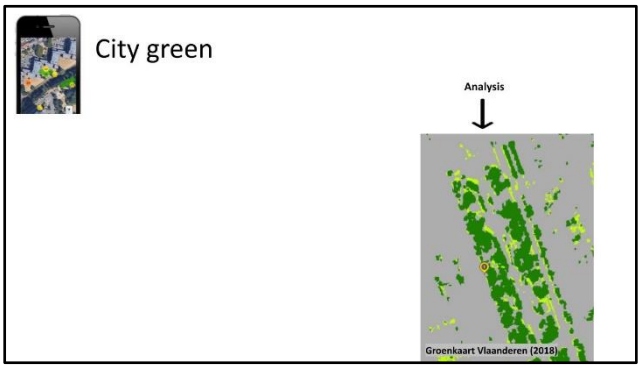


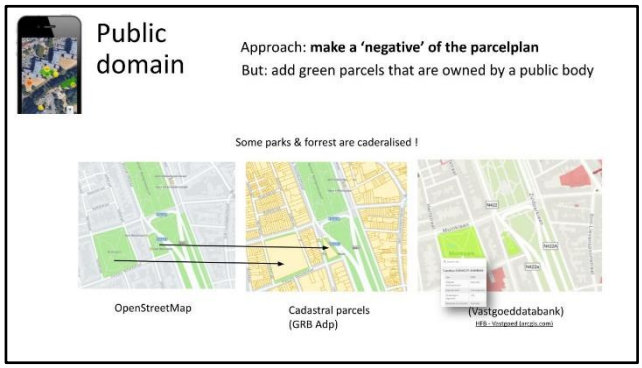


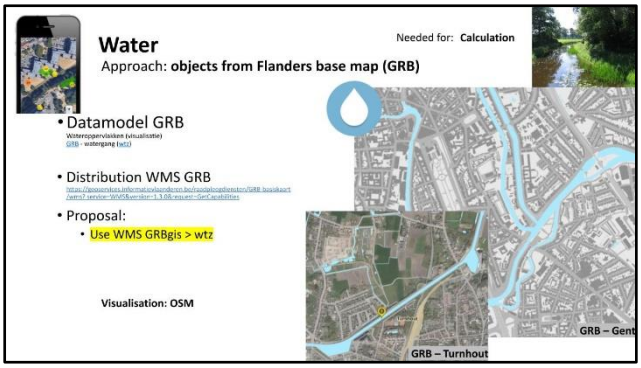


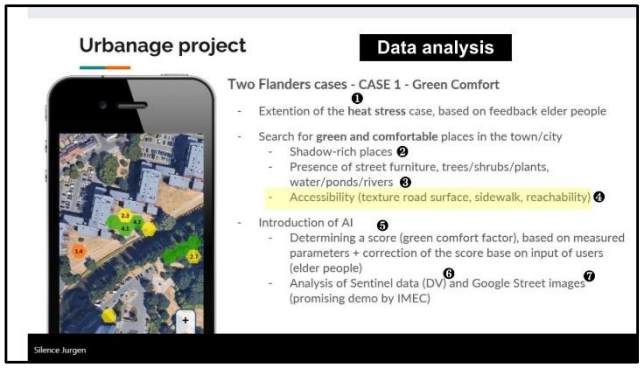

Trees ❸
Approach: OSM + optionally local data
Datamodels
Openstreetmap /Indivual trees
(leaf type, species, circumference, height, ...)
OSLO
("Openbaar Domein / Straatmeubilair")
(species, circumference, hieght, ...)
Method
Extract (only) point-elements from OSM
add local points if available
With MapComplete
Indivual trees can easily be added
Needed for: Calculation
Visualisation
Local data - Ghent
Openstreetmap - Leuven


City green
Visualisation
Analysis
Depreceated
Openstreetmap (2021)
Stedelijk groen (2002-2003)
Groenkaart Vlaanderen (2018)

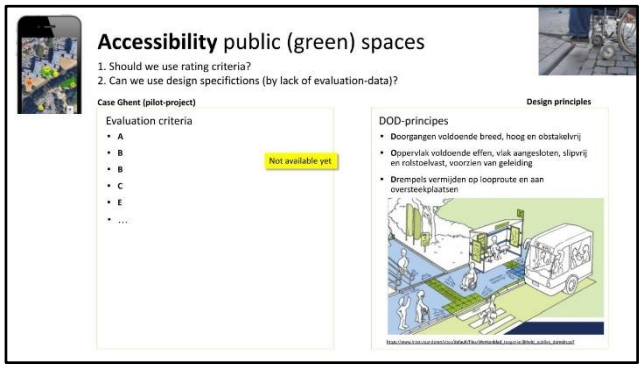

City green
Analysis
Groenkaart Vlaanderen (2018)


Public domain
Approach: make a 'negative' of the parcelplan
But: add green parcels that are owned by a public body
Some parks & forrest are caderalised !
OpenStreetMap
Cadastral parcels
(GRB Adp)
(Vastgoeddatabank)


Water
Approach: objects from Flanders base map (GRB)
Needed for: Calculation
• Datamodel GRB
• Distribution WMS GRB
• Proposal:
• Use WMS GRBgis > wtz
Visualisation: OSM
GRB – Gent
GRB – Turnhout


Urbanage project
Data analysis
Two Flanders cases - CASE 1 - Green Comfort
❶
- Extention of the heat stress case, based on feedback elder people
- Search for green and comfortable places in the town/city
- Shadow-rich places ❷
- Presence of street furniture, trees/shrubs/plants, water/ponds/rivers ❸
- Accessibility (texture road surface, sidewalk, reachability) ❹
- Introduction of AI ❺
- Determining a score (green comfort factor), based on measured parameters + correction of the score base on input of users (elder people)
- Analysis of Sentinel data (DV) and Google Street images ❻ ❼ (promising demo by IMEC)
Silence Jurgen


Accessibility public (green) spaces
For elders with reduced mobility
A person with reduced mobility (PRM) is understood to mean any individual whose mobility is reduced due to physical incapacity (sensory or locomotory), intellectual deficiency, age, illness, or any other cause of disability.
Target group is very mixed
Experience of accessibillity is very different


Accessibility public (green) spaces
1. Should we use rating criteria?
2. Can we use design specifictions (by lack of evaluation-data)?
Case Ghent (pilot-project)
Evaluation criteria
Not available yet
Design principles
DOD-principes
• Doorgangen voldoende breed, hoog en obstakelvrij
• Oppervlak voldoende effen, vlak aangesloten, slipvrij en rolstoelvast, voorzien van geleiding
• Drempels vermijden op looproute en aan oversteekplaatsen

Accessibility public (green) spaces

1. Should we use rating criteria?
2. Can we use design specifictions (by lack of evaluation-data)?

Design principles

DOD-principes

- Doorgangen voldoende breed, hoog en obstakelvrij → **Passages** sufficiently wide
- Oppervlak voldoende effen, vlak aangesloten, slipvrij en rolstoelvast, voorzien van geleiding → Sufficiently smooth **surface**, flatly connected, non-slip and wheelchair-proof, fitted with guides
- Drempels vermijden op looproute en aan oversteekplaatsen → Avoiding **barriers** on the walking route and at crossings

Accessibility

Desing specifications

OPPERVLAK: voldoende effen, aaneengesloten en slipvrij, voorzien van geleiding

Een goed belcoopbaar oppervlak bepaalt in sterke mate het comfort van de voetganger. Het beperkt o.a. het struikelgevaar maar ook de rolweerstand (rolstoel, kinderwagen, rollator, koffer op wieltjes,...).
Om uitschuivers te beperken is de verharding slipvrij. Voorzie bij gladde materialen een duurzame en afdoende antislipbehandeling. Draag zorg voor het onderhoud door bv. bladeren en sneeuw te verwijderen.

Het oppervlak is
- Vlak, eventuele oneffenheden bedragen max. 0,5 cm.
- Aaneengesloten: min. voegbreedte, bij roosters max. 2 cm (witte stok mag nergens blijven steken).
- Slipvrij, ook bij vochtige omstandigheden.
- Rolstoelvast: de rolstoel mag niet wegzakken of blijven steken.
- Stabiel: denk aan bruggen, vlonderpaden.

SURFACE:
sufficiently smooth, contiguous, non-slippery, equiped with guidance

Accessibility

Complex topic & **data scarce**

1. Can data about **sidewalks**/roads (material/quality) be used?
2. Can database of obstacles on public domain be used?
3. Can Google Streetview-API offer usefull data? IMEC?

No (polygon) sidewalks in OSM
nor in Flanders base map (GRB)
Data about sidewalks available in Ghent &

Accessibility: surface material

❶ Wegenregister (Digitaal Vlaanderen) Objectcatalogi (WR v1.4 (geopunt.be)

Road registry
No (polygon) sidewalks
Too limited?
Attribute-values: Fixed or loose road pavement

❷ https://wiki.openstreetmap.org/wi

Extensive material codelist
Filled in very heterogeneous

❸ Wegeninformatiesysteem Gent – Open Data Portaal - Stad Gent

Only in Ghent

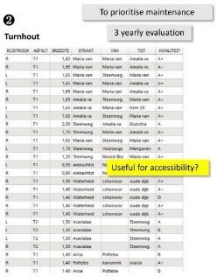
Accessibility: quality of sidewalks

❶ Ghent
"Trottoir-actieplan"

New project under development: pilot phase
Not data yet

❷ Turnhout

To prioritise maintenance
3 yearly evaluation
Useful for accessibility?



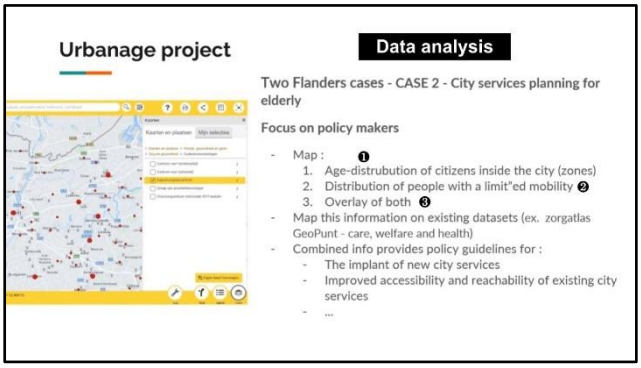
Accessibility

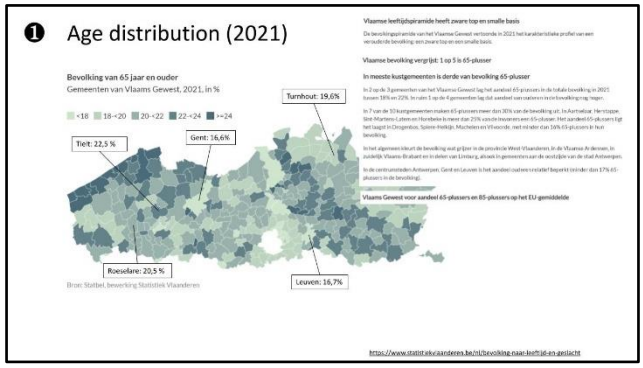
Can database of planned & temporary **obstacles** on public domain be used?

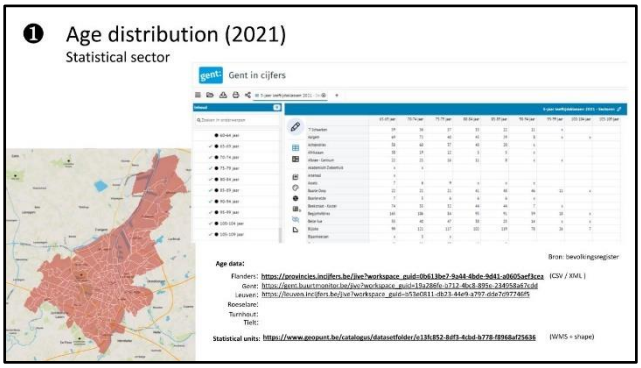
Probably: select object types that hinder normal accessibility for pedestrians together with users and try it out

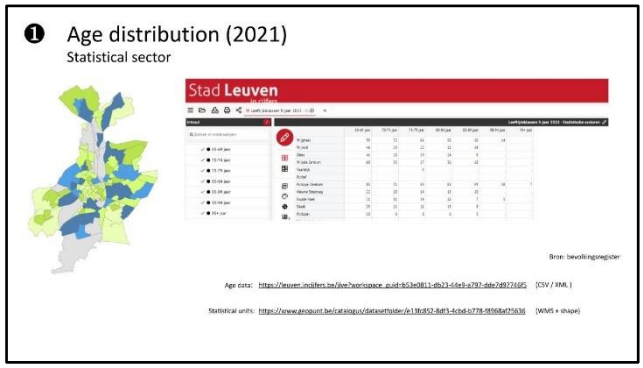
https://www.geopunt.be/ > "hinder in kaart"

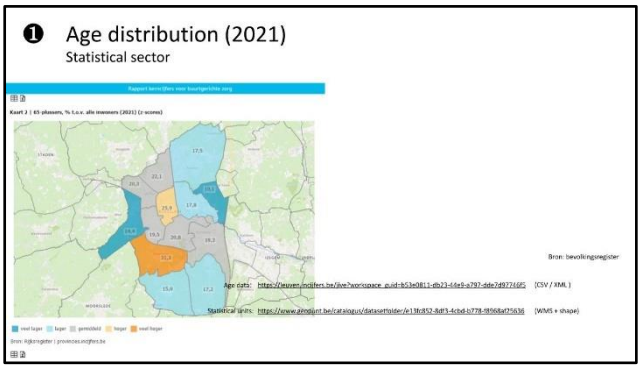
9.2. Data analysis Flanders case 2

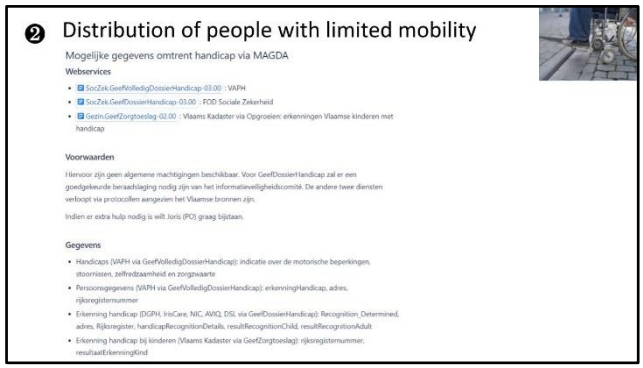


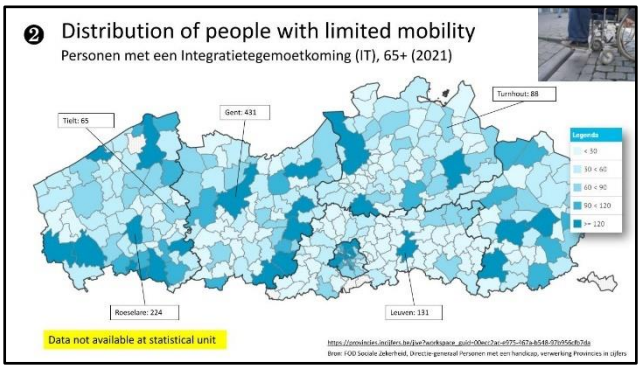


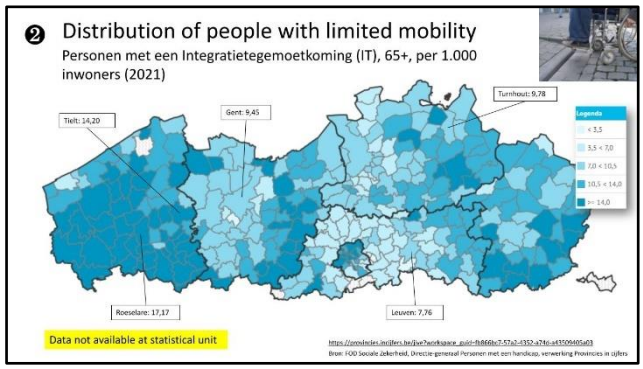


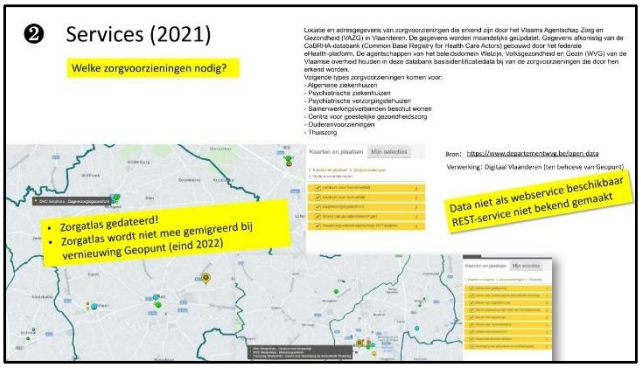


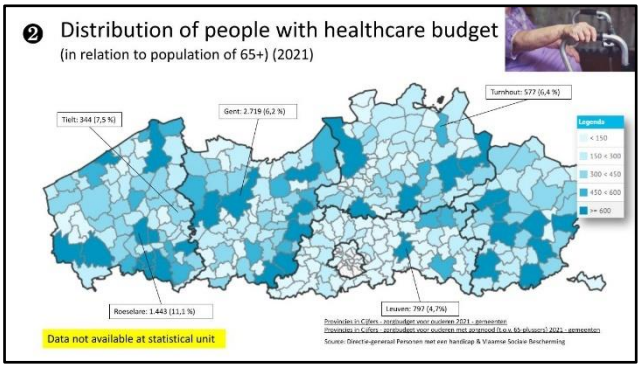


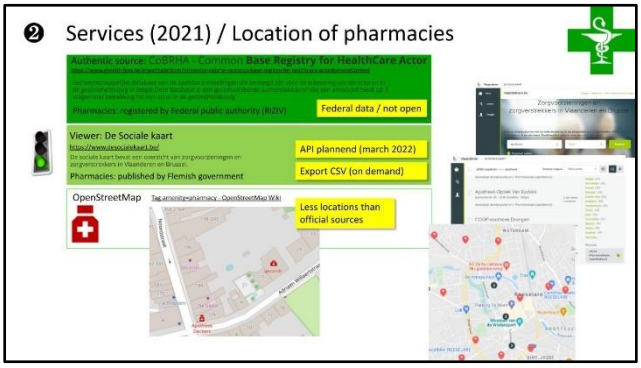


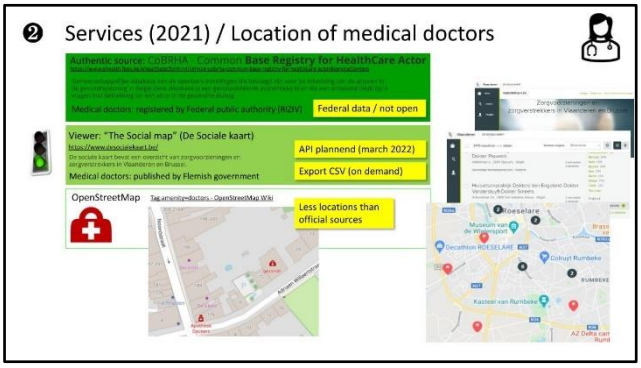


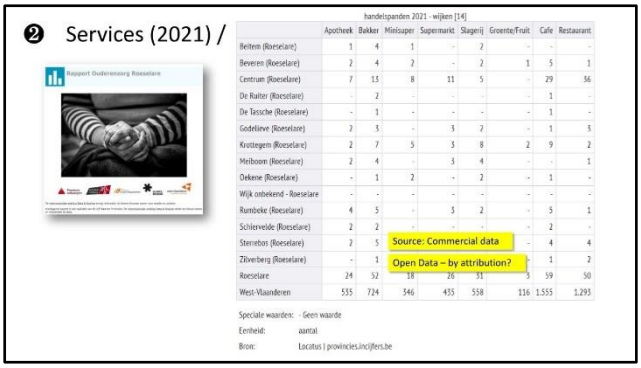












handelspanden 2021 - wijken [14]	Apotheek	Bakker	Minisuper	Supermarkt	Slagerij	Groente/Fruit	Cafe	Restaurant
Beitem (Roeselare)	1	4	1	-	2	-	-	-
Beveren (Roeselare)	2	4	2	-	2	1	5	1
Centrum (Roeselare)	7	13	8	11	5	-	29	56
De Ruiter (Roeselare)	-	2	-	-	-	-	1	-
De Tassche (Roeselare)	-	1	-	-	-	-	1	-
Gobelieve (Roeselare)	2	3	-	3	2	-	1	3
Krottegem (Roeselare)	2	7	5	3	8	2	9	2
Meiboom (Roeselare)	2	4		3	4	-	-	1
Oekene (Roeselare)	-	1	2	-	2	-	1	-
Wijk onbekend - Roeselare	-	-	-	-	-	-	-	-
Rumbeke (Roeselare)	4	5	-	3	2	-	5	1
Schierveide (Roeselare)	2	2	-	-	-	-	2	-
Sterrebos (Roeselare)	2	5	-	-	-	-	4	4
Zilverberg (Roeselare)	-	1	-	-	-	-	1	2
Roeselare	24	52	18	26	31	3	59	50
West-Vlaanderen	535	724	346	435	558	116	1.555	1.293

Speciale waarden: - Geen waarde
Eenheid: aantal
Bron: Locatus | provincies.incijfers.be