DELIVERABLE

D2.3 – The scope of Smart City use cases

Project Acronym: ESPRESSO

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C	Confidential, only for members of the consortium and the Commission Services	

1. Revision history and Statement of originality

1.1. Revision history

Rev	Date	Author	Organization	Description
1.0	18/05/16	Sabina Dimitriu	ISOCARP	Initial TOC (v 0.0)
2.0	20/05/16	Sabina Dimitriu	ISOCARP	Development of chapters 2-3
3.0	28/05/16	Sabina Dimitriu	ISOCARP	Development of chapter 4
4.0	17/03/17	Sabina Dimitriu Juan Bareño	ISOCARP ATOS	Deliverable reopened for changes requested through 1st year review report
5.0	03/04/17	Kadri Uus, Rene Tonnisson	TARTU	Provision of final Use Cases
		Rob Poll, Rick Klooster	ROTTERDAM	Provision of final Use Cases
		Claus Nagel, Richard Redweik	VCS	Provision of technical approach to UC: UML schemes and pilot support
6.0	03/04/17	Sabina Dimitriu, Pietro Elisei	ISOCARP	Final D2.3
7.0	18/04/17	Irene Facchin	TRILOGIS	Quality Check

1.2. Statement of originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

2. List of references

Number	Full Reference
[1]	ITU-T Focus Group on Smart Sustainable Cities
[2]	*Cockburn, Alistair, "Writing Effective Use Cases", Addison-Wesley, 2001, hyperlink: http://alistair.cockburn.us/get/2465, retrieved 18.05.2015*
[3]	*UML – Unified Modelling Language, OMG, hyperlink: http://www.uml.org*
[4]	*International Electrotechnical Commission, IEC 62559-2:2915, https://webstore.iec.ch/publication/22349*
[5]	*Mathias Uslar, Michael Specht et al (2013), Standardization in Smart Grids – introduction to IT-Related Methodologies, Architectures and Standards, Springer-Verlag Berlin Heidelberg 2013, ISBN 978-3-642-34915-7*
[6]	*UN, World Urbanization Prospects (2014)*
[7]	*Population Division, DESA, United Nations, World Population Ageing 1950-2050*
[8]	*City of Rotterdam, Facts and Figures Rotterdam 2013, http://www.rotterdam.nl/*
[9]	*Global Cities Registry™ for ISO 37120 - http://www.dataforcities.org/global-cities-registry/*
[10]	*RCI – Rotterdam Climate Initiative, www.rotterdamclimateinitiative.nl*
[11]	*C40 Cities - http://www.c40.org/*
[12]	*Rotterdam Adaptation Strategy, City of Rotterdam, Oct 2013, http://www.turas-cities.org/uploads/biblio/document/file/271/RCI_RAS_2013_EN_LR.pdf*
[13]	*SOBEK water management solution - http://www.ipp-hydro-consult.de/visioncontent/mediendatenbank/090630132150.pdf*
[14]	*Smart Urban Water project, Climate-KIC Portal - http://www.climate-kic.org/projects/smart-urban-water/*
[15]	*Robles, Alcarria, Martin et.al, „An IoT based reference architecture for smart water management processes", Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, volume: 6, number: 1*
[16]	*Holland Trade and Invest, http://www.hollandtradeandinvest.com/key-sectors/water/contents/water-technology*
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[19]	*BusinessTartu Portal - http://business.tartu.ee/*
[20]	*KNOEMA Data Atlas*
[21]	*Tartu 2030 Strategy – http://info.raad.tartu.ee/teated.nsf/0/C26E6D2D24CF3ADAC22571F6003D800F/$FILE/tartu2030uus.PDF*
[22]	*EIFL, Open access and open data Estonia project, http://eifl.net/eifl-in-action/open-access-and-open-data-estonia-project*
[23]	*TARTU Open Data 2016 - http://hub.garage48.org/tartu/blog/tartu-open-data-*

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[24]	*Artur Novek, Estonian eHealth Integration, Estonian e-Health Foundation, https://www.mindtrek.org/wp-content/uploads/sites/7/2015/09/Artur-Novek-Estonian-eHealth-Integration.pdf*
[25]	*ECMI, „Smarten Tartu", 21 January 2016, https://ecmiindmath.org/2016/01/21/smarten-tartu/*

3. Table of Acronyms

Acronym	Description
BIM	Building Information Modelling (BIM)
CASSIOPEiA	ConceptuAl StandardS InterOPErability frAmework
CEN	European Committee for Standardization
CENELEC	European Committee for Electro technical Standardization
CityGML	City Geography Mark-up Language
DIN	German Institute for Standardization
DKE	German Commission for Electrical, Electronic & Information Technologies of DIN and VDE
EIF	European Interoperability Framework (EIF)
ENoLL	European Network of Living Labs
ESO	European Standardization Organizations
FH	Fachhochschule/University of applied science
GCIF	Global City Indicator Facility
GDP	Gross Domestic Product
ICLEI	Local Government for sustainability
ICT	Information and Communications Technology
IFHP	International Federation for Housing and Planning
IoT	Internet of Things
ISO	International Standardization Organization
ITS	Integrated Transport Systems
KIC	Knowledge and Innovation Community
NGO	Non-Governmental Organization
PLEEC	Planning for Energy Efficient Cities
RAS	Rotterdam Adaptation Strategy
RCE 2030	Rotterdam Circular Economy Roadmap 2030
SCL	Smart City Lab Tartu
SDO	Standards Development Organizations
SIP	Strategic Implementation Plan
SSCC-CG	'Smart and Sustainable Cities and Communities' (SSCC-CG)
UML	Unified Modelling Language

4. Executive Abstract

A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects[1].

The fundamental change brought by Smart Cities (SC) solutions will transform significantly the way citizens live, work, use resources and services and interact with the decision-makers. However, for SC solutions to expand, scale up and replicate, they need a systemic approach to interoperate, using standards. The **Horizon 2020 project ESPRESSO** (*systEmic standardisation apPRoach to Empower Smart citieS and cOmmunities*) focuses on the development of a conceptual Smart City Information Framework based on open standards, consisting of a **Smart City platform** and a number of data provision and processing services to integrate relevant data, workflows, and processes. The project will build this framework by identifying relevant **open standards, technologies, and information models** that are currently in use or in development, together with potential gaps and overlaps among standards addressing them. Although "horizontal" interoperability is outside the scope of ESPRESSO, preferences will be given to **"common denominator" solutions** that can facilitate horizontal interoperability between the various sectors of a Smart City. This approach is fostering a **case study based approach** to define key requirements for Smart Cities, applicable to the pilot cities involved in ESPRESSO.

In order to understand the state of the art of SC standardization requirements, which can be addressed through real-life testing and application, the present deliverable addresses the **definition of Use Cases and requirements** for ESPRESSO. It builds on the findings of D2.1 – Scope of Smart City Standardization and identifies, jointly with the pilot cities Rotterdam and Tartu, the user stories fitting with the approach of the project. This process requires several iterations in which the user stories (or storyboards) are refined, transformed into UML case models and expanded with standardization requirements. It is therefore a "live document".

For the initial definition of Use Cases, several tools have been used: a Smart City Requirements questionnaire, skype interviews (Tartu), workshops (Rotterdam, Bucharest), as well as literature review. The D2.3 deliverable encloses the results:

- a set of Smart City drivers and priorities across the cities analysed, outlining the sectorial systems of highest interest for the project;
- the definition of pilot partner profiles and pre-existing initiatives for use case build-up;
- the **set of use cases and requirements** for pilot cities Rotterdam and Tartu;
- a supplementary set of "general" use cases and topics of interest, including background in Smart Cities initiatives of the two pilots, matching the main priority topics of the sectorial systems (ANNEXES).

This deliverable has been reopened in March 2017, in order to provide more detail to the use cases of the pilots Rotterdam and Tartu, including analytics on the data for each use case to be later developed in D2.6 Interoperability Pilot Deployment and Test Plan and in the piloting stage.

[1] ITU-T Focus Group on Smart Sustainable Cities

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8. Introduction

The Horizon 2020 project ESPRESSO (*systEmic standardisation apPRoach to Empower Smart citieS and cOmmunities*) focuses on the development of a conceptual Smart City Information Framework based on open standards. This framework will consist of a **Smart City platform** (the "Smart City enterprise application") and a number of data provision and processing services to integrate relevant data, workflows, and processes. The project will build this framework by identifying relevant **open standards, technologies, and information models** that are currently in use or in development in various sectors throughout partner cities (pilots and early adopters) and members of the Smart City Stakeholder Network – the SmaCStak established through WP1.

Based on **a detailed requirements-engineering campaign** executed in close cooperation with cities, standardisation organizations, administrative bodies, and private industry, the project will identify **open standards** matching the elicited requirements and will establish a **baseline for interoperability** between the various sectorial data sources and the Smart City enterprise application platform. ESPRESSO's novel approach emphasizes cost reduction and will foster an open market for many actors, avoiding lock-in to proprietary solutions.

Within this process, an essential activity is the **understanding of the current state of the art of Smart City developments in various sectors**, the requirements and gaps to be addressed, as well as starting an open dialogue with city authorities, regions, policy makers, industry and NGOs. The **Work Package 2 - Smart City Interoperability Scope** delivers this comprehensive and cross-sectorial analysis, through activities aimed at scope definition, analysis of sectorial systems, definition of use cases and test scenarios, which will yield a conceptual standardized interoperability framework and will represent the basis for cross-harmonization (WP3) and Piloting (WP4).

8.1. Aims of the Task and synergies

As part of the definition of a Smart City interoperability scope, the ESPRESSO project will address the **identification and selection of use cases of relevance**, to be used further in real-life test-beds by the pilot cities of ESPRESSO.

The present document outlines the definition of the **first "unconstrained" use cases**, which will be refined through the process of scoping, carried out by technical partners, in order to ensure technical feasibility. A refinement of the sectorial systems and use cases both will be carried out before the deployment of piloting by the cities involved in ESPRESSO.

The task will start from the first results of the T2.1 – Definition of sectorial systems and, using a methodology based on the iterative involvement of cities, it will identify the use cases of relevance and their mapping with the pilot and early adopter cities of ESPRESSO. The definition of use cases and requirements is built directly on the previous deliverable of the work package 2, the **Scope of Standardization (D2.1)**, which identified both the technical and non-technical boundaries and implications of the Smart City concept and which concretized into a set of **sectorial systems of Smart Cities, for each identifying:**

- General technological and research trends and barriers
- Market and regulatory trends and barriers
- Competitive positioning of European stakeholders at global level
- Requirements for Smart City standardization aspects.

Technical partners will transform the initial "storyboards" of D2.3 into UML case models including: 1) actor lists and benefits. 2) Use case packages and hierarchy between the use cases. 3) UML Use Case (UC) diagrams, i.e. graphical/pictorial representations of the UC models from several views that help understand the model from different angles (of the different final users). After a few iterations (that may require a number of web-based conferences calls) each UC will be "committed" and agreed upon with the users and assigned a unique ID. Each UC will be associated to one or more city.

The resulting Use Cases are further expanded and detailed through the task T2.5 – Design of Testbeds (including cross-city examples) for interoperability experiments, which identified through a detailed analysis the requirements in terms of data transfer standardization, the data sources that need to be represented or exchanged in the context of pilot cities, the specific technologies required, administrative aspects related to piloting, as well as all steps necessary in order to ensure deployment of piloting with operational technical and service requirements.

The deliverable is strongly linked and continued through **D2.6 – Interoperability Pilot Deployment and Test Plan**. In parallel to use case definition, technical partners will survey standardisation requirements in terms of: 1) different protocols or technologies to be supported; 2) different software required; 3) different datasets to be harmonized and integrated; 4) different hardware to be supported; 5) regulatory requirements; 6) privacy and security requirements. Each agreed requirement will be identified, classified and qualified through: 1) unique ID; 2) importance, i.e. "required", "preferred", "optional"; 3) textual description.

Deliverable 2.6 will essentially refine the use cases enclosed in this deliverable including, but not limited to: specific features, applications, services, stakeholders involved, different datasets to be harmonized and integrated, existing technologies, regulatory aspects in place at the city level, etc. using a similar iterative involvement of pilots/cities. The results of T2.5, to which D2.3 contributes to, will be tested by the cities in **Piloting Activities (T4.5).**

Furthermore, as the Use Cases are pertaining directly to future real-life testing scenarios in pilots and early adopters, but need to respond at the same time to the contextual European drivers for Smart City strategies and frameworks, the D2.3 deliverable is also strongly linked with the **Work package 1 – Smart City Ecosystem**, drawing from the experiences of the SmaCStak in order to build the Use Case repository. The participatory process to definition of requirements represents a prerequisite for the relevance and usability of the selected scenarios, hence the present deliverable will leverage on completing the Use Case repository with crowdsourced „storyboards" from the ESPRESSO SmaCStak community as well.

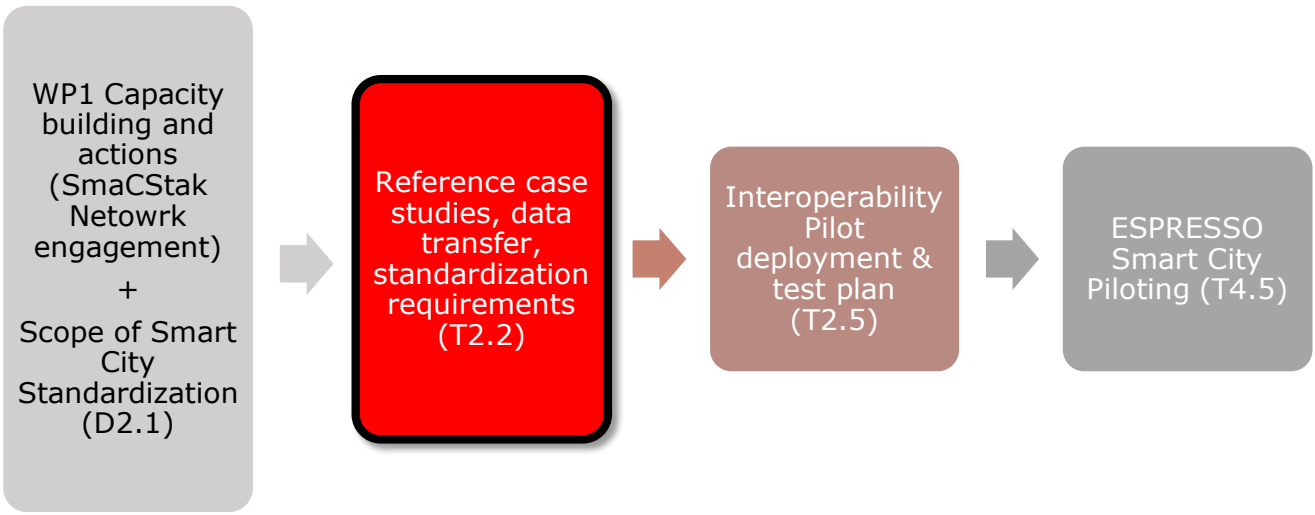


Figure 1. Main relations of the T2.2 within the ESPRESSO project.

8.2. Methodology. The Use Case approach in ESPRESSO

The concept of use cases is imported from software engineering, where its main aim is to outline a list of actions or steps, typically defining interactions between a role and a system, in order to achieve a specific goal. Its focus is on the description of general functionalities, being independent of design specifics and focusing firstly on the identification of requirements[2]. The concept of use cases is also supported by the Unified Modelling Language (UML)[3] which provides use case diagrams to supports their description.

This type of „problems / requirements first" approach can be effectively extrapolated to dealing with complex territorial development aspects and city processes. The concept of Smart Cities, albeit broad in scope, essentially leverages interoperability within and across policy domains of the city, in the aims of improving citizens' quality of life. All the encompassed sub-domains or sectorial systems as described in D2.1 (smart energy management, mobility, smart grids, waste and water management, security and safety, governance, etc.) play their role in providing citizens with services and facilities to improve the standard of living, and the landscape of smart solutions is growing increasingly complex.

While new technologies and services are constantly being created in order to respond to needs, fill gaps or fit existing or planned systems, this technological expansion should also be followed by actions designed to ensure interoperability between systems and components for smart cities. This is addressed by the ESPRESSO project through the Smart City Interoperability Framework, but in order to achieve a realistic perspective on the current landscape of requirements, the scoping for standardization needs to consider multiple facets of the sectorial systems and subsystems of Smart Cities.

[2] Cockburn, Alistair, "Writing Effective Use Cases", Addison-Wesley, 2001, hyperlink: http://alistair.cockburn.us/get/2465, retrieved 18.05.2015
[3] UML – Unified Modelling Language, OMG, hyperlink: http://www.uml.org, retrieved 18.05.2016

The Use Case approach allows for a holistic analysis of the sectorial systems and specific components, starting from the needs and requirements formulated by the pilot cities and extended group of stakeholders which are part of the SmaCStak.

The process of definition in ESPRESSO is closely related to the iterative involvement of the territorial partners (pilot cities, early adopters) as well as the actors of the SmaCStak. All of the above tools will support the illustration of the use cases, data transfer and standardization requirements:

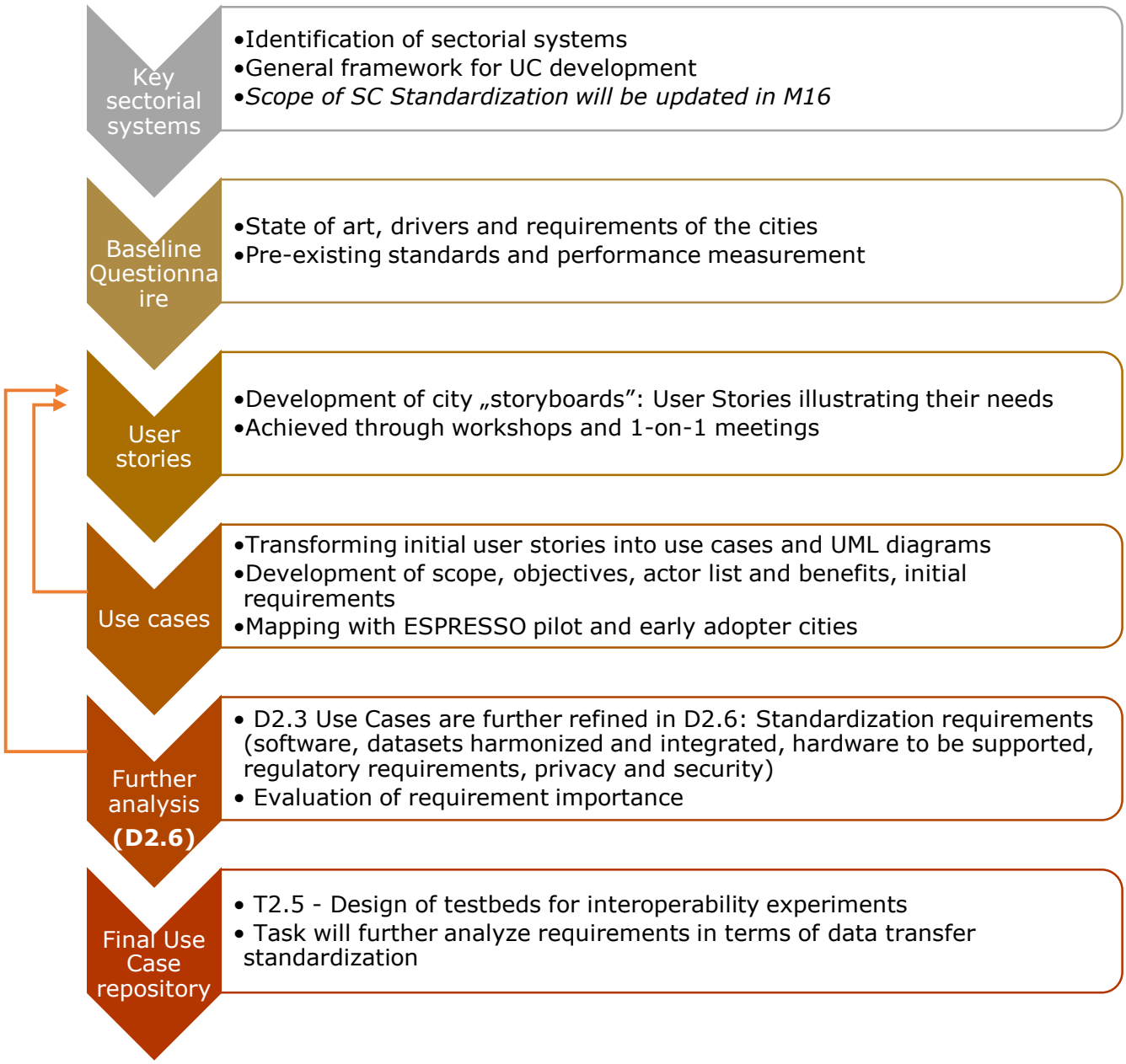


Figure 2. Use Case Approach and links to D2.6.

The User Stories defined by the cities will represent a short outline of specific needs, using the index card and/or the storyboard method. User stories will be expanded on in workshops, meetings and Skype interviews. As this implies several iterations it will

be a lengthier process, running in parallel with the redefinition of sectorial systems within the first year of the ESPRESSO project.

The selected ESPRESSO Use Cases for piloting will be illustrated in D2.3 and detailed in D2.6 through the following template, coherent across the two deliverables:

Table 1. ESPRESSO Use Case template for pilot cities (D2.3, D2.6).

ESPRESSO USE CASE TEMPLATE FOR PILOT CITIES		
A. **INFORMATION REQUESTED THROUGH D2.3 SCOPE OF SC USE CASES**		
1. Use case Name		
a. Domain/sector of activity		
b. Subdomain (s)		
c. Objectives/benefits of the use case		
2. Description		
a. User Story Description		
b. Storyboard		
c. UML Diagram		
3. Scope and Objectives		
Scope of Use Case		
Objectives		
4. Actor List and Requirement		
Actors identified		
Requirements (from actor's perspective)		
B. **INFORMATION PROVIDED THROUGH D2.3 AND EXTENDED THROUGH D2.6 INTEROPERABILITY PILOT DEPLOYMENT AND TEST PLAN**		
5. Available Data at the Pilot Site and Open Portals		
Data	***Technical Description***	***Standards applied***
Which are the available data at the pilot site for this use case?		
Which are the available and useful data coming from Open Portals?		
C. **INFORMATION REQUESTED THROUGH D2.6 INTEROPERABILITY PILOT DEPLOYMENT AND TEST PLAN**		
6. Available HW and SW Technology(ies)		

Technical Components	***Technical Description***	***Standards applied***
Devices and sensor technology		
Communications and Connectivity		
Infrastructure		
Integration/Interoperability		
Applications		
IoT Architecture		.
Security and Privacy		
7.Standards app lied from D2.3 CASSIOPEA: *Use of Management standards, maturity models, standard sets of indicators, and standard information models.*		
Standards applied for	***List of Standards applied***	
Management standards		
Maturity models		
Indicators		
Information models used		
Architectural frameworks		
Sectorial Standardization Initiatives		
8. Legal and normative requirements / barriers		
Identify the normative boundaries that regulate the acquisition of Data from sensors		
Identify the use cases main requisites		
Identify main regulatory barriers		
Other administrative issues		
9. Operative conditions about Deployment		
Hardware and software status		
10.Notice about installation and Test-bed		
Pilot operational conditions		
Define an agenda for onsite deployment and field test activities		

This approach will ensure a high degree of consistency and overall coherence of the ESPRESSO approach to pilot definition.

With the involvement of the technical partners of the task (DIN, TRILOGIS, VCS), the standardization requirements will be further developed in D2.6, starting from the development of the UML Diagrams and the following relevant aspects will be identified:

- Protocols supported
- Technologies supported
- Software requirements
- Hardware requirements
- Datasets
- Regulatory requirements
- Privacy and security requirements.

9. Needs and drivers for smart city planning

9.1. General findings and state of art

The understanding of the need for Smart Cities planning and technologies, as well as the need for integration, interoperability and standardization requires assessing the defining trends at European level which can shape the cities of tomorrow. Several conclusions can be drawn from a contextual macro-analysis:

- **Europe and the world are faced with a migration phenomenon from rural to the urban regions and metropolitan areas**. The United Nations foresees that Europe, with currently 73 percent of population living in urban areas, will be expected to reach over 80% urbanization by 2050[4]. Under these circumstances, attaining a successful and sustainable urbanization requires competent, responsive and accountable governments at the helm of city and urban expansion management, as well as appropriate use of IC technologies for more efficient service delivery. Sustainability and safety are, within this context, key overarching scopes for long-term development.
- **However, population is aging, and Europe is currently leading the trend**, having the highest proportion of elderly. By 2050, almost 30 percent of the population is projected to be 65 or over, a figure that doubles than the 15 percent recorded in 2000[5]. The aging index (number of persons 65 or over per hundred children under 15) will grow past 250, with fundamental policy implications and a very high impact on social and economic issues. Apart from government spending on pensions, healthcare, long-term care, the rapid growth of the 65+ share of population will require the implementation of smart ICT solutions in order cope with the demand for quality of life improvement, personalized solutions, and cost reduction. Independent Living Services (ILS) and Ambient Assisted Living (AAL) programmes will be at the forefront of government agendas.
- **Cities are experiencing the effects of decentralization and devolution of power from the central level to the regional and local ones.** Affected by crisis, Europe is moving towards regionalization and a metropolitan- and city-centric approach. As the principle of local self-government becomes increasingly prominent, cities will have more power to determine their own success and the command of the full financial capacity using European, regional and local capital. This aspect is vital as a response to the increasingly competitive environment in which cities are faced with pressure to attract economic activities. Local self-government has deeper implications for smart city technology as it fosters the key requirements for "Smart Cities" as platforms: decentralization, openness, the ability for bottom-up innovation, transparency and human-centric design.
- **The global climate is warming,** and cities are at the forefront of this transformation, as they consume 75 percent of the world's energy and generate in turn 80 percent of its greenhouse gas emissions. Disaster preparedness, risk mitigation and resource management are the three pillars of any long-term city

[4] UN, World Urbanization Prospects (2014), http://esa.un.org/unpd/wup/Publications/Files/WUP2014-Highlights.pdf
[5] Population Division, DESA, United Nations, World Population Ageing 1950-2050

vision with respect to climate change. **Buildings** are key to establishing sustainable development patterns (since the sector consumes 40% of the annual energy consumption, 20% of the annual water usage, and generates up to 30% of all energy-related greenhouse gas (GHG) emissions), but sustainable transport and city management systems also factor in strongly as a necessity for future.

- **Rapid evolution of technologies underpinning Smart Cities,** at a scale and pace which is not easily predictable and which will require ample process of adaptation on behalf of the states and local administrations, historically inertia-driven;

The **17 new Sustainable Development Goals**[6] (SDGs) for 2030, agreed in August 2015, provide a policy response to these aspects. They are the key set of pillars on which future development should be built on, as they provide a set of universally applicable goals that balances the three dimensions of sustainable development: environmental, social, and economic.

Figure 3. The UN Sustainable Development Goals.

Beyond these macro-tendencies to which Smart Cities need to adapt to, each city or metropolitan region is faced with **its own drivers and challenges in one or several Sectorial Systems** (as defined in D2.1), pertaining to the local situation and stemming from differences in history (e.g. Evolution of the planning system), culture, location (coastal cities have different priorities than landlocked ones, for example), economy and trade, societal needs, demographics, political and administrative aspects.

There is no "one size fits all" formula to addressing these specific challenges and facilitating intelligent and sustainable development. However, for the scope of the ESPRESSO Project, a number of transversal priorities can be identified which are vital to the application of Smart City strategies:

[6] United Nations, Sustainable Development Goals - http://www.un.org/sustainabledevelopment/sustainable-development-goals/

1. **Mapping the course of adoption for the Internet of Things** as a data provider for smart technologies.
2. **Closing the gap and addressing the wide variability** of scale and pace in technology adoption by the administrations.
3. **Developing the methodology for smart city maturity.** Performance standards and KPI are needed for any city developing an SC strategy and roadmap, to evaluate the state of the art and monitor progress
4. **Addressing Smart City residents as a resource, not just a consumer:** developing civic technology as well as devolving prerogatives to the community.
5. **Improving analytics and the capacity of processing and displaying big data**.

An essential feature of Smart Cities is **the capacity of its systems and components to interoperate and articulate**, as the optimal functioning and use of resources across a complex urban environment depends on the interaction between different city services and systems. Communication between different component systems, captured by various infrastructure elements, should be shared between services and hence homogenous. While there are a high number of standards covering specific Sectorial System interoperability (i.e. CEN-CENELEC-ETSI SGCG/M490/G Smart Grid Set of Standards), there is a general lack of interoperability framework standards that work transversally.

9.2. Key Sectorial Systems

In order to ensure the creation of relevant and in scope scenarios for testing, Use Cases are subscribed to the Sectorial Systems of reference identified in the D2.1, which implies scenarios selected are part of either one or several of the following priority/key Smart City systems:

Table 2. Summary list of key sectorial systems. Source: D2.1.

ISO 37120	EU	ETSI	Networks European Technology Platform Expert Working Group on Smart Cities	PAS 181	DKE/DIN ROADMAP	International Electro technical Commission	Frost & Sullivan	Smart Cities Readiness Guide	ESPRESSO Grant Agreement
Economy	Smart Economy			Finance and economy					
Education	Smart People	Education/HR Development		Education and training		Education	(Smart Governance and) Smart Education		
Energy		Energy	Energy Efficiency	Energy	Energy	Energy	Smart Energy	Energy	(Energy efficient buildings), Energy management & Energy trading
			Smart Grids		Smart Grids	Smart Grids			Smart Grids
Environment	Smart Environment	Environment/Green Development	Environment	Environmental services					
Finance				(Finance and economy)					
Fire and emergency response				Policing and emergency response					
Governance	Smart Governance		Developing E-Government				(Smart Governance and) Smart Education		
Health	Smart Living	Health/Medicine	Health, Inclusion and Assisted Living	Health		Health	Smart Healthcare	Health (and Human Services)	
Recreation									
Safety					Safety and Security	Public Safety		Public Safety	SafeCity
Shelter				Housing	Buiding Construction and Urban processes	Building and Homes	Smart Building	Built Environment	Energy efficient buildings
Solid waste									
Telecommunication and innovation				Telecommunications			Smart Technology	Telecommunications	
Transportation	Smart Mobility	Transportation	Intelligent Transportation Systems		Mobility	Mobility	Smart Transport		
Urban Planning									
Wastewater				Waste				Waste (and Wastewater)	Waste management
Water and Sanitation						Water	Smart Infrastructure		

Out of the above, the highlighted systems are of particular importance for sustainable city development:

- **Smart Education**: addressing the societal demands and needs of the future through classroom latest technologies, fostering data literacy, innovative teaching systems, e-learning, institutional integration;
- **Smart Energy Management**, intelligent systems and integrated communication infrastructure;

- **Smart Environment:** environmental protection, sustainable resource management, liveability;
- **Smart Transport / Mobility;**
- **Smart Healthcare;**
- **Smart Governance, Participation and Planning;**
- **Smart Security / Safe City;**
- **Smart Buildings;**
- **Smart Infrastructure, wastewater, water and sanitation systems.**

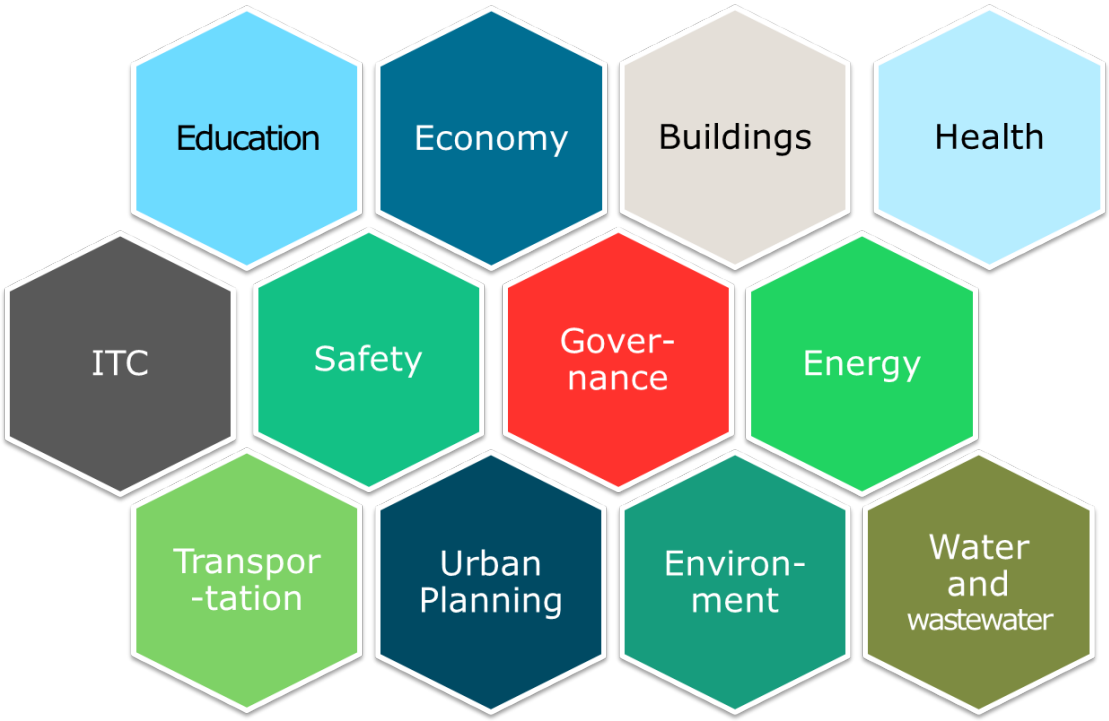
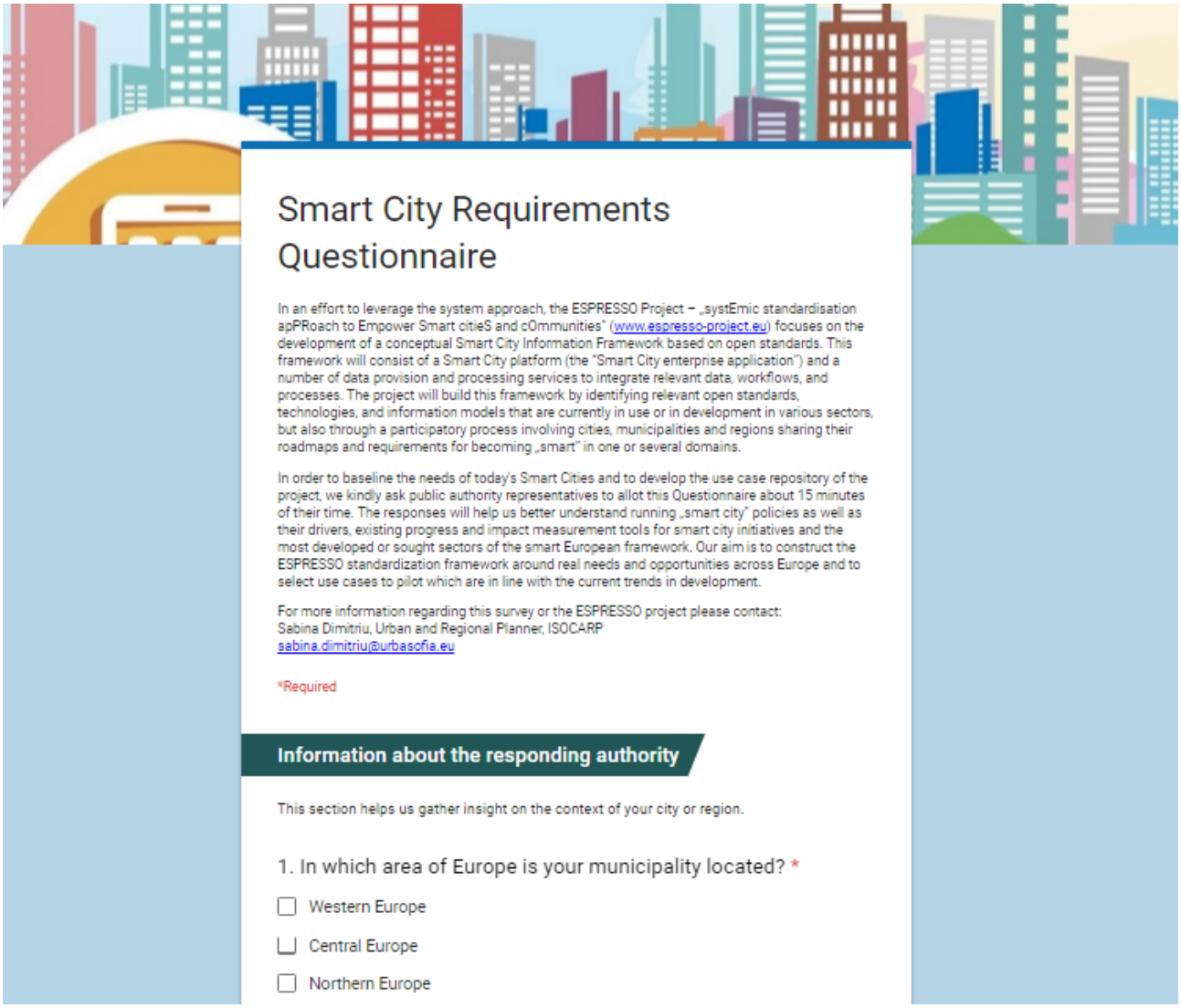


Figure 4. Sectorial Systems for Smart Cities.

Before developing the Use Cases, an understanding of the conditions and drivers for Smart City technologies and approaches was necessary for pilot cities, in order to baseline the needs to be addressed by the ESPRESSO standardization framework.

9.3. The Smart City Requirements Questionnaire

A questionnaire has been drafted at the beginning of M03 of the project, designed to collect initial feedback from both pilot and early adopter cities as well as external stakeholders.



Smart City Requirements Questionnaire

In an effort to leverage the system approach, the ESPRESSO Project – „systEmic standardisation apPRoach to Empower Smart citieS and cOmmunities" (www.espresso-project.eu) focuses on the development of a conceptual Smart City Information Framework based on open standards. This framework will consist of a Smart City platform (the "Smart City enterprise application") and a number of data provision and processing services to integrate relevant data, workflows, and processes. The project will build this framework by identifying relevant open standards, technologies, and information models that are currently in use or in development in various sectors, but also through a participatory process involving cities, municipalities and regions sharing their roadmaps and requirements for becoming „smart" in one or several domains.

In order to baseline the needs of today's Smart Cities and to develop the use case repository of the project, we kindly ask public authority representatives to allot this Questionnaire about 15 minutes of their time. The responses will help us better understand running „smart city" policies as well as their drivers, existing progress and impact measurement tools for smart city initiatives and the most developed or sought sectors of the smart European framework. Our aim is to construct the ESPRESSO standardization framework around real needs and opportunities across Europe and to select use cases to pilot which are in line with the current trends in development.

For more information regarding this survey or the ESPRESSO project please contact:
Sabina Dimitriu, Urban and Regional Planner, ISOCARP
sabina.dimitriu@urbasofia.eu

*Required

Information about the responding authority

This section helps us gather insight on the context of your city or region.

1. In which area of Europe is your municipality located? *

- [ ] Western Europe
- [ ] Central Europe
- [ ] Northern Europe

Figure 5. Smart City Requirements Questionnaire.

The questions were formulated in order to achieve a better understand of running „smart city" policies as well as their drivers, existing progress and impact measurement tools for smart city initiatives and the most developed or sought sectors of the smart European framework. The questionnaire collects information on the following:

- The responding authority, identifying the cities as pilots or external and their location (at macro region level) and size for trend identification purposes;
- Their main demographic, environmental, governance and planning, societal, economy, safety and ICT drivers;

- The existence and stage of implementation of their smart city strategies, and best practices;
- Barriers and opportunities in developing a successful smart city model;
- Performance measurement requirements.

The full list of questions is available in the ANNEX 1.

Findings show that respondent cities are currently faced with several development drivers and challenges which prompt them to address the Smart City question (below the aspects all respondents have selected as relevant):

1. **Demographic drivers:** Aging population and outward migration, the latter being an aspect of relevance especially in the southern and eastern Europe (Herceg Novi Municipality, Baia Mare Municipality);
2. **Environmental drivers**: Environmental protection, energy consumption, green/renewable energy, standardization/harmonization and integration of environmental data;
3. **Governance and planning drivers**: Participation in decision-making, strategy development and prioritization of investments, urban planning. It is to be noted that open urban data banks, project result evaluation and public procurement have scored lower;
4. **Societal drivers:** formal and informal education both, social inclusion;
5. **Economy drivers:** Tourism has scored 100%, with industry, RDI, SME, start-ups and competitiveness scoring lower (66%);
6. **Mobility drivers:** Infrastructure investments, alternative transportation, standardization/harmonization and integration of mobility data;
7. **Safety / security drivers:** Urban design (considerations for built design) and standardization have been identified as main drivers, with disaster management and smart solutions as secondary.
8. **ICT and Big Data drivers:** ICT development (digital infrastructures and services) and standardization/harmonization and integration are primary drivers for the respondents, with Open Data, Crowdsourcing and Data protocols / data collection as secondary.

Out of the current responses, the most important considered Smart Specialization Sectors at local level, subject to standardization, are **Energy efficient buildings, energy market & energy trading, Developing e-Government**, followed by **Intelligent Transport Systems (ITS), Quality of life projects and Waste management.**

As far as barrier identification goes for developing a successful smart city model, respondents have pointed out that **developing a successful business model, poor administrative capacity, lack of leadership /„champions" and demographic decline** are at the forefront. Interestingly, the low degree of acceptance of new technologies (non-technological barriers for adoption) has not been identified as a barrier.

The topic of main financial challenges identifies:

- **The cost of infrastructure investments**;
- **The absorption capacity of EU funding** (especially relevant in South and Eastern Europe and IPA countries) of both national and local institutions;
- **Resources needed to sustain the interventions at city leve**l;
- **Difficulty to obtain access to new financial institutions**;
- **The shift from macro to micro economy**.

The biggest technological challenges, as identified:

- Adaptation of technology by people;
- Raising public awareness and education on ICT concepts (data and technology literacy) in the public sector;
- The fact that micro-economic interventions need an inter sectorial neighbourhood approach, which is hart do develop;
- Technological concepts are not best understood yet.

None of the respondents has as of yet an **Agency and/or a Department dealing with Smart City developments** at local level, nor an Urban/Smart Management Platform offering city services, however it is identified that the Open Data System of the local government is an important use case.

The cities have also been asked to identify, on a scale from 1 to 5, the areas in which they would need to measure their performance the most. Responses pointed out the sectors of **Smart citizens and participation** (5) **Governance** (4.66), **Mobility** (4.33) and **Energy** (4.33) as the most important ones. Healthcare (3) scored least.

None of the responding cities measures their Smart City performance at city level, but rather in certain key areas, at project level or neighbourhood level. This measurement is either achieved without a consecrated set of indicators, or by using indicators developed by a third party. Project oriented methodology is still the primary modus operandi, without horizontal and vertical standardization and with the project managers in charge of evaluating the results in a case-by-case manner. However, in the case of Tartu Municipality (described in Chapter 4.2), the city uses a set of indicators based on the Vienna University of Technology Prof. Giffinger Methodology.

The questionnaire will be kept open for input collection from the SmaCStak and other Early Adopters. While it is still early to draw conclusions based on limited input, responses as of yet can point towards the fact that use cases of interest should prioritize **Governance and participation, Mobility and Transport, Energy, Water and Waste management (city infrastructures).**

9.4. Workshops, interviews and engagement tools

Workshops provide an excellent outlet for discussion and represent one of the most important tools for collaborative use case definition, as they gather together for open dialogue city authorities**, regions, policy makers, industry and SDOs**. Specifically, for the task 2.2, two types of events have been planned, based on the location and attendants (pilot / non-pilot):

- Pilot workshops, aimed directly at defining the requirements, storyboards and pilot preparation activities (the workshop in Rotterdam, 24 May 2016);
- General ESPRESSO workshops, focusing on the dissemination of the project and on the opening of smart city standardization dialogue with external stakeholders (the workshop in Bucharest, 19 April 2016).

Skype / WebEx interviews have been planned and organized as well in order to engage pilot cities remotely. As the process of requirement definition needs several iterations for refinement, but also perspectives for Early Adopters, Interviews with partners will continue to be organized to identify and narrow the scope, especially in regards to Early Adopters.

9.4.1. Results of the Bucharest Workshop.

The first ESPRESSO-Workshop took place at the 19th of April in Bucharest. The aim of this workshop was to start an open dialogue with city authorities, policy makers, industry and NGOs on what challenges they face with respect of making cities more liveable, sustainable, and efficient with the focus for future development of Smart Cities and potential roadmaps for integration. Interesting questions regarding the integration of Smart City solutions and the improvement of solutions offered to citizens were discussed as well as the question how can we make sure we speak the same language across Europe, with specific focus on:

- Definition of a Smart City in terms of standards and connected key sectors. Key traits – what is a Smart City and what is the opposite?
- Successful stories in the efficient management of Smart Cities
- Main challenges of a Smart City
- Opportunities and barriers for sustainable communities

Figure 6. The Bucharest Workshop (1).

9.4.2. Key findings

Smart City Concept (SC) is based on the idea of using technology as an enabler for cities development. What is sometimes missing from the explanation of a SC is the piece related to ***Smart citizens*** and ***Smart management***. Therefore, SC should be seen as an *umbrella concept,* defined by using resources in an efficient and intelligent manner in order to achieve competitiveness.

Discussions have been focused on the following points:

- The definition of an all-round Smart City should factor in a **threshold of performance in sectorial systems**. Oftentimes when discussing best practices, examples of relevance include a smart, but **punctual solution**, which in the broader picture cannot transform city processes on a larger scale. How much and in which domains should cities have an innovative approach in order to qualify as a smart city? The discussion centred on ***impact on resources (financial, environmental, human, etc.)*, rather than product or process** – if investments generate a significant impact or outcome at local level in terms of integrating and making city systems more efficient in generating sustainable outputs and easy to manage, then the city could be considered smart.

- An **integrated urban planning approach to SC** – what are the most relevant sectors? Which are the most important standards that reveal the smartness of a

city? In Romania and post-communist Eastern Europe in general, an important issue is the **land ownership and incomplete cadastre (land register).** Efficiently managing a city leverages essentially on integrating city systems, but without up-to-date spatial information pertaining to these systems, punctual investments will not yield results. A top priority is **mapping out the city (including underground cadastre) and moving towards paperless planning**.

- **Mobility aspects** are the second key issue considered highly relevant for Bucharest and Romania in general. The car is still representative for social status and the city is the second congested one in Europe.

- Definition of Smart Cities through exclusion (i.e. `Dumb City`) could support a better understanding of the necessity for concerted actions at city level and could assist in breaching non-technological barriers.

- **What is the role of public authorities in a SC?** How can public bodies accelerate a city to become smart? Local administrations should be drivers for change, as within them lies the biggest barrier for SC deployment and upscaling **– historical silo thinking**. In order to change this and integrate city systems, a **restructuring of the local administration** is needed, which can be met with much resistance. Beside containerization, for local administrations the second issue is also the lack of know-how and existence of non-technological barriers – civil servants need good **training and development programmes** in order to be able to operate the solutions. Investments in hard infrastructure are tertiary next to (lower impact, more affordable) investments in human resources development and in development of a **joint city database for city management**.

- Regions lagging behind in what concerns the penetration of smart technologies and tools for city management and development can leapfrog ahead with assistance from ESPRESSO. Open data and open source technology are key instruments for doing that – cities should make it a priority to **migrate from using proprietary software**.

- **Involving the community:** local administrations do not have the resources to constantly monitor „traditional" city infrastructure (without remote access intelligent solutions), hence involving individuals in the process of monitoring and reporting considerably reduces time and resources (validation is still necessary). This kind of approach could lay the foundation for real-time planning.

- Smart people and culture should be a top priority for SCs, and their **development should be *community-centric* as opposed to technology-centric.**

- Standards and the standardization process lay common grounds – this is essential for urban and regional planning, as a common language can not only enhance the transfer of best practice but also link cities together, facilitate trans-border cooperation and integrated development, promote investments in urban development.

- **The issue of trust is a vulnerability of the SC concept** and mostly elderly are reticent towards e-services (e-payment, e-government services, using online applications), albeit this mistrust witnesses a reduction as new generations teach the older ones.

Figure 7. The Bucharest Workshop (2).

9.4.3. Overall goals achieved during the workshop

The workshop gathered stakeholders involved in town and regional planning, to:

- Develop a common understanding for all professionals in the field of urban planning and SC standardization
- Define a conceptual framework for SC standards in different sectors related to SC (infrastructure, mobility, economy, social environment).

After the first interim results of the project, a follow-up workshop in Bucharest will be organized, supported by the Romanian Planning Association and aimed this time at engaging the local administrations in an ampler discussion.

10. Pilot specific needs and use cases

10.1. Rotterdam, The Netherlands

10.1.1. Partner profile

Rotterdam City is the second largest city in The Netherlands, totalling over 620,000 inhabitants and being located in the delta of the Rhine and Meuse rivers. Dubbed „**Gateway to Europe**", the settlement hosts the largest cargo port in Europe and the 10th largest in the world.

With a GDP (Greater Rotterdam Region) of EUR 53,457 million, a very low unemployment rate and a population primarily consisting of active citizens (70% of total between 15-64 years), as well as having a high percentage of highly skilled population (37%), Rotterdam is one of the more competitive urban centres in Europe[7].

During World War II, the city was heavily bombarded, which prompted efforts for reconstruction spanning the period between 1945 – 1968 and beyond, as after 1970, a reconsideration of the new „reconstruction era" city centre by Amsterdam architects such as Piet Blom generated the contemporary configuration of today.

This uncommon trait and high-rise, intensive development within the centre which is today a pinnacle of new business, coupled with are unique in the Netherlands. Coupled with Rotterdam's strategic position and subsequent transport and trade network lay the foundation for an early start for becoming a Smart City.

Figure 8. Rotterdam City. Source: ifmsa.org.

However, the city is also faced with specific challenges in connection with its location. Rotterdam is surrounded by water on all sides, with almost 90% of the city being below the sea levels (up to 6 m below). The low-level altitude of the city and rapid growth of the Rotterdam Harbour generated a strong environmental footprint, addressed with a systemic approach, but also a strong concern for water-related consequences of climate change.

Rotterdam has a **large geospatial department**, which serves both the internal and external customer. Because of the rapidly changing environment within the city the need for information is high and the quality demands are equal. Therefore, the department of geo-information always needs to invest and be on the forefront of adopting new techniques. **One of the priority topics for Rotterdam is the 3D city model**. A large program called Rotterdam 3D V2.0 is set up to implement an

[7] City of Rotterdam, Facts and Figures Rotterdam 2013, http://www.rotterdam.nl/

organization wide 3D infrastructure based on open standards to serve as a central base for all departments to effectively do and share their work.

In 2010, Rotterdam joined the **Global City Indicators Facility (GCIF).** The GCIF set of indicators was further developed into the first ISO standard for city indicators (**ISO 37120**), which was launched in 2014 along with the World Council on City Data (WCCD). Rotterdam became certified the same year as Platinum (ID 2014-P-0017)[8].

Rotterdam is planning to use ISO 37120 (in combination with local data and GIS which they call the smart city planner) to be able to measure their smart city performance as a whole. This is something Rotterdam is devepoling at the moment.

Innovation Map: Rotterdam City displays an overview of all innovative projects in the public area through an ArcGIS interactive map of the municipality. The department of geo-information has produced a publicly-available map of all innovative projects related to the management and development of the Rotterdam outdoor space, being implemented either by the municipality alone or in collaboration with partners. The map is currently in development in order to visualize other Smart City projects across the city as well.

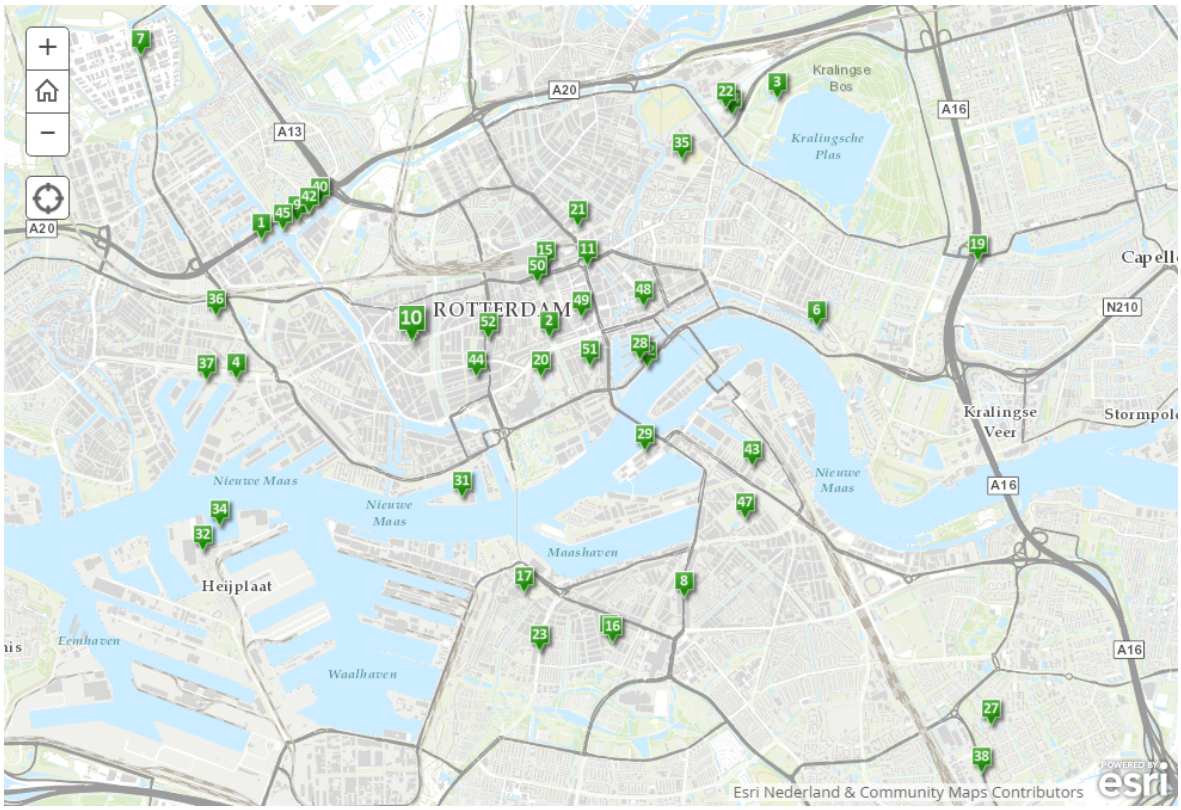


Figure 9 – Rotterdam uses an ArcGIS platform to showcase innovation projects being tested within the municipality. Source: Rotterdam.maps.arcgis.com.

Apart from the innovation map there are other tools like the energy atlas, investment map and many more. These are all available online and can be used by everyone who is interested in a certain topic. The tooling in this situation is not being 'smart' but it is

[8] Global Cities Registry™ for ISO 37120 - http://www.dataforcities.org/global-cities-registry/

the usage that makes it 'smart'. We use the tools in our collaborations with other (external) stakeholders for example in order to create common business cases or co-creation.

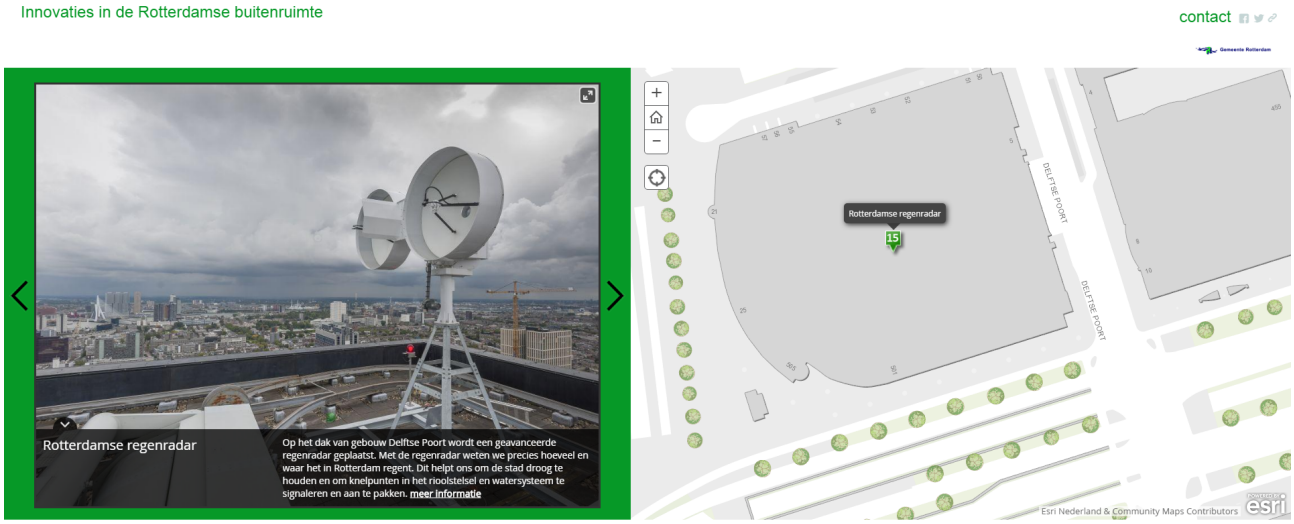


Figure 10. Rotterdam Innovation Map and example of outdoor SC Project – Rain Radar. Source: Rotterdam.maps.arcgis.com.

10.1.2. Pilot workshop in Rotterdam

The Pilot Workshop in Rotterdam has taken place May 24 2016, in the Gemeente Rotterdam, Wilhelminakade 179. The meeting witnessed 14 participants, mainly from the Rotterdam municipality (account managers, head of department of Geo-information, GIS experts, project manager for Smart Cities, initiator of „The Digital City"), but also key stakeholders such as Future Insight. The main aim of the workshop was to establish a first discussion on the priorities of Rotterdam for being an ESPRESSO Pilot, starting with the key questions:

1. What represents the concept of Smart Cities for Rotterdam?
2. What are the principles of SC for the city, and which are the current achievement?
3. What future plans and strategies need to be taken into account?
4. What are the opportunities, barriers and future development plans in the key sectors of importance for the city?
5. What case studies of interest can be considered for the ESPRESSO project?

Figure 11. Pilot workshop in Rotterdam (1).

The workshop started with a presentation of the Smart City state of the art of Rotterdam. The city has about 150 smart projects ongoing and aims to be „the smartest city in the world", under 4 thematic pillars: Smart Port, Smart Industry, Smart City, and Smart Government. Some key pre-existing initiatives are:

- **controlling the management of water flows in the city; inter grown management system**
- **automatic parking control**
- **underground system: dialogue with the development building and objects to be aware of which are the needs**
- **garbage collection: measured with sensors (route optimisation)**
- **light pools in the city (like SUNSHINE): control of the light pools with only one backend system**
- **use of intranet and social networks to inform people of the city initiatives.**

The 3D City Model is a flagship initiative, a 10-year program needed to have an equivalent of reality in order to assess city processes, flows and determine interoperability.

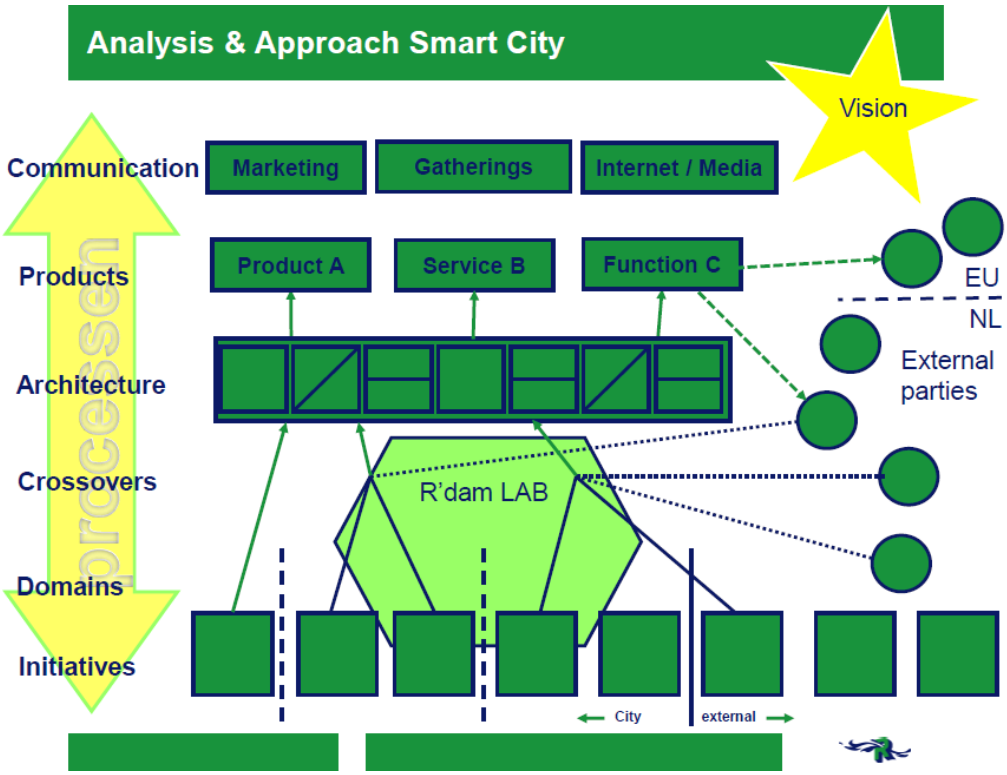


Figure 12. Rotterdam's approach to Smart City development. Source: Frank Vieveen, see Annex 2.

Sectorial Systems and priorities

Key sectorial systems have been identified as:

- Safe City concept (Rotterdam has a mixed population and aims at enhancing the intra-urban safety);
- Water and waste management,
- Mobility, in an effort to plan together with the neighbouring municipalities;
- Education and youth
- Energy transition
- Healthy environment and the liveable city;
- Communication and participation
- Housing.

Another priority is the **facilitating and supporting of cooperation and trade economy.** All systems have been identified as interconnected, meaning each system will leave a mark on the others.

Additionally, **energy, ICT and mobility are encompassed in a Lighthouse Project** (SCC, results of evaluation will be received in October 2016) which Rotterdam have under evaluation and would like to transform that into use cases. The focus of piloting in this regard would be the redevelopment area Stadium (integration of systems for public transport, public lighting, data from sensors, etc.)

Rotterdam is in the process of setting up a **Data Marketplace** to capitalize on the „economy of scale" of putting out data which is open from public and private sources. The (end) goal is to organize an independent open data exchange platform where all kinds of data can be exchanged under negotiated conditions. It concerns big, open, linked and other kinds of data. At this moment people within the organization are working on an open data platform for the own data of the Municipality. A key concern for Rotterdam is how to make data coming from quite a lot of sources **useable and useful** (defining primary but also secondary uses or positive externalities and transforming the interface to big data). Key question: How can open data usage be, in the end, monetized? Delivering open data requires a cost, so can the advantages be somehow quantified?

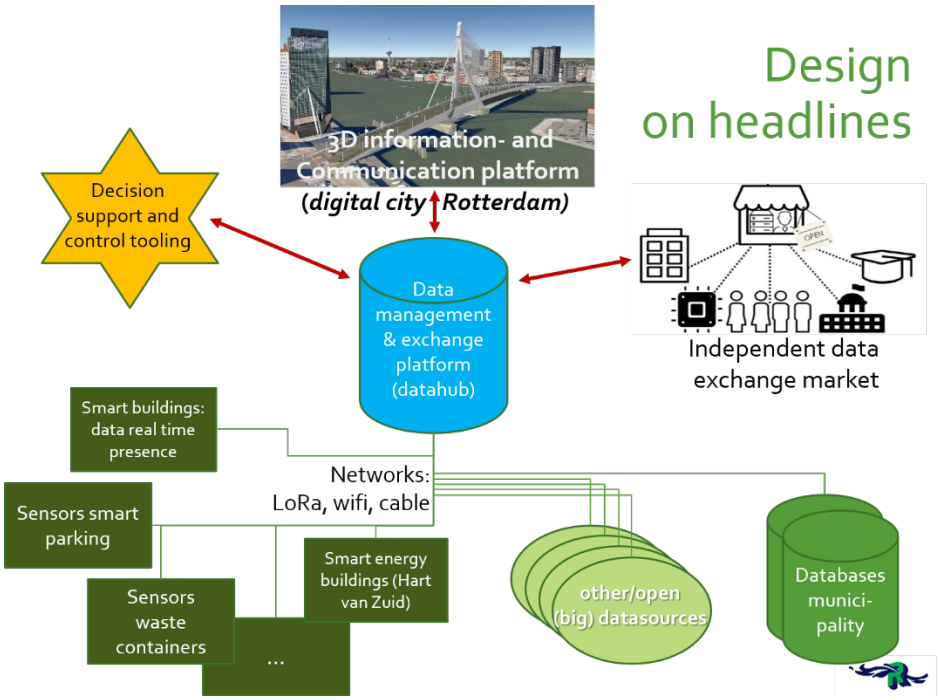


Figure 13. The data management and exchange platform Rotterdam.

Rotterdam is still in the process of figuring out how to quantify, or „show" the benefits of open data (monitor economic and societal results and outcomes). Data should be presented user friendly, since not all users have the required technical background to use it. Additionally, in order to build user trust, it was discussed that a potential approach would be to have an organization outside the municipality to communicate with citizens (like a catalyst), offering a „non-aligned" position and being able to leverage and understand interests.

Moreover, open data is still not high-quality, and this aspect was discussed as one of the reasons why businesses still do not use open data.

Figure 14. Pilot workshop in Rotterdam (2).

Asset management is the key: Rotterdam draws microdata at building level all across the city in various sectors (including education, demographics, etc.) and they want the municipal work to start becoming information-driven work in a „smarter" way.

Ideas for use cases and scenarios which they are considering / developing now: self-learning maintenance department alerts, water management via rain sensors (which they have installed) and reusing wastewater to warm up roads in winter (scenario to be expanded to warm up also buildings), waste bin „fullness level" sensors for optimization of waste management vehicle routes, and other initiatives.

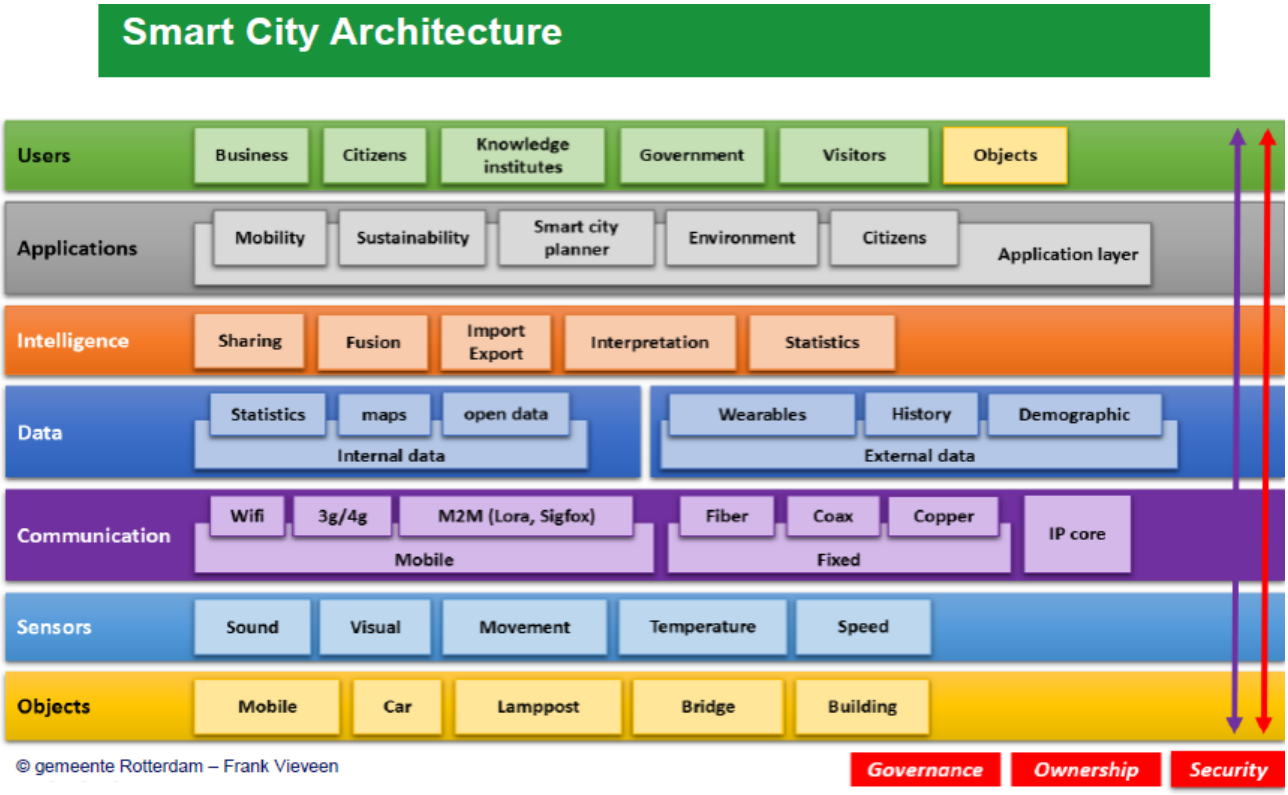


Figure 15. Smart City architecture of reference for Rotterdam.

10.1.3. ROTTERDAM Main use cases

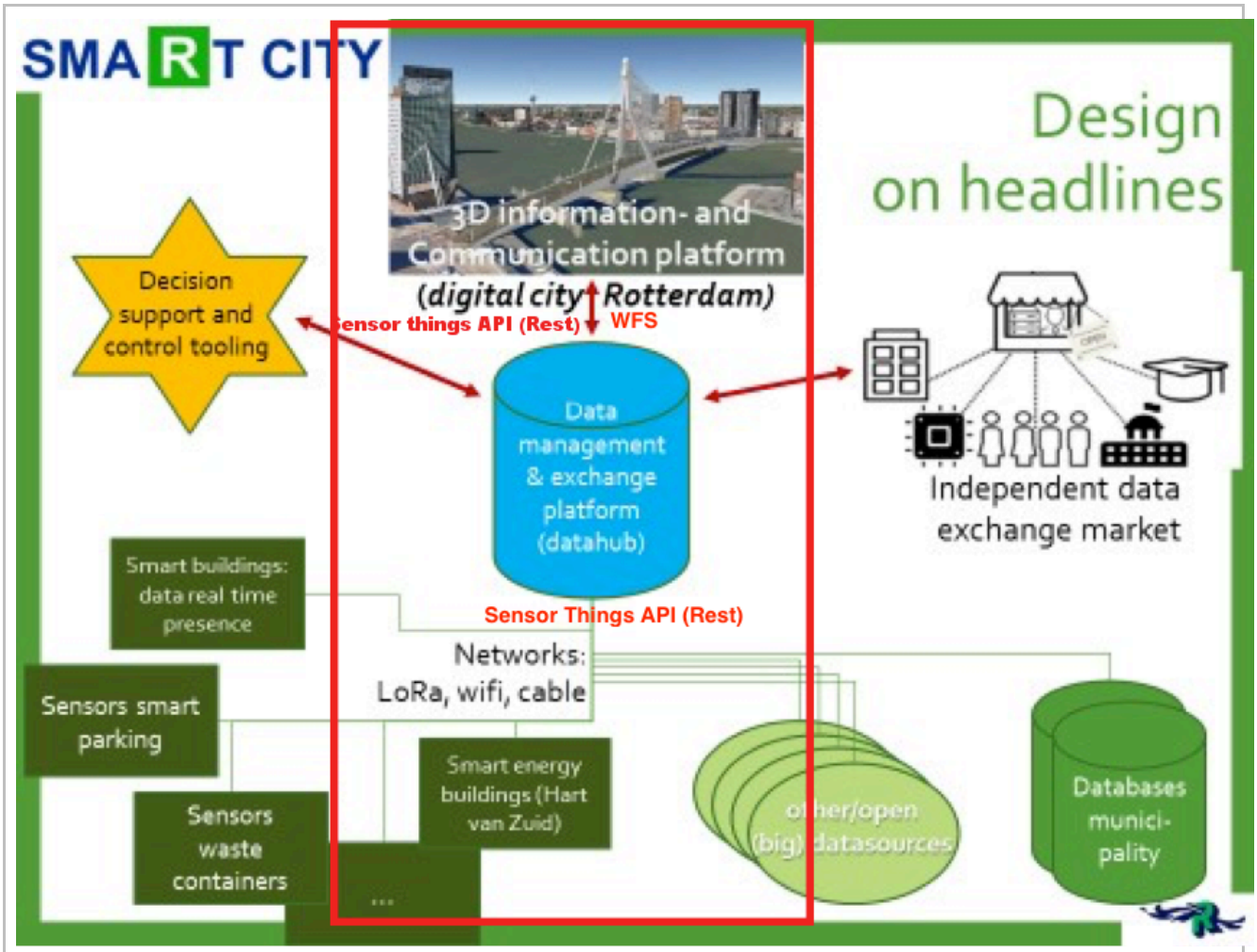
USE CASE 0 – 3D Digital City
1. Use case Name
ROTTERDAM_UC00_3D
a. Domain/sector of activity
Overall infrastructure serving as a base for all smart sectorial systems. For example: • Safety and Security: Safe City concept (Rotterdam has a mixed population and aims at enhancing the intra-urban safety); • Cleantech: Water and waste management • Mobility: in an effort to plan together with the neighbouring municipalities; • Education and youth • Energy transition • Health Care: Healthy environment and the liveable city; • Smart Government: Communication and participation • Built Environment: Housing.
b. Subdomain (s)
Use Case is transversal
c. Objectives/benefits of the use case
The objective is to make all kind of information which is there for the city available in an easy, open and transparent way for both the internal municipal organization and external stakeholders. By setting up an open infrastructure to make available all kind of smart information like for example sensor data, 3D models, and geospatial data in a standardized way, the data can be used for multiple purposes and applications. Expected benefits are that because of all these new applications, the current single use effect of the data are multiplied. This can be in all kind of areas.
2. Description
The overall current smart development is the 3D Digital City project which is an information- and communication platform for everybody with an interest in Rotterdam. In the end, it enables all kinds of virtual interactions between organizations and people throughout the 3D city. First topics we want to populate the platform with are **dynamic parking- and groundwater level info from sensors combined with the new open 3D city model**. Subsequently we are thinking about virtual shopping, gaming, art, social events, digital neighbourhood communities etc. Based on the 3D model of the city all kinds of information can

be allocated and found by others.

a. User Story Description

The main idea: The real and virtual worlds are getting more and more intertwined. From that perspective, a city should think about their role in this new reality. One role can be found in the maintenance of the (real AND virtual) city, which can be seen as a public affair. A free and open access to the city (real or digital) should be guaranteed to all, which also can be seen as a public affair.

b. Storyboard and UML diagram



3. Scope and Objectives

Scope of Use Case	Currently the infrastructure does not exist yet. The scope of the first use cases is to setup and technically test the central datahub and connect it to the online 3D city model using open standards. In a later stage other parts of the infrastructure, like the data exchange market and decision support tools will be connected/developed.
Objectives	The main objective of this first phase of the project is to build up knowledge about the entire workflow from connecting to the sensor data to making it available to the public through the online 3D city. The lessons will be both on technical and organizational level

4. Actor List and Requirement

Actors identified	• City administration as data supplier • City administration as principal for the data supplier

	• Data suppliers • Companies using the data for their products • Citizens using the data from the digital city • Users from the city administration using the data from the digital city or applications build on top of it for their work.
Requirements (from actor's perspective)	• Easy, standardized, reliable, known actuality
5. Available Data at the Pilot Site and Open Portals	
Which are the available data at the pilot site for this use case?	Technical description: • 3D city model available • For sensor information, WFS and the SensorThing API will be used. Sensor readings will be sent over Lora to the data lake. Readings are taken out of the lake using Sensor Things API and linked to the CityGML model using the Dynamizer concept. The readings may be visualized in the 3D city model based on the open specification 3DTiles or the open standard 3D Portrayal Service (3DPS). Standards applied: CityGML, 3D tiles, REST, WFS
Which are the available and useful data coming from Open Portals?	• Data coming from the 3D CityModel will be used. The 3D city infrastructure will be based on the open source 3D city DB database and the Cesium platform. Standards applied: CityGML

USE CASE 1 – Parking

1. Use case Name

ROTTERDAM_UC02_Parking

a. Domain/sector of activity

Smart Mobility
Smart Governance

b. Subdomain (s)

Parking management

c. Objectives/benefits of the use case

The objective is to better inform inhabitants of the area where the sensors are being placed about the availability of parking spaces as to bring down the amount of "searching traffic" in the area.

Other results are reliable numbers on the movement of cars. This can be used in other areas of the city where there is a restriction on parking times.

In the future the city is aiming to give reliable numbers on the availability of parking spaces in all areas of the city so that traffic coming to the city can already be directed on the orbital motorway.

All data being available online, this can also directly be used in navigation systems.

2. Description

The city of Rotterdam is working on a smart automatic parking control system.

First tests have been done with two different systems on a small scale (25 to 50 parking spots). The results of these first test are being evaluated and used to design a new technical description of how the test area can be improved. (i.e. standard data format, only send messages when the situation changes).

a. User Story Description

Throughout the city of Rotterdam, the available parking spaces in parking garages is very well known and indicated on electronic billboards throughout the city and on the highway around the city to direct traffic to garages with available parking spaces. The available parking spaces on the streets are not considered in these numbers. For several reasons the city of Rotterdam is very much interested in these numbers (i.e. less search traffic, better information for citizens and tourists, information on the occupancy rate of the spaces).

b. Storyboard

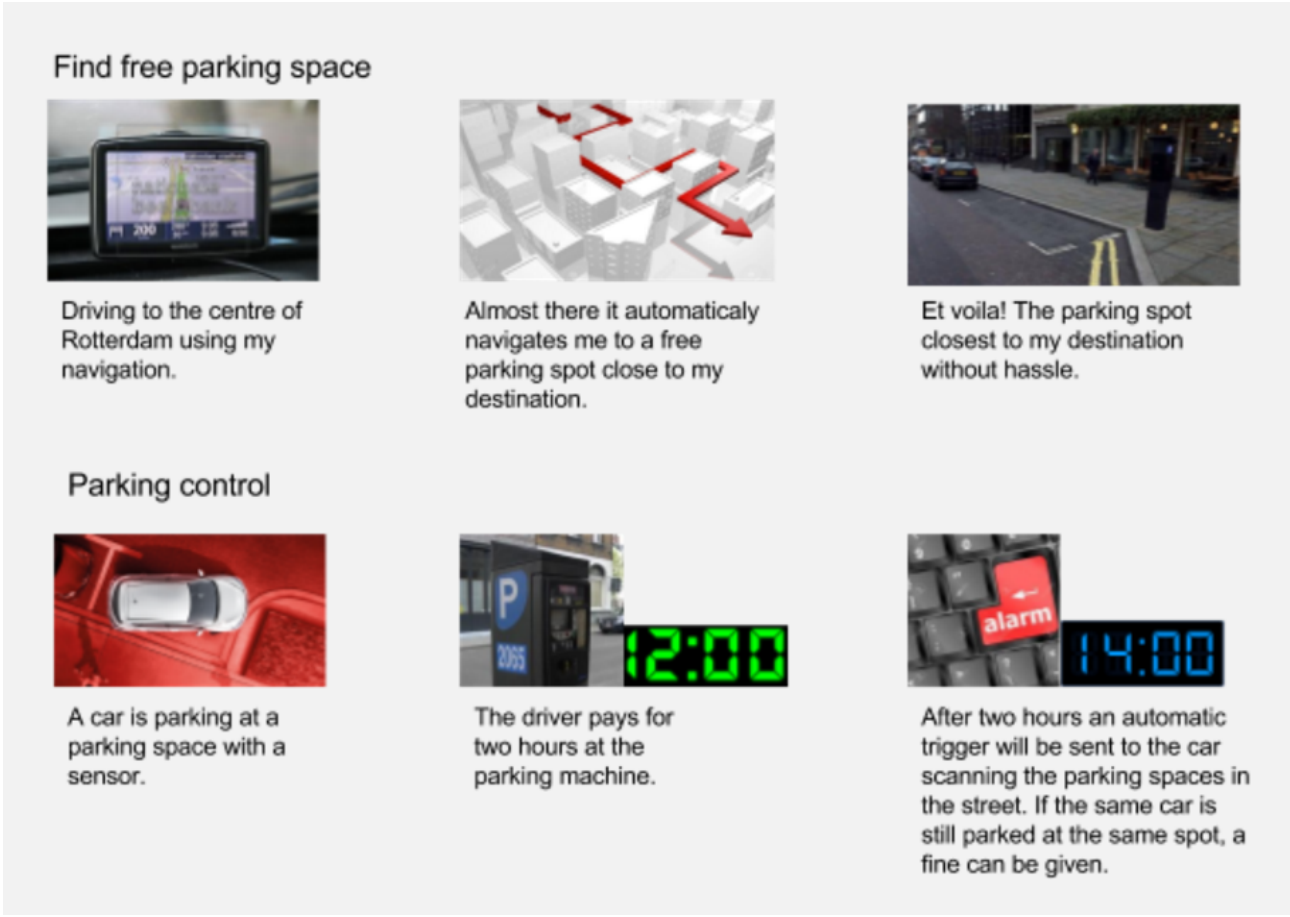


Figure 16. Rotterdam Use Case Storyboard - UC01 Parking.

c. UML Diagram

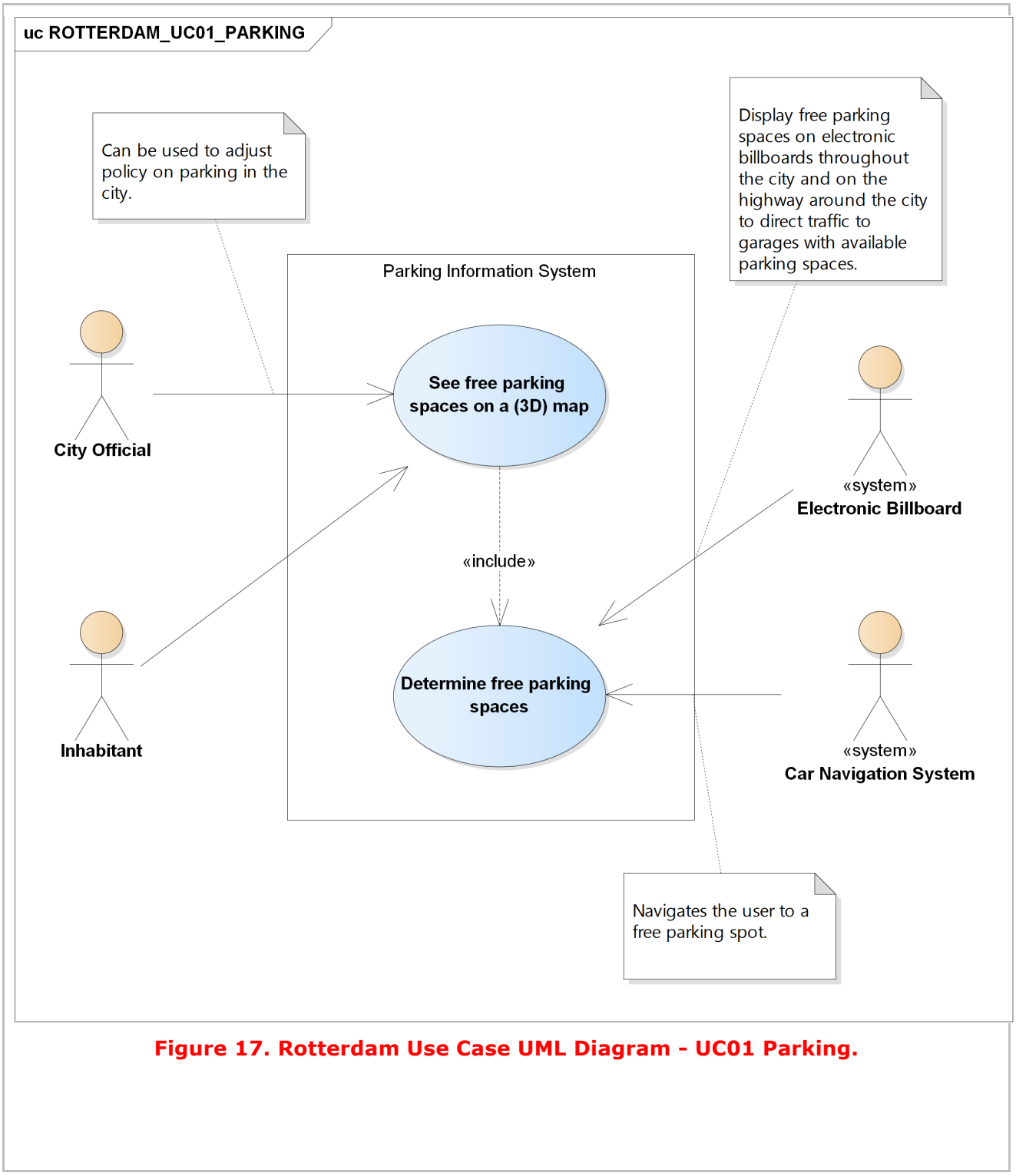
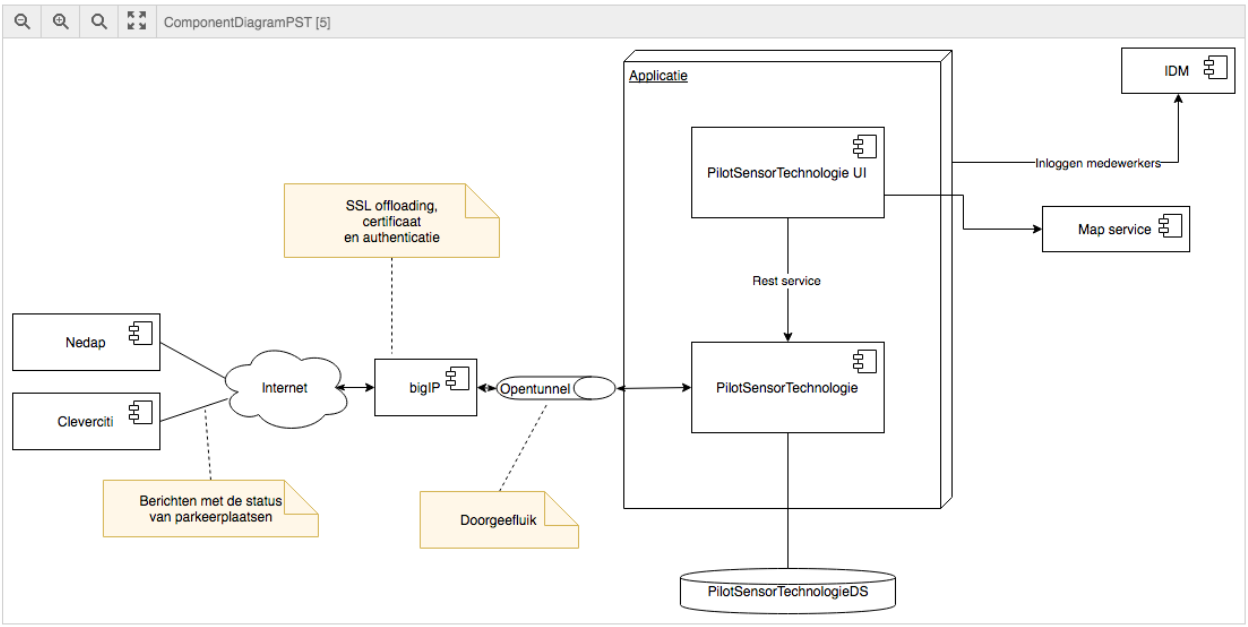


Figure 17. Rotterdam Use Case UML Diagram - UC01 Parking.

Gewenste situatie



Huidige situatie

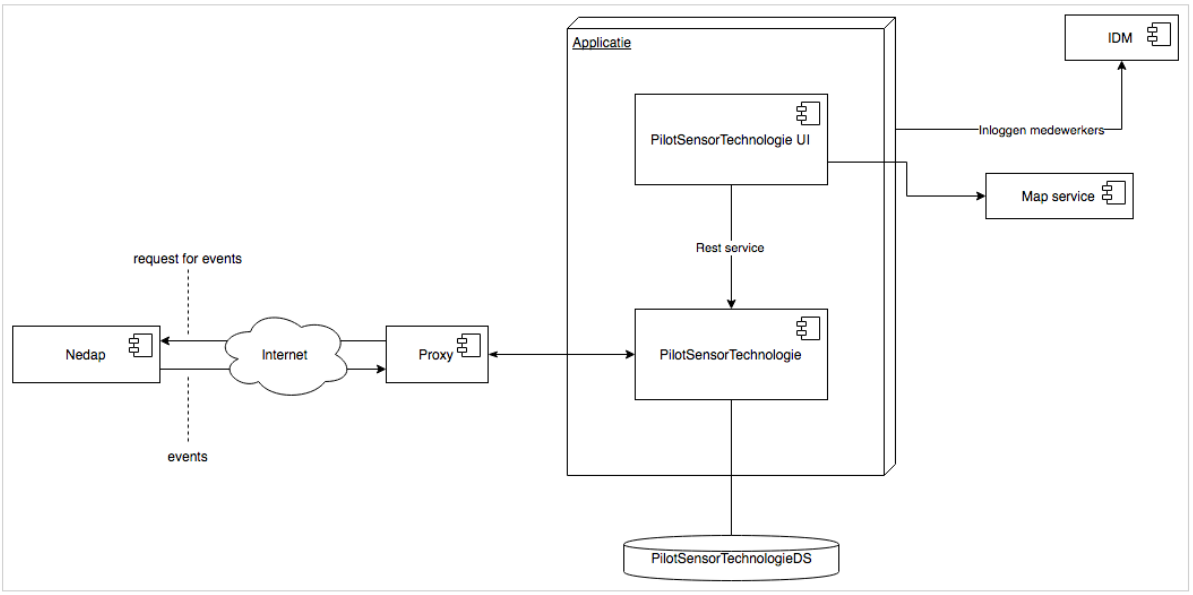


Figure 18. Architecture of the parking sensors in Rotterdam (Desired situation – top image, versus current situation – bottom image).

3. Scope and Objectives

Scope of Use Case	The test with the parking sensors on the street will be for a small area at the Kruiskade for a total of 59 parking spots. The information gathered is not only applicable for the inhabitants, but also as input for the municipality to

	adjust their policy on parking in the city (i.e. Smart Governance) 
Objectives	• Better informing of inhabitants about parking space availability in order to reduce "searching traffic" in the area • Input for the municipality for parking policy improvement in the city
4. Actor List and Requirement	
Actors identified	• City administration as party gathering and maintaining the data and using the data for better parking control and management. • Users of the parking spaces (in a passive manner and anonymous) • Possible developers of app's (i.e. navigation app's) • Inhabitants and entrepreneurs
Requirements (from actor's perspective)	• Data: Reliable (availability and accuracy), Standardized, Real time available • description of the parking area and localisation (e.g. localisation provider) • deployment of the detection system (system supplier), • occupancy data provision (parking operator), • data integration in a centre for the purposes of traffic control and traffic information services provision and open data provision for apps developers (a city centre operator, e.g. traffic information centre).
5. Available Data at the Pilot Site and Open Portals	

Which are the available data at the pilot site for this use case?	Technical description: • For this project, a pilot area of approximately 95 parking spaces is available with underground parking sensors Standards applied: The protocol being used to send the data is standard http, using JSON. The format of the data is still proprietary to the producer of the system. This issue will be addressed by Rotterdam in the next phase of the pilot. The common rules in the field of data provision and publication are based on European standard DATEX II, which applies for all smart on street parking detection technologies, payment terminal and other methods of payment and traffic information and control centres data work.
Which are the available and useful data coming from Open Portals?	• Available data coming from the sensors already in place will be used, in order to be able to present the desired results at the end of the piloting phase. Standards applied: CityGML. The data collected will be mapped in the 3D city model (see Use Case 00), which will be connected to the Open Data topographic map of the Netherlands. The textures of the model will be retrieved from aerial photos, collected yearly by the city.

USE CASE 3 – Groundwater levels measurement

1. Use case Name

ROTTERDAM_UC02_Groundwater

a. Domain/sector of activity

Cleantech

b. Subdomain (s)

Water management

c. Objectives/benefits of the use case

Currently there are approximately 2000 wells in the city of Rotterdam which are being measured manually once a month.

By making them sensor-based, a lot of time and effort can be saved of course, but moreover much more information will be available about the wells.

The effects of heavy rain or a long dry period are now only measured once each month. Using sensors could provide the city (and hence citizens, developers and so on) with numerous additional data.

2. Description

A majority of the old houses in Rotterdam are built on wooden poles and these need to be kept wet, to avoid that they rot. Groundwater levels are measured at regular intervals using both sensors (currently 3) and human readings (approximately 2000 wells in the city manually measured). More sensors are planned so that more accurate, frequent, flexible measurements, less manual labour.

These sensor readings (height of the groundwater level in relation to the national heigth datum of the average sealevel, NAP) are sent and stored in the Data Lake for retrieval and analysis.

Sensor readings are read from the Data Lake using Sensor Things API (or SOS) and linked to the existing CityGML based 3D model of the city. The readings may be visualized in the 3D city model based on the open specification 3DTiles or the open standard 3D Portrayal Service (3DPS).

a. User Story Description

As an engineer working within the Administration of Rotterdam, I am part of a team tasked with manually recording the groundwater level in 2,000 different wells in Rotterdam, each month. With the introduction of remote sensor-based measurement, not only can I dedicate the time I would normally spend on this tedious task to make more advanced calculations and projections, but I can have

access to more accurate data, collected more often and without such a very high physical effort.

b. Storyboard

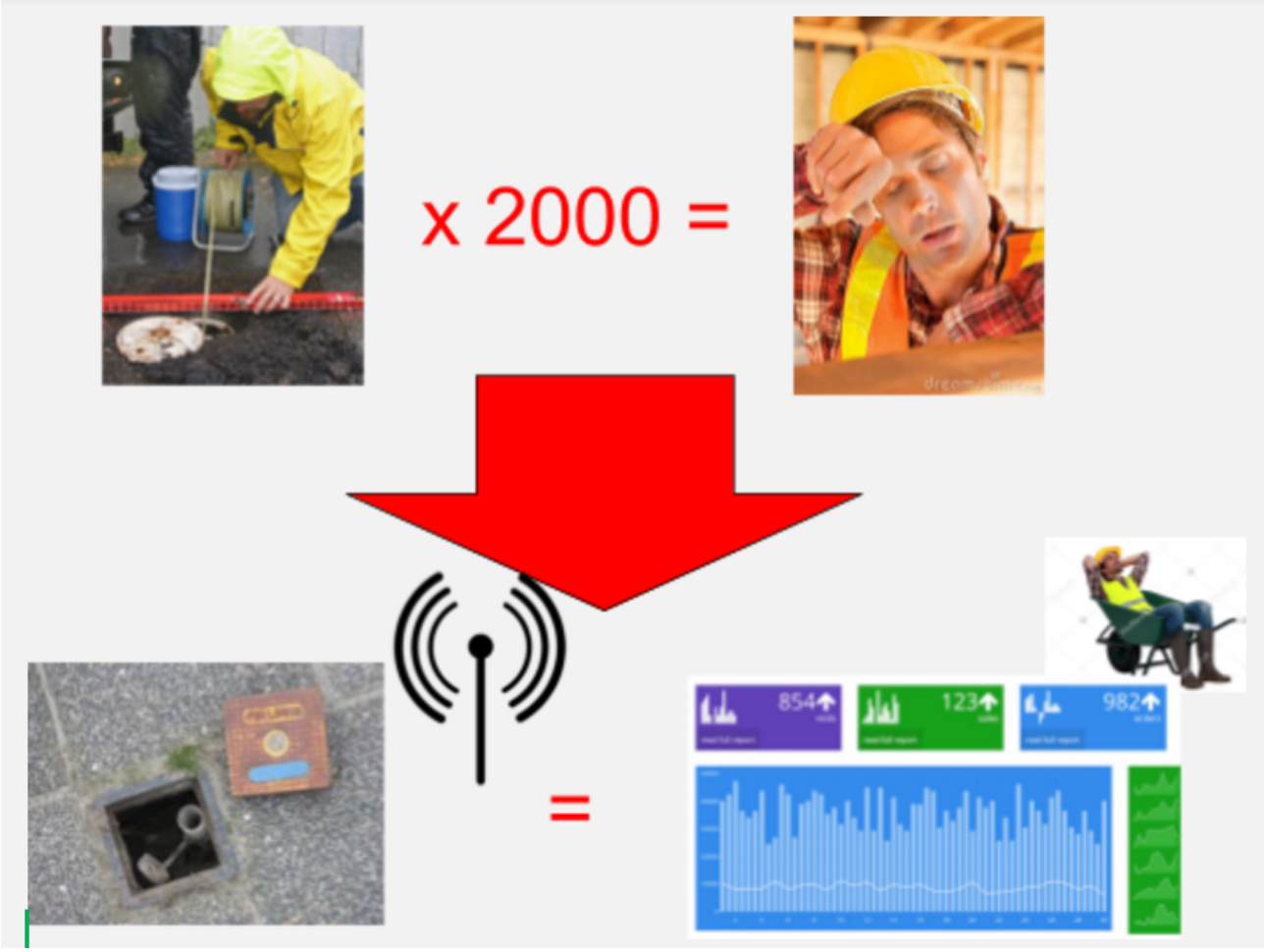


Figure 19. Rotterdam Use Case Storyboard - UC02 Groundwater level measurement.

c. UML Diagram

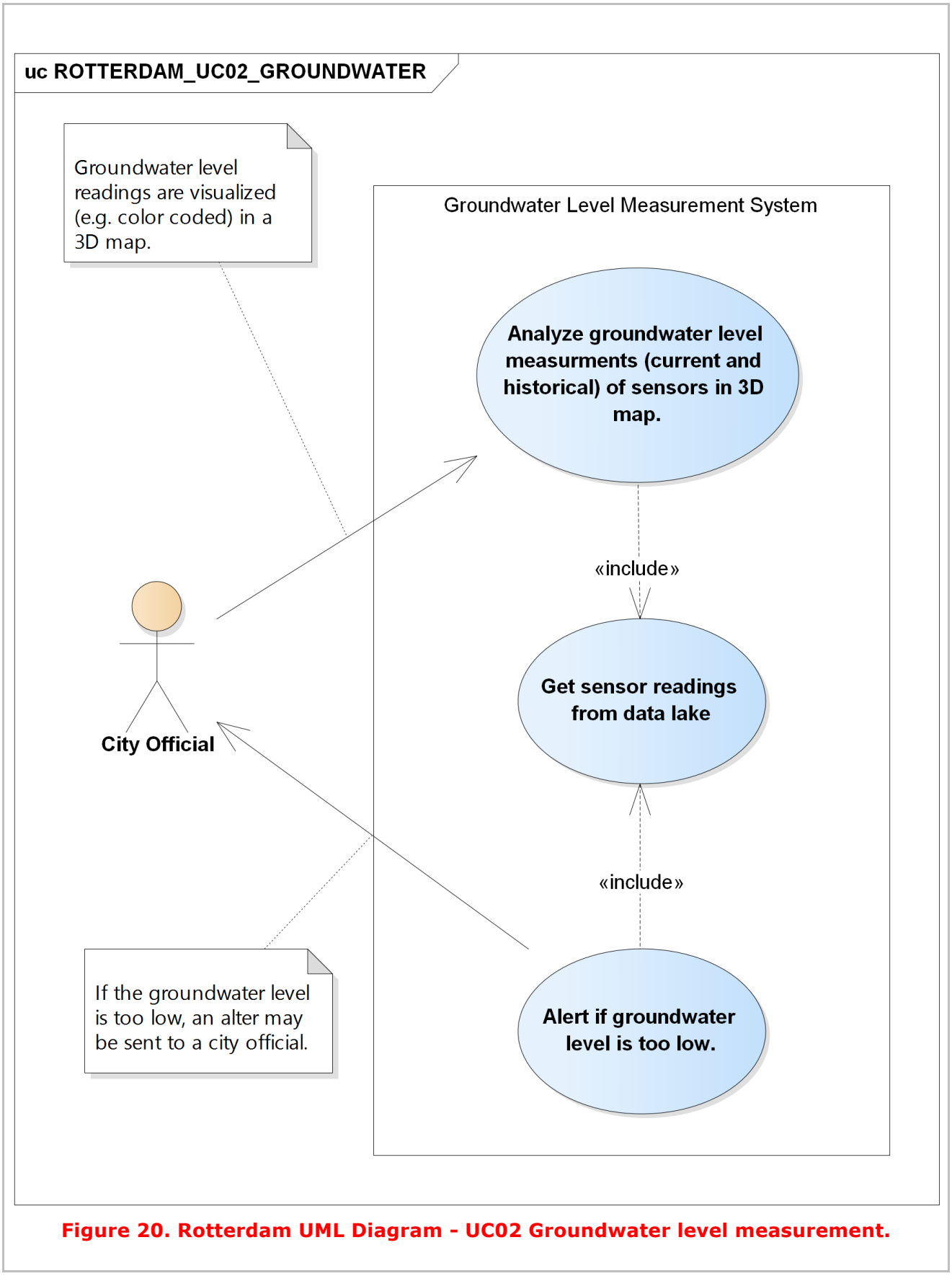


Figure 20. Rotterdam UML Diagram - UC02 Groundwater level measurement.

3. Scope and Objectives	
Scope of Use Case	The current use case is about a first technical test with the groundwater level sensors for a limited number of wells. Depending on the outcomes of the tests decisions will be made about the next steps
Objectives	Obtain more knowledge and experience about the use of sensors for measuring the groundwater levels.
4. Actor List and Requirement	
Actors identified	• Data / sensor supplier • Administration of Rotterdam (water, civil technical, geotechnical and geophysical engineers • Inhabitants (the readings are provided as open data to the citizens of the city) • Developers
Requirements (from actor's perspective)	• Reliability (availability and accuracy) • Easy to use, open standards
5. Available Data at the Pilot Site and Open Portals	
Which are the available data at the pilot site for this use case?	Technical description: • For this project, the sensors are already installed, providing data. The data provided is the ground water level, measured and relayed in centimetres above or below NAP (sea level).
Which are the available and useful data coming from Open Portals?	*Information not applicable for this particular pilot.*

USE CASE 4 – Waste Paper Containers

1. Use case Name

ROTTERDAM_UC03_WastepaperContainers

a. Domain/sector of activity

Smart Environment

b. Subdomain (s)

Waste management

c. Objectives/benefits of the use case

Municipal paper waste in Rotterdam is a challenge to manage efficiently, and due to traditional management solutions, a considerable amount of effort and funding is allotted to waste collection and transportation. In order to make the Waste paper management process more efficient and to improve savings (energy, time, money), this use case will leverage on new sensor technology in order to assist in data-driven decision-making with respect to waste management, leveraging on real-time data on waste bin fullness in order to plan and optimize waste pick-up routes and to access analytics on trends, patters, projections, maintenance and collection activities.

2. Description

This use case currently being deployed but the sensor data is not available to the pilot because the supplier of the sensors and app does not want to share the data.

They have another business case based on the data, so they don't want to make it open. Important lesson for the future regarding the procurement procedure to make sure the municipality will be the owner of the data.

a. User Story Description

Instead of driving the regular route along all the containers collecting the waste paper, only the containers which are full are collected. Also the most optimal route along the full containers is calculated.

b. Storyboard

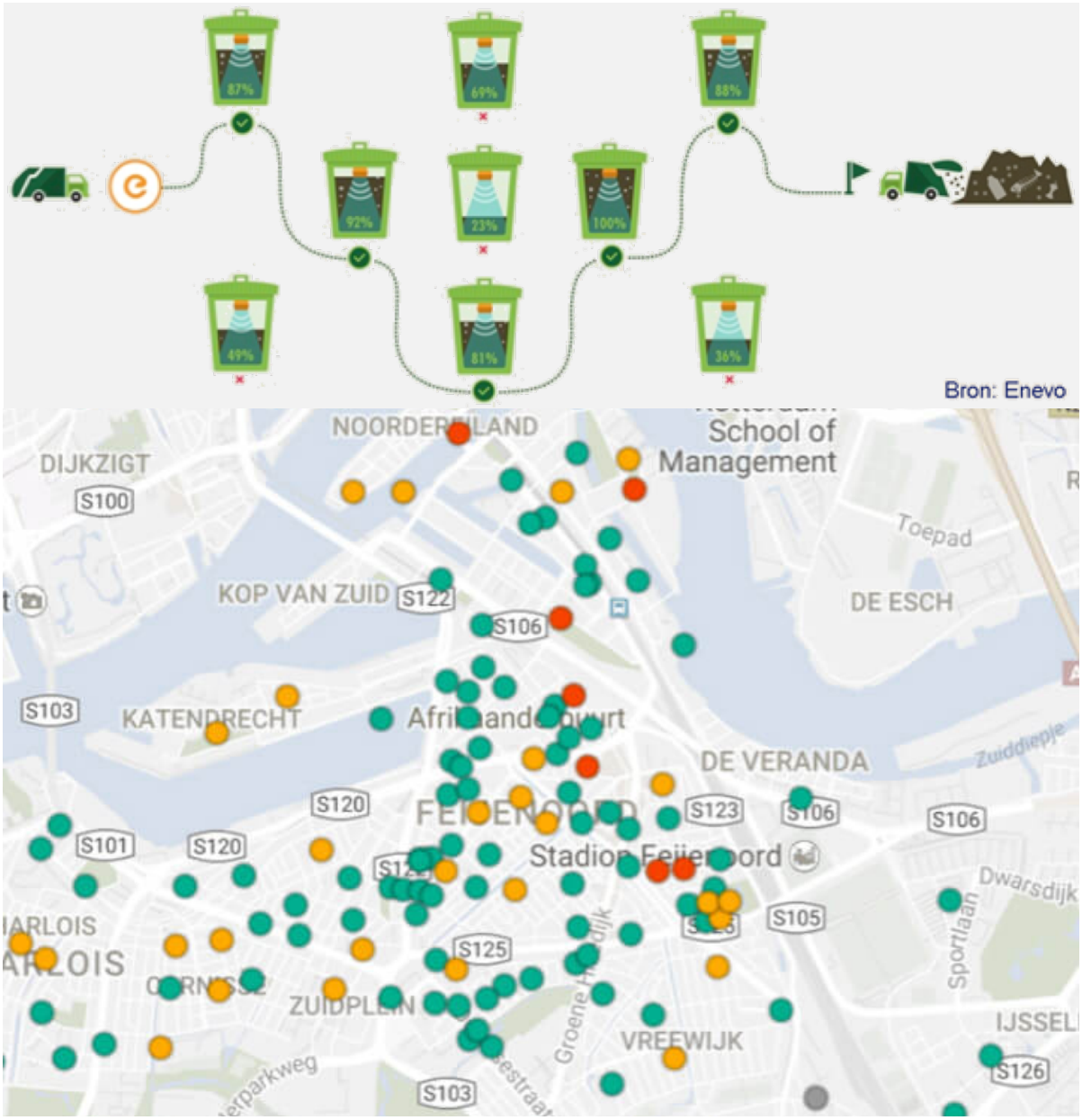


Figure 21. Rotterdam Use Case Storyboard - UC03 Waste Paper Containers (routing, mapping). Source: Enevo.

3. Scope and Objectives

Scope of Use Case	Sensors registering the fullness of the containers for different purposes.
Objectives	• Optimizing the collection routes • Registering defects • Registering demolition

4. Actor List and Requirement

Actors identified	• Administration of Rotterdam (Waste Collection and Recycling) • Enevo – supplier of sensors and data
Requirements (from actor's perspective)	Data: • Reliability • Availability and accuracy of data • Easy to use, open standards Solution: • View planned, missed and unscheduled collections • Track average fullness of your containers • Know, with accuracy, how much waste you are generating • Record percentage of waste you are diverting from the landfill by recycling • Manage how fast your containers are filling up • Identify containers that need emptying • See when missed sites might overflow and react ahead of problems • Manage containers that don't need to be collected • Receive a time record of each collection • Track volume and weight collected • Quantify total collections over a period of time • Validate if missed collections led to overflow • Monitor collection performance against agreed schedule • Export data to excel for further analysis or reporting needs
This use case was dropped from the Rotterdam piloting options as the current private company managing the waste bin sensors and the application has denied the request for access to the data.	

10.2. Tartu, Estonia

10.2.1. Partner profile

Tartu represents the second largest city in Estonia, after the political and financial capital of Tallinn, and the capital of the southern region. The city has a highly homogenous (80% Estonian) population of just under 100,000 inhabitants (2015) and hosts the University of Tartu and the Ministry of Education in Estonia (since 2001), being a strong intellectual and innovation centre.

Figure 22. Location of Tartu. Source: Wikimedia commons.

The city is one of the examples of socialist to post-socialist development dynamics, facing a rapid growth and almost doubling from 57,000 inhabitants to over 100,000, in part due to immigration. Tartu is now confronted with a slow decline in population, and its current positioning as a shrinking city point towards a different set of challenges to overcome.

The city is an important business and commercial centre, having observed a significant evolution of entrepreneurship, cluster development and knowledge-based economy in the key fields of **metal processing and machine building, IT, woodworking, biotechnology and food industry**[9], albeit the recent economic crisis has determined a rise in unemployment (at 11.9% in 2009, 9.10% in 2011[10]).

The main identified drivers (following the ESPRESSO Questionnaire) for Tartu are:

1. Demographic: Aging population and Shrinking city
2. Environmental: Resource management, environmental protection, energy consumption and efficiency, renewable energies, GHG emissions, fossil fuel share in energy consumption, standardization and integration of data
3. Governance and planning: policy making, participation in decision making, strategy development and prioritization of investment, urban planning, public procurement;

[9] BusinessTartu portal - http://business.tartu.ee/keysectors/metal
[10] KNOEMA Data Atlas - https://knoema.com/urb_llma-20151104/labour-market-functional-urban-areas

4. Societal drivers: formal and informal education, entrepreneurship, social economy, social inclusion, healthcare and aging
5. Economy: industry, tourism, RES sector, RDI sector, SME and start up sectors, PPPPs;
6. Mobility drivers: all mobility drivers have been identified (infrastructure, software integration, traffic management, alternative transportation, smart ticketing, standardization);
7. Safety and security: safety by urban design, law and order, cyber security, standardization;
8. ICT and big data: ICT development of digital infrastructures and e-services, open data, data protocols and collection, crowdsourcing, sensor-based solutions, monitoring and intervention, Living Labs, standardization.

The most important pillars of Tartu's 2030 strategy are the **development of ICT, Healthcare and local resource based economy**, as the vision of the Strategy is outlining a number of 5 pillars[11]:

- **A city of knowledge** (open educational space, knowledge and skills, integration of educational institutions)
- **A city of entrepreneurship** (sustainable technologies, niche production, clusters, open competition);
- **A city with a modern urban environment** (social cohesion, decision making based on partnership, systemic district-centred integrated urban space, ITS, citizen responsibility, sustainable financial policies);
- **A caring city** (health supporting environment)
- **A creative city**.

Open Data

Since 2009, the University of Tartu Library (UTL) has been developing open access (OA) initiatives in Estonia. The „**Open access and Open Data in Estonia[12]**" project aimed to formulate national OA policies and broaden OA discussions to include opening access to research data. The project also focused on educating researchers about the benefits of publishing in open access and making more research output available in the UTL repository. As a result, the OA principles have been added as underlying basis of the national Research Development and Innovation (RD&I) strategy **"Knowledge Based Estonia 2014-2020"**.Furthermore, an infrastructure set for researchers to share open research data has been set up, by UTL joining Data Cite and receiving funding from the Estonian government to improve the quality of research data.

[11] The Tartu 2030 Strategy – http://info.raad.tartu.ee/teated.nsf/0/C26E6D2D24CF3ADAC22571F6003D800F/$FILE/tartu2030uus.PDF
[12] EIFL, Open access and open data Estonia project, http://eifl.net/eifl-in-action/open-access-and-open-data-estonia-project

At the moment, the city council is in the process of changing platforms and migrating data, also creating data bundles, and Tartu Open Data could be accessed starting from 2018[13].

Performance measurement

Tartu currently assesses its Smart City performance in certain key areas, using the methodology developed by Prof. Giffinger at the Vienna University of Technology. The PLEEC – Planning for Energy Efficient Cities FP7 project assessed the performance of Tartu through the set of 81 indicators, 28 domains and 6 key fields considered for Smart Cities:

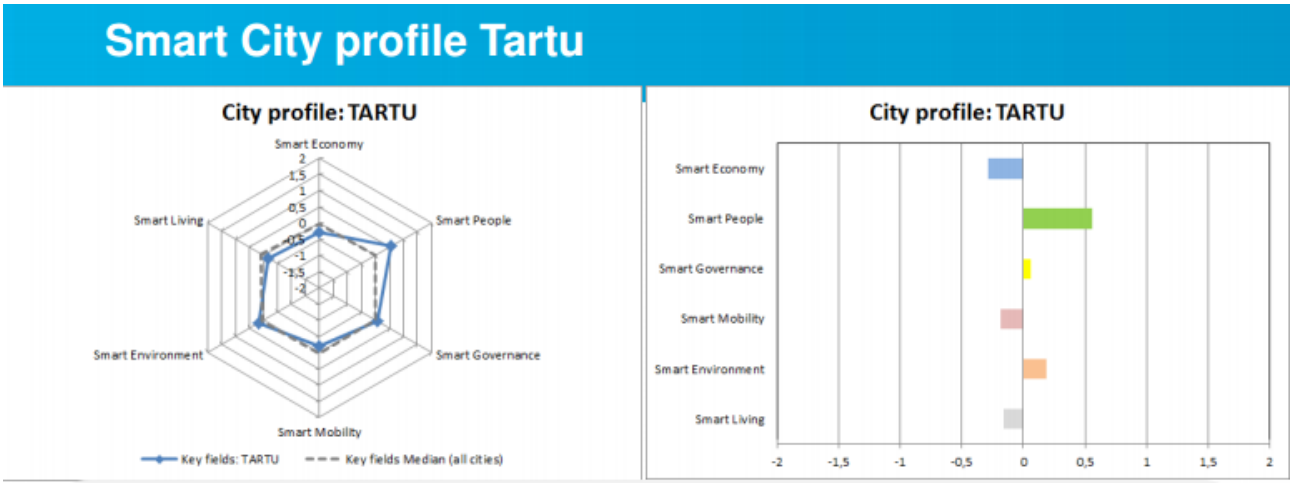


Figure 23. SC Profile Tartu, PLEEC Project. Source: pleecproject.eu.

Conclusions enforce the „smart people", „smart environment" and „smart governance" sectors, which are performing above average of cities considered for the study. Low economic productivity, economic insecurity and lack of financing for transportation systems upgrade account mostly for underperformance in the remaining three key fields.

The Smart City Lab

Smart City Lab (SCL) is a triple helix collaboration initiative in Tartu, Estonia which is aiming at development, delivery and export of smart ICT and mobile based services and products in the following priority areas - Transport, Energy and Environment, Tourism, Healthcare and Wellbeing, Governance and public services. Smart City Lab is part of the Estonian National Cluster Programme and is linked with 18 industrial cluster initiatives supported by the programme. Smart City Lab is actively promoting international cooperation of Estonian companies, universities and clusters with relevant international counterparts. Smart City Lab is connected through its members to the Enterprise Europe Network, European Network of Living Labs (ENoLL), International Association of Science Parks.

The SCL is the first and only acting living lab in Estonia focusing on end-user feedback collection and is currently focusing on:

- Future Internet and IoT;

[13] TARTU Open Data - http://hub.garage48.org/tartu/blog/tartu-open-data-event

- E-Government and e-Participation
- Thematic tourism, culture services;
- Sustainable mobility and ITS;
- New business models for innovative energy supply in urban districts;
- nZEB renovation in smart city districts.

10.2.2. TARTU Main Use Cases

USE CASE 1: Energy Efficiency
1. Use case Name
TARTU_UC01_Energy Efficiency
a. Domain/sector of activity
Smart Energy Management
b. Subdomain (s)
Increasing Energy Efficiency in Buildings
c. Objectives/benefits of the use case
The main objective is to contribute to the increase of energy efficiency in the new smart district developed in Tartu City centre where a number of old Soviet-era residential buildings will be renovated to meet the contemporary smart city standards in various fields but primarily in terms of energy. The goal is to reach energy consumption level 90 kWh/m2/year - decreasing the energy consumption level three times from the current 270 kWh/m2/year. The objectives are to: 1. **Mobilize support and build momentum for Smart Energy Management** among the residents of the new smart district in Tartu and the general public via **better visualization of positive changes to take place in the context of the Horizon 2020 lighthouse project SmartEnCity** 2. **Make better informed decisions regarding the use of solar energy** based on solar potential analysis data integrated in the city information model in the context of the pilot.

Figure 24. Online map of the pilot area available at the webpage of the lighthouse project: http://tarktartu.ee/avaleht/pilootala/.

2. Description

The use case will include the following elements to be included to the advanced 3D City Information Model (data in CityGML) to be developed in the context of the Tartu pilot.

- Data about energy consumption history per building (available by Tartu Regional Energy Agency) serves as a starting point for the model
- Fraunhofer IGD is ready to offer their Heating Demand simulation model to be used in Tartu across the city information model for a demonstrator. The model includes a number of factors influencing heating demand: A user can 'play' with the values related to each factor and see on the 3D map how this influences the heating demand of a specific building. Relevant input data needs to be provided from Tartu´s side (tbs).
- Solar potential analysis information based on using satellite imagery as input in collaboration with another EU project NextGEOSS.

The 3D map will outline development as the lighthouse project proceeds, allowing for visualising changes, getting a better comparative overview of different neighbourhoods in terms of energy consumption, identifying problematic spots, etc.

The following will contribute to higher energy efficiency in buildings renovated in the context of SmartEnCity:

- State-of-the-art building materials
- Full thermal insulation
- Windows/doors U-factor < 1
- Indoor climate category II
- Heat recovery ventilation
- Heat regulation by each room
- PV panels
- Smart home sensors

a. User Story Description

The residents of the buildings involved in SmartEnCity pilot area want to clearly understand the benefits of the lighthouse project: They both have to provide co-financing for the retrofitting as well as go through some inconvenient changes at times (e.g. exchanging windows that were changed rather recently but are still not energy efficient enough; some people do not share the enthusiasm for the use of solar panels as it´s not clear how this will pay off in the context of their buildings, etc).

The SmartEnCity consortium members, led by Tartu City Government, have to be able to demonstrate the expected positive changes very clearly: as a first step to the Apartment Association Board and then (potentially through the Apartment Association Board members) to the residents. Being able to simulate changes taking into account various factors that are part of the pilot can make the process considerably smoother (coming down to savings in time/finances).

User 1: City official working with the SmartEnCity project

I currently work with the SmartEnCity project where we have an ambitious goal of decreasing the energy efficiency of 20+ old Soviet era buildings in the city centre. The goal is to reach energy consumption level 90 kWh/m2/year from the current 270 kWh/m2/year. However, it has been sometimes quite difficult to make the residents of the buildings understand why we have quite strict rules about everything and how all of it will contribute to increased energy efficiency.

But now we have this 3D city information model that we can use for visualising the changes in energy efficiency. This is very helpful in communication with residents and citizens. Also, the model allowed us to better understand the solar energy potential of each building and how to position the solar panels on them.

All in all, having the simulation model helps us to save time and money in explaining this complex project to people and reduces the risks that we have related to implementing this ambitious project (being ready on time, reducing errors, etc).

User 2: Resident

As a resident of this building, part of the money for renovation comes from my pocket.

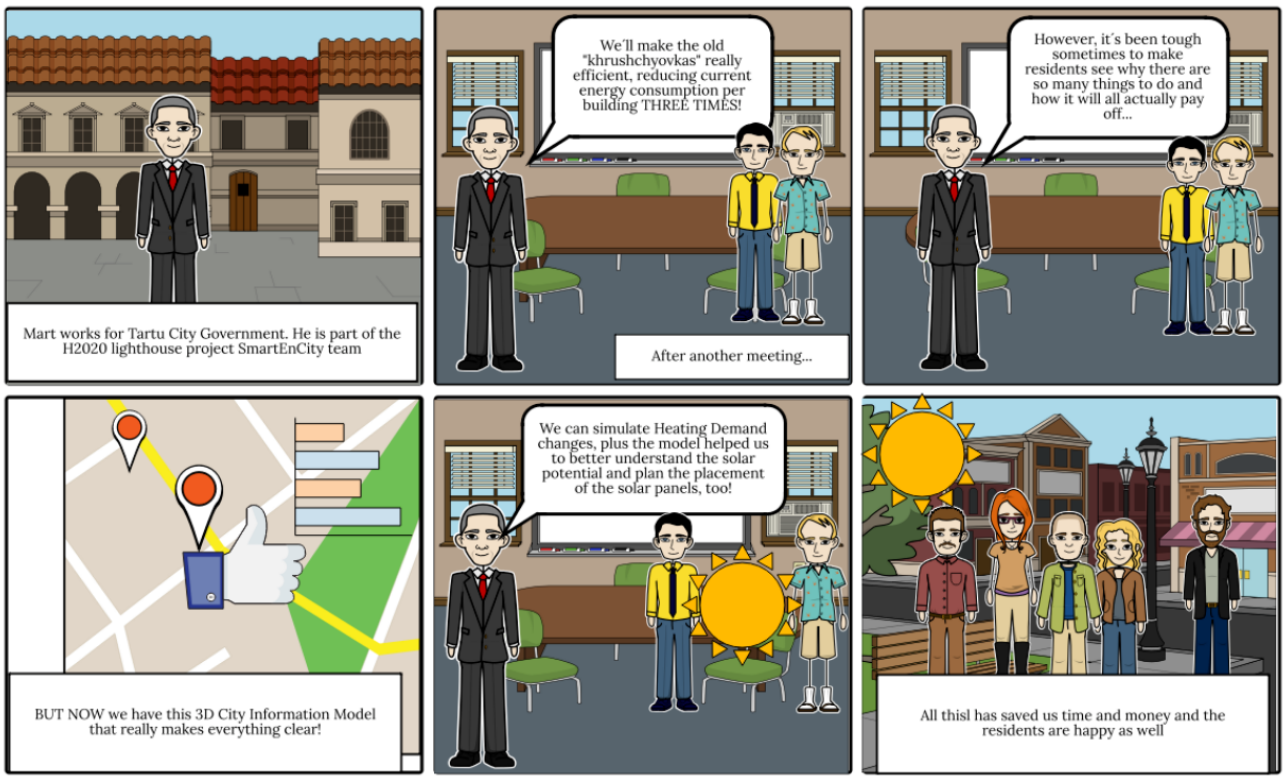
Of course, I´d like to save on my monthly energy costs in the future, but I wasn´t sure at first how all of it will pay off. There´s a lot that we have to do: Change windows and doors that we´ve just changed a couple of years ago, have the solar panels on the roof, etc. Now I can see it all better because we have the 3D map in Tartu, that shows how all the planned changes will indeed result in higher energy efficiency.

People from the City Government/ SmartEnCIty project representatives explained me how to use the model and now I can do it myself. I can see the starting point for our building – how inefficient this house is in terms of energy use, how inefficient the whole block is. And I can also see how, having changed the various factors addressed by the SmartEnCity project, how the efficiency of our building will improve and how the heating demand will decrease.

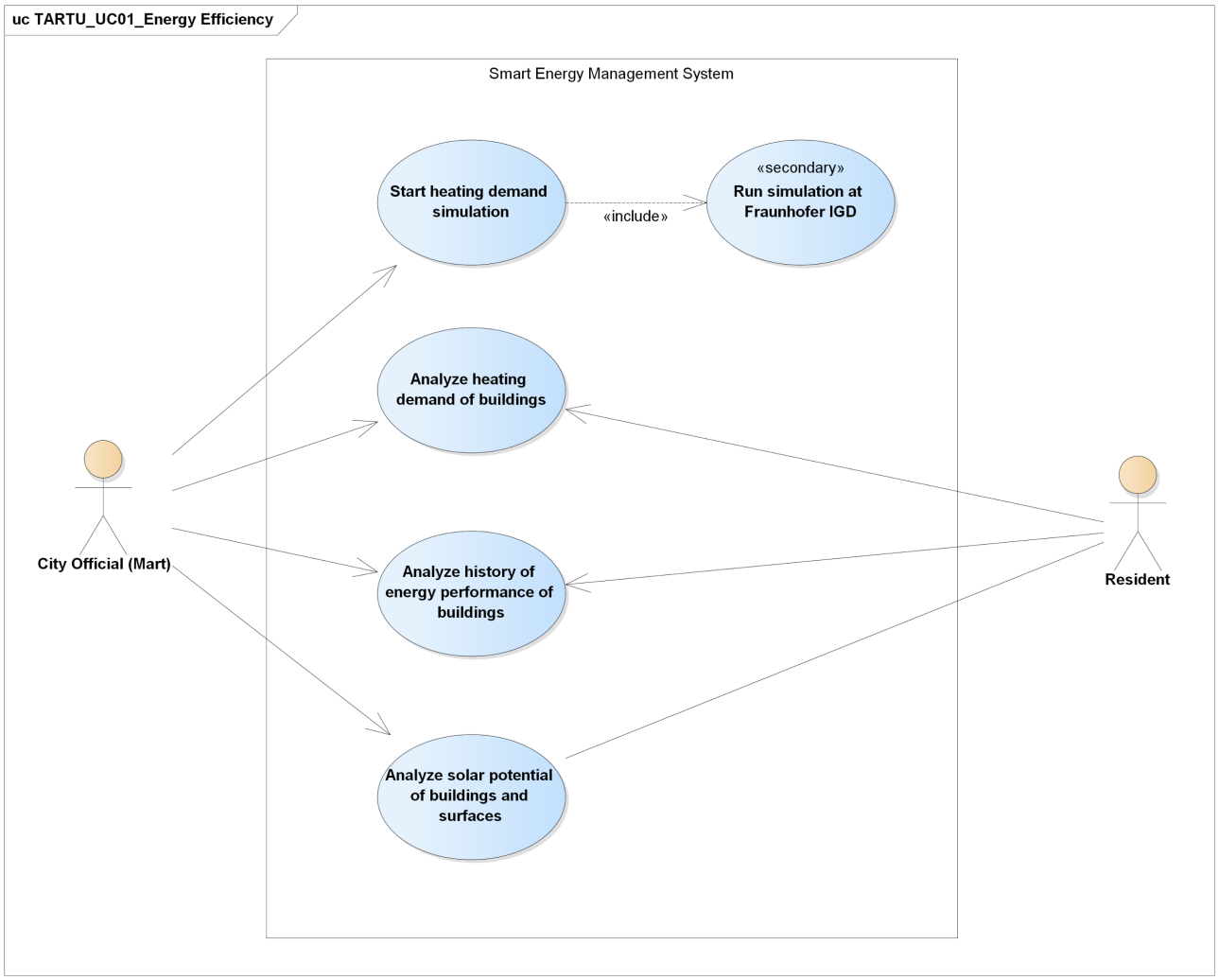
I now have more confidence in this project and that my money is well spent.I have also learnt quite a few things from this process and given some tips to my friends and colleagues who are also thinking about renovating their houses in the future.

b. Storyboard

User 1 – City Official view:



c. UML Diagram



Background information for the UML scheme development

Current state of the affairs:

1. Tartu Regional Energy Agency & VirtualCitySystems information exchange for integrating energy related information in the model;

VCS needs	***Information from TREA***
1. **Building ID-s** (this id matches an id in the 3D city model, so that the link between the city model and the energy performance data can be established)	= addresses

2. **Energy consumption history**: absolute value [kWh/m^2/year] and classified value (A - G)	3 year history available on monthly basis
3. **CO2 emissions**: absolute value [kg/m^2/year] and classified value (A - G)	For CO2 and water, TREA only have absolute value. There is no classified value used in Estonia. Data would hence be classified by VCS either on their own or just to show the graphical information with the coloured arrows only for the energy consumption.
4.**Water consumption** (absolute value [l/m^2/year] and classified value (A - G))	

2. Data input needed for Fraunhofer´s Heating Demand simulation model

- Most important: a building typology library for Estonia.
- As minimum input: Valid 3D building geometry (solid) to calculate building volume, facade area and orientation etc. In addition year of construction and building usage (residential, etc.).
- Building typology would be helpful, but this can be derived based on building geometry as well. All other attributes necessary for the simulation will be used from a building topology library such as Tabula (to fill in gaps in the input data set such as heat transfer coefficient (u-Value) based on building age and typology). Of course, the more accurate the input attributes are, the better the simulation results will be.

3. Potentially using satellite imagery as input for solar potential analysis in cooperation with NextGEOSS

3. Scope and Objectives

Scope of Use Case	The 3D city information model developed as part of the pilot is primarily focused on the SmartEnCity pilot area (42 "khrushchyovkas" and buildings around them). Based on the results of the pilot, the model could be developed further to involve the entire city. The more specific scope of the use case is integrating all available energy management related information into the model in an interoperable way.
Objectives	The objectives are to:

	1. Mobilize support and build momentum for Smart Energy Management among the residents of the new smart district in Tartu and the general public via better visualization of positive changes to take place in the context of the Horizon 2020 lighthouse project SmartEnCity **2.** Make better informed decisions regarding the use of solar energy based on solar potential analysis data integrated in the city information model in the context of the pilot
4. Actor List and Requirement	
Actors identified	• Buildings involved in SmartEnCity: (1) Apartment Association Board; (2) residents • SmartEnCity consortium: primarily Tartu City Government, TREA, Fortum Tartu (heating) • Citizens of Tartu
Requirements (from actor's perspective)	• SmartEnCity consortium: need to be able to present the data in an understandable way to create momentum; need better input data about solar potential • All stakeholders: the usability of the 3D city information model is important. The SmartEnCity consortium members have to be able to present it to the Apartment Association Board and residents in an easily understandable manner. Preferably, the residents and all interested parties should be able to understand and use the model by themselves without any extensive effort.
5. Available Data at the Pilot Site and Open Portals	
Which are the available data at the pilot site for this use case?	Data requirements for this pilot have been developed between the Tartu Regional Energy Agency (TREA) and VirtualCitySystems (VCS) and will be provided by the first: • Addresses (building IDs), matching an ID in the 3D city model, in order to establish a link between the model and the energy performance data. • Energy consumption history (in absolute values, kWh/m^2/year) and classified value (A – G): data is available on monthly basis for the last 3 years (36 months) • CO2 emissions (in absolute values, kg/m^2/year) • Water Consumption (in absolute values, kg/m^2/year)

	• Valid 3D building geometry (solid) in order to develop Fraunhofer's Heating Demand simulation model – minimum input • Year of construction, building usage • Building typology can be derived based on building geometry as well, but considered useful Data typology: Sensor metadata, Unified Data Model, exchange formats.
Which are the available and useful data coming from Open Portals?	• Building topology libraries such as TABULA (to fill in gaps in the input data set such as heat transfer coefficient (u-Value) based on building age and typology). • OpenStreetMaps • Potentially, satellite imagery as input for solar potential analysis, in cooperation with NextGEOSS.

USE CASE 2 - CIM City Information Modelling

1. Use case Name

TARTU_UC02_CIM

a. Domain/sector of activity

Smart Governance

b. Subdomain (s)

Data interoperability

c. Objectives/benefits of the use case

On a broader scale, the value of this Use Case is demonstrating the level of effort needed (i.e. how easy or difficult it is) to integrate data currently existing separately in different databases and in different formats to a state-of-the-art 3D city information model based on open standards, facilitating interoperability and data exchange among different platforms. This is a crucial issue for many cities in Europe (and beyond), hindering the development of open standards-based 3D CIM platforms, as cities often see value in such approach to city information management but they consider integrating the existing data to be too difficult and painful.

The pilot activities also help visualising changes taking place in the context of the development of the lighthouse project in the city of Tartu in other fields, in addition to energy (Use Case 1) – this is very important for communicating the importance and value of the project to the residents of involved buildings, various partners, citizens and the general public.

2. Description

The various existing datasets exist in different databases that are not connected with each other. Therefore, the use of certain data is primarily limited to the "main owner" of the data, while access for other stakeholders is complicated.

The use case demonstrates how an interoperable platform in the form of a 3D City Information Model can be created by:

1. Translating various existing datasets to formats enabling interoperability;
2. Adding new datasets created in the context of SmartEnCity to the platform from the very beginning.

This will also serve as basis for potential future third party engagement (e.g. tech startups) to build new products/services based on different datasets

a. User Story Description

Lead User: City official working with the SmartEnCity project

We are in the middle of implementing a big and interesting project in Tartu, more than 20 old Soviet-era 'khrushchyovkas' in the downtown area of Tartu will become 'smartovkas' (fully renovated smart buildings) in the context of the EU Horizon 2020 lighthouse project SmartEnCity. This will change the life and appearance of an entire district.

It´s a great project and there´s a lot of interest from residents of the buildings, other citizens of Tartu as well as media. Using the 3D City Information Model, we can show all these parties how our vision about the new smart district in Tartu will turn into reality.

We have also included a number of other datasets (e.g. bus stops, electric vehicle rental spots, vegetation) in the model. The starting point for Tartu, as in many other cities, is that lots of different city datasets still exist in "silos". Building this CIM demonstrator also helps us understand how much resources it takes to bring this data together on an interoperable platform.

We also want to engage citizens strongly to the change processes and public services development in the city, not only related to SmartEnCity, but in a wider perspective. The first step for better engagement of the citizens is that they have a better overview and understanding of things.

In addition, the 3D CIM also facilitates interoperability and better joint public services development at the City Government level, between its different departments and sub-units.

Through implementation of the pilot, we therefore learn what it takes to integrate data from silos together and we´ll also

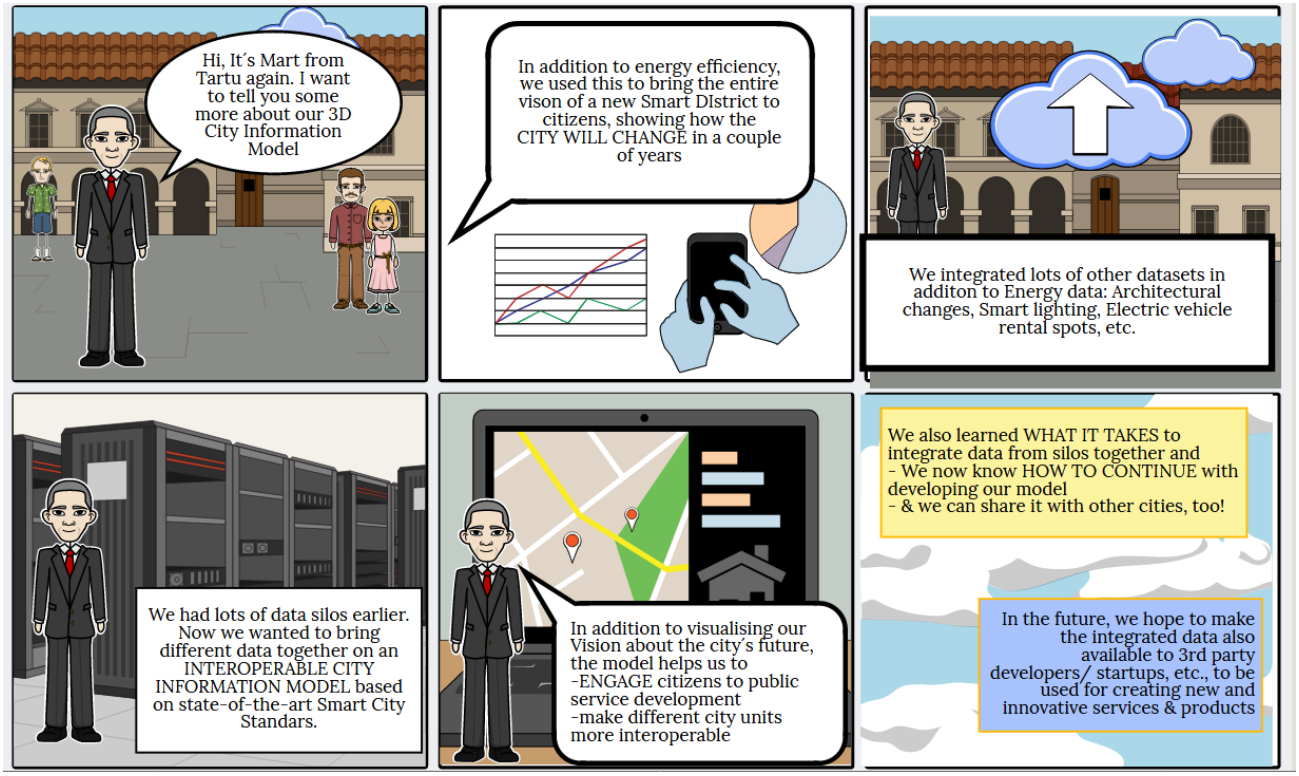
- *know how to continue with developing our model*
- *be able to share our learning points with other cities in Estonia and Europe.*

This is particularly important because the lighthouse project is not only about Tartu: More than 100 million people in Europe live in this type of buildings and we want to build a smart renovation model that is replicable for other countries.

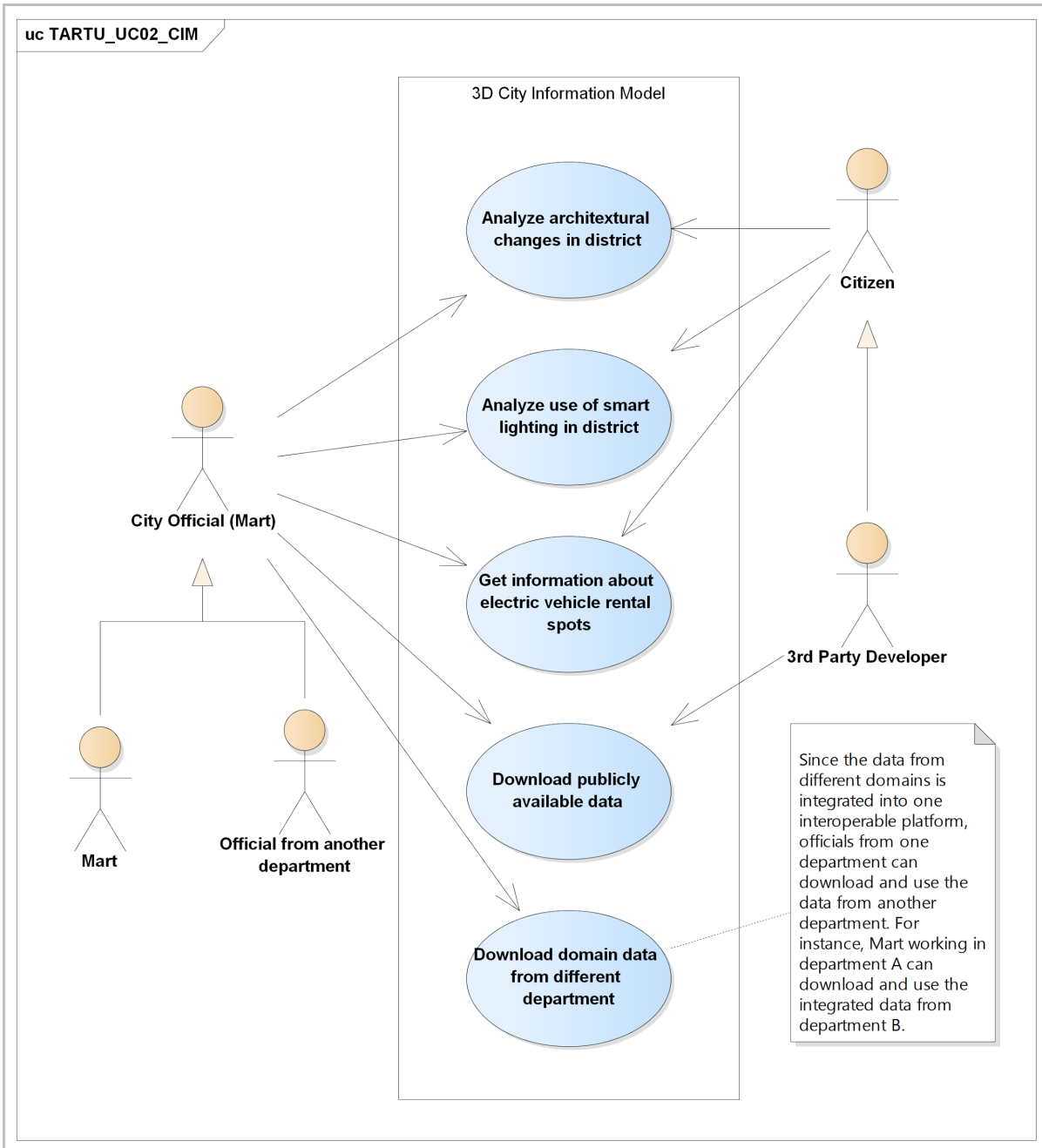
Coming back to Tartu - later on, once we´ve validated the platform and more data is integrated in the model, various third parties (citizens, companies) could also have access to the actual datasets that have been integrated in the model in an interoperable manner, and build new services and products based on the data.

b. Storyboard

City Official view:



c. UML Diagram



3. Scope and Objectives

Scope of Use Case	The 3D model developed as part of the pilot is primarily focused on the SmartEnCity pilot area (42 "khrushchyovkas" and buildings around them). Based on the results of the pilot, the model could be developed further to involve the entire city. The more specific scope of the use case is integrating various available city information datasets into the model in an interoperable way. This includes critical assesment of effort needed for translating datasets to standard formats

	and determining a process for adding new datasets to the model in the future, to continue developing the 3D CIM platform of Tartu.
Objectives	The value of this Use Case is demonstrating the level of effort needed (i.e. how easy or difficult it is) to integrate data currently existing separately in different databases and in different formats to a state-of-the-art 3D city information model based on open standards, facilitating interoperability and data exchange among different platforms.
4. Actor List and Requirement	
Actors identified	• Buildings involved in SmartEnCity: (1) Apartment Association Board; (2) residents • SmartEnCity consortium: primarily Tartu City Government, TREA, Fortum Tartu (heating) • Citizens of Tartu • Third parties interested in creating new products/services based on the information made available
Requirements (from actor's perspective)	• Open access to data (integration of data to the 3D city information model based on relevant standards) • Ease of use of the model for various expert (e.g. city government, third party developers) and non-expert (e.g. residents of the buildings renovated, citizens) stakeholders
5. Available Data at the Pilot Site and Open Portals	
Which are the available data at the pilot site for this use case?	The following data are already available: • Placement / positioning of new smart street lighting (lampposts) • Existing vegetation in the area (trees) Expected availability on the following data for the next phase of piloting: • Architectural changes made in the context of retrofitting • Design of artworks to be created on the building façades (murals)/ areas near the buildings (sculptures) • Placement/positioning of electric vehicle rental and charging points

	• Existing bus stops in the area (coordinates)
Which are the available and useful data coming from Open Portals?	• Potentially: orthophotos, 2D maps (also as WMS), or OpenStreetMaps • Potentially: Free 3D object libraries, in order to better reflect the real-world objects in the CIM

11. Conclusions

The Smart City, beyond its leveraging on ICT and intelligent solutions, is essentially a city which addresses its challenges transversally, integrated, in the most sustainable, inclusive and resource-efficient way. Yet all cities are different: they have evolved in different systems, with different challenges, are located in specific areas, have an overall socio-economic, environmental and political-administrative framework which is not homogenous, and hence face different needs, sometimes event opposite ones (e.g. growing versus shrinking cities). The challenge is to address these differences with the most fitting smart solutions: **providing custom responses to city-specific problems through a unique Smart City framework, leveraging on standards, interoperable technology and services and open data.** In order to understand and address the different requirements, the **Use Case model is being employed in ESPRESSO**. Use cases piloted will be used as success stories and concrete examples for other city administrations and will support dissemination, upscaling and replication of the ESPRESSO approach.

Macro-trends of the current society make future investments in city development (coping with demographic trends and aging, needs requiring real-time responses, obsolete infrastructure, etc.) the main priorities of today. However, there is also another challenge, and that is to offer a common framework to address these priorities and make change happen. Further aspects can be viewed as macro-cases: ***Improvement and display of analytics and big data, Citizens-as-a-resource, Benchmarking and methodologies for Smart City maturity, Open Data strategies, Transnational frameworks for technology adoption and adoption of IoT as data provider***.

The **priority areas / sectorial systems of specific interest for ESPRESSO with respect to piloting** and mapping with pilots and early adopters have been narrowed to the following:

1. **Smart Governance and Participation**
2. **Smart Mobility and ITS**
3. **Smart Energy Management / Building Automation**
4. **Smart environment / Cleantech**

Of the above, the main priorities of Rotterdam and Tartu are the following:

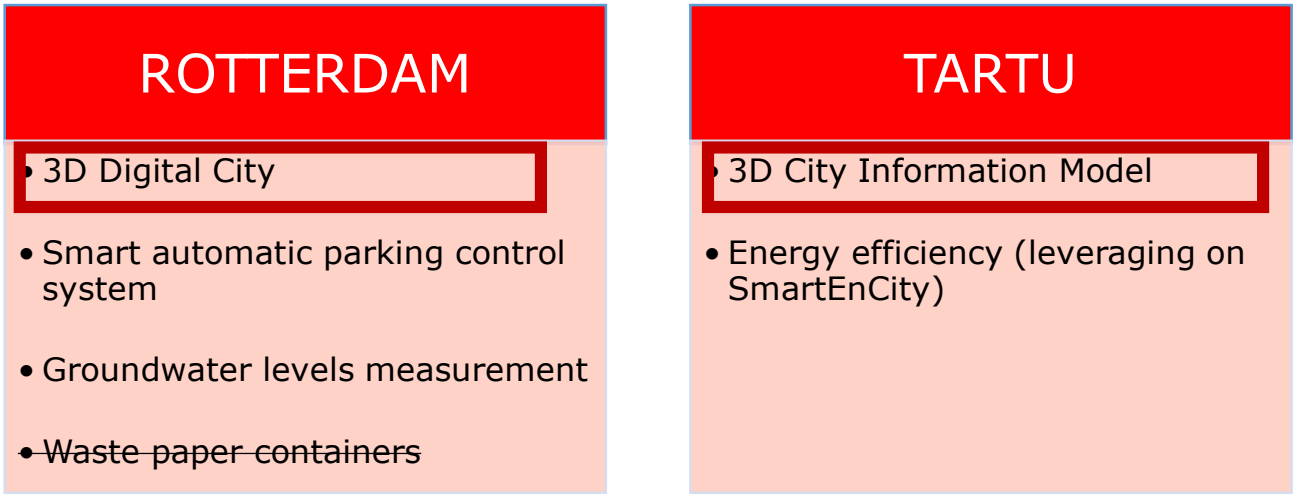


Figure 25. ESPRESSO piloting use case list.

There are strong synergies between the pilots, which will both address as an overarching use case the development of a 3D city platform, based on CityGML, and integration of various data regarding urban management (parking availability, energy efficiency of buildings, solar potential, groundwater levels, etc.).

Exploration of the pilot-specific use cases will be further conducted through the deliverable D2.6 before piloting.

11.1. Conclusions for piloting in Rotterdam

Findings of the discussions with partner **Rotterdam have shown a very advanced framework for Smart City topics pertaining to water management, energy transition, mobility, healthy environment, housing, and business innovation**. The city has a solid smart city policy and a set of developed strategies which represent the overarching framework for integrating new initiatives and programmes (among which the Rotterdam Climate Initiative). About 115 Smart City projects are already running or planned in Rotterdam, and because they already joined the GCIF and use the ISO 37120, they will represent an important test-bed for developing the ESPRESSO Smart City information framework.

The foci for future piloting have been identified through the 24 May 2016 workshop and refined in March 2017:

1. **3D Rotterdam for assisted decision making:** The Digital City project as an information- and communication platform allowing interdepartmental and open communication as well as multiple uses in city planning, traffic management, energy planning etc., under an interoperable framework with other proprietary, vendor-specific solutions pre-existing in the City Hall
2. **Smart Automatic Parking Control System** for better public and real-time information on availability of parking spaces, in order to lower „searching traffic" in the city
3. **Groundwater levels measurement** via sensors, in order to efficientize and save resources on the traditionally manual measurement of water levels in 2000 wells in the city

Other initiatives which can be considered in the future:

4. Rotterdam Data Marketplace: smart solution enabling processing and user-friendly display of open datasets (114 are already available), as well as easy scale-up and monitoring of data access for quantifying the benefits.
5. Support for cooperation and circular economy: enabling performance measurement and measurement of circularity for the ongoing 26 initiatives under the Rotterdam Roadmap for Circular Economy
6. Integrated redevelopment of Stadium Area (under a SCC Lighthouse proposal)> integration of systems for public transport, public lighting, data from sensors, introduction of AAL, etc.)
7. Dynamic real-time waste management by use of sensors. Sensors transmit their 'fullness level" and decisions can be made on the spot for adapting the waste collection routes and minimizing costs.
8. Water system management via Rain Radar and rain sensors, expansions to reuse of wastewater to warm up roads and also buildings in winter.

11.2. Conclusions for piloting in Tartu

Discussions with the Smart City Lab (SCL) in **Tartu have shown a strong focus on the key sectorial systems of IoT, e-government and e-participation**, sustainable mobility and ITS, energy transition. Tartu currently implements the lighthouse project SmartEnCity, which will be the main focus of the piloting in ESPRESSO and will yield the requirements for smart city standardization (albeit in the following month).

Tartu currently benchmarks performance under the set of 81 SC indicators provided through the PLEEC project. Interesting findings pertaining to the local situation address the issue of the open e-platforms used by the Estonian and local government for a range of services such as paperless government, e-voting, e-prescriptions, etc.

The foci for future piloting have been identified based on the Lighthouse project SmartEnCity in March 2017:

1. **Increasing Energy Efficiency in Buildings via better visualization**, specifically in what concerns the new smart city district developed in Tartu City centre which will be redeveloped through SmartEnCity;
2. **Tartu City Information Modelling (CIM),** a data integration pilot targeting data currently existing separately in different databases and formats, to be integrated into a state-of-the-art 3D city information model based on open standards, facilitating interoperability and data exchange among different platforms.

12. ANNEXES

12.1. ANNEX 1 –Stakeholder Workshop Agenda (Used for Rotterdam, Bucharest)

ESPRESSO WORKSHOP

19 April 2016, Bucharest

24 May 2016, Rotterdam

About the workshop

The 1-day event is part of the ESPRESSO project activities aimed at gathering feedback from key stakeholders on the development of an interoperable Smart City framework across Europe.

The Horizon 2020 project ESPRESSO (*systEmic standardisation apPRoach to Empower Smart citieS and cOmmunities*) focuses on the development of a conceptual Smart City Information Framework. The project will build this framework by identifying relevant **open standards, technologies, and information models** that are currently in use or in development in various sectors throughout partner cities and members of the Smart City Stakeholder Network which we aim at establishing.

Within this process, an essential activity is baselining the current state of the art of Smart City developments in various sectors, and **starting an open dialogue with city authorities, regions, policy makers, industry and NGOs** on what challenges they face with respect of making cities more liveable, sustainable, efficient.

Smart city programmes face significant risks to successful delivery. Given the plethora of technological advancements and solutions available, which cities are already implementing and planning, a key aspect of the process is making sure that the investments and actions reach their desired impact. How do we manage integration of Smart City solutions? How can we make sure we speak the same language across Europe? How do we monitor and improve the solutions we offer the citizens, keeping up with the individual advancements in technology and addressing the aspirations and needs of the population? These are but a few questions we will address in the workshop.

The event is an important opportunity for participants to **influence the way standards can be developed for the Smart Cities of the future** and to explore where standards might facilitate the wider uptake of the Smart City concept.

Description and Objectives

In the aims of benchmarking the state of the art of Smart City (SC) developments and standards, as well as priorities for the current financing programme, we are organizing a half-day workshop structured into three parts: a plenary presentation session and two thematic sessions on smart cities and standards. We wish to introduce the ESPRESSO themes and discuss with the participants the Smart City areas / services important to them (section 2) and to consider the importance of generating the desired impact of processes and ongoing projects using open-standards and thus moving away from the traditional proprietary solutions and silo thinking.

Section 1 – Let's talk ESPRESSO

Firstly, we will present the ESPRESSO project and the rationale behind the systemic approach towards standardization. We will address the development of a European-wide Smart City Stakeholder exchange Network and open up discussion on a joint roadmap for standardization in the SC Landscape.

Section 2 – Thematic session: A state of art of Smart Cities

We aim at discovering from our participants the following:

1. Current trends of development for cities, the underlying drivers which challenge cities to position themselves competitively in the European market: Opportunities and Barriers;
2. Best practices, experience exchange and future plans: Smart City conceptual development strategies for local administrations
3. Aims and foci for future development: addressing the sectorial systems of the SC Concept

Section 3 – Thematic session: Open Standards and Performance Measurement

This section's scope is to discuss smart city integration, monitoring and performance measurement: most important areas in which Smart Cities should make use of standards and most important indicators. Our key questions are:

1. If and how cities or key stakeholders in the SC landscape measure the results of their projects, beyond standard performance indicators (provided for example through the Operational Programmes)
2. If stakeholders have defined a set of KPI at urban level which they use in a systemic way, or whether they still struggle with containerization;
3. If the smart projects in development or foreseen on different topics (mobility, e-governance, remote management systems, etc.) use proprietary interfaces and how to tackle the issue of vendor lock-in through open data and the formation of a smart city market.
4. What are the barriers faced in the process of assessing the performance (lack of interoperability, indicators, cost of collection and standardization of data silos administrative, legislative barriers, etc)

AGENDA OF THE MEETING	
10:00 – 10:30	Registration and welcome coffee
10:30 – 11:00	**Welcome and introduction by the host institution** – General welcome and an introduction to the city **The concept of Smart Cities** **Smart City principles of Rotterdam**
11:00 – 11:30	**Section 1 – Let's talk ESPRESSO** • *A systemic standardization approach to empower cities and communities* ○ *Presentation of the project, its objectives, results and outputs. Introduction of the SmaCStak* • *Examples of success stories in the efficient management of smart cities* • *Introduction of the workshop themes*

11:30 – 12:30	**Section 2 - A state of art of Smart Cities**
	• Working Group 1: opportunities, barriers and future development plans in key sectors Mobility, Energy and Smart grids, waste management site
	• Working Group 2: idem, key sectors governance, quality of life, safety
	• Short conclusions Plenary:
	  ○ How do we integrate these systems, solutions, services? Are there prerequisites for an integrated approach? (Introduction section 3)
	  ○ What priorities can we identify from the working groups pertaining to the sectorial systems?

12:30 – 13:30	Lunch
13:30 – 15:00	**Section 3 – Open Standards and Performance Measurement** • Roundtable discussion on the theme of standardization, integration and performance measurement in Smart Cities Conclusions and wrap up of the open / public section of the workshop

15:00 – 16:30	**Section 4 – ESPRESSO Storyboarding for Rotterdam**
	• Pilot in Rotterdam: Definition of priority sectorial systems and topics for piloting (e.g. What key areas of Smart Cities would like Rotterdam to focus on and test the standardization approach within the project)
	• Definition of constraints
	• Storyboarding: identification of first Use Cases for piloting – as this action is highly necessary at this stage (having been foreseen to start ever since kick-off) we need to have a discussion on the needs of the pilot city. Starting from the priorities and constraints identified earlier, this discussion should result in a number of „stories" identified together with the city and for each:
	  ○ An understanding of the scope and objectives (why the use case is needed)
	  ○ A short description
	  ○ An identification of the actors involved

16:30 – 17:00	Conclusions and wrap-up of the Rotterdam pilot meeting: definition of next steps for pilot preparation

12.2. ANNEX 2 – PILOT CITY BACKGROUND INFORMATION AND SYNTHESIS

12.2.1. ROTTERDAM: Relevant initiatives for ESPRESSO use cases

12.2.1.1. The Rotterdam Adaptation Strategy (RAS)

Rotterdam has a resilience stragety and is a memeber of the 100 Reslillient Cities Network of the Rockefeller Foundation.

The **Rotterdam Climate Initiative (RCI)**[14] was launched in 2006 with the aim of reducing CO2 emissions by 50% by 2025 while promoting the economy in the Rotterdam region. This is a more ambitious target than The Netherland's national target of a 30% reduction by 2020. This program is developed as part of the global **C40 Climate Leadership Group**[15], which is an international body aggregating several large cities wishing to fight against climate change, and in which Rotterdam is an Innovator City. Under the umbrella of the RCI, the Port of Rotterdam Authority, Deltalinqs, DCMR Environmental Protection Agency Rijnmond and the City of Rotterdam work as partners to enhance the sustainability of the city, the port and the industrial complex.

In the **Rotterdam Climate Proof programme**, climate change is seen as an opportunity instead of a threat. The goal is to make the city climate proof by the year 2025, by developing an integrated adaptation strategy to ensure that the city is completely resilient to impacts and externalities of climate change. As a result of this programme, the **Rotterdam Adaptation Strategy**[16] outlines four pillars:

1. Rotterdam as a leading centre for **water knowledge** and **climate change expertise**;
2. Investments for enhancing the attractiveness of the city and port for residents, companies and knowledge institutions
3. Adaptation innovations and knowledge as an export product
4. **Innovative water management** for an attractive city and stimulation of economic activity.

[14] See RCI - www.rotterdamclimateinitiative.nl
[15] See C40 Cities - http://www.c40.org/
[16] Rotterdam Adaptation Strategy, City of Rotterdam, Oct 2013, http://www.turas-cities.org/uploads/biblio/document/file/271/RCI_RAS_2013_EN_LR.pdf

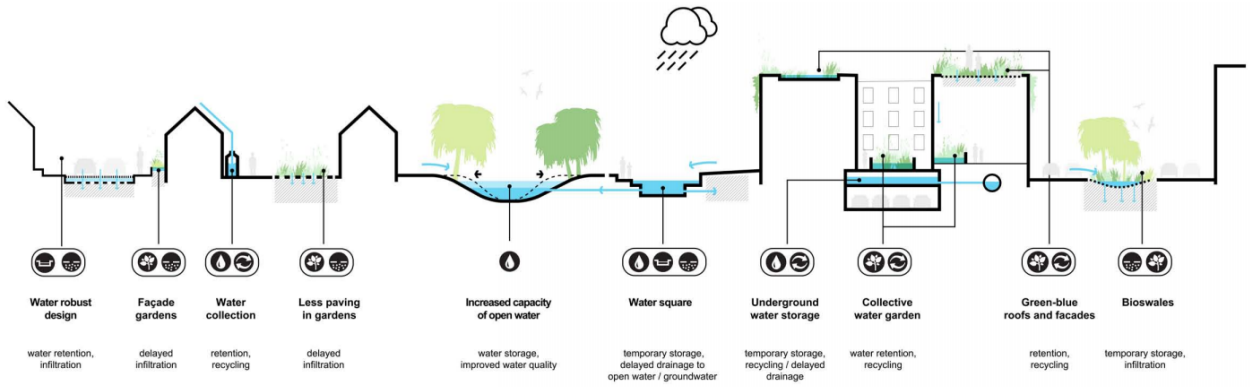


Figure 26 – Rotterdam Adaptation Strategy: Smart City infrastructure systems and Water Management as potential ESPRESSO Use Cases. Source: RAS

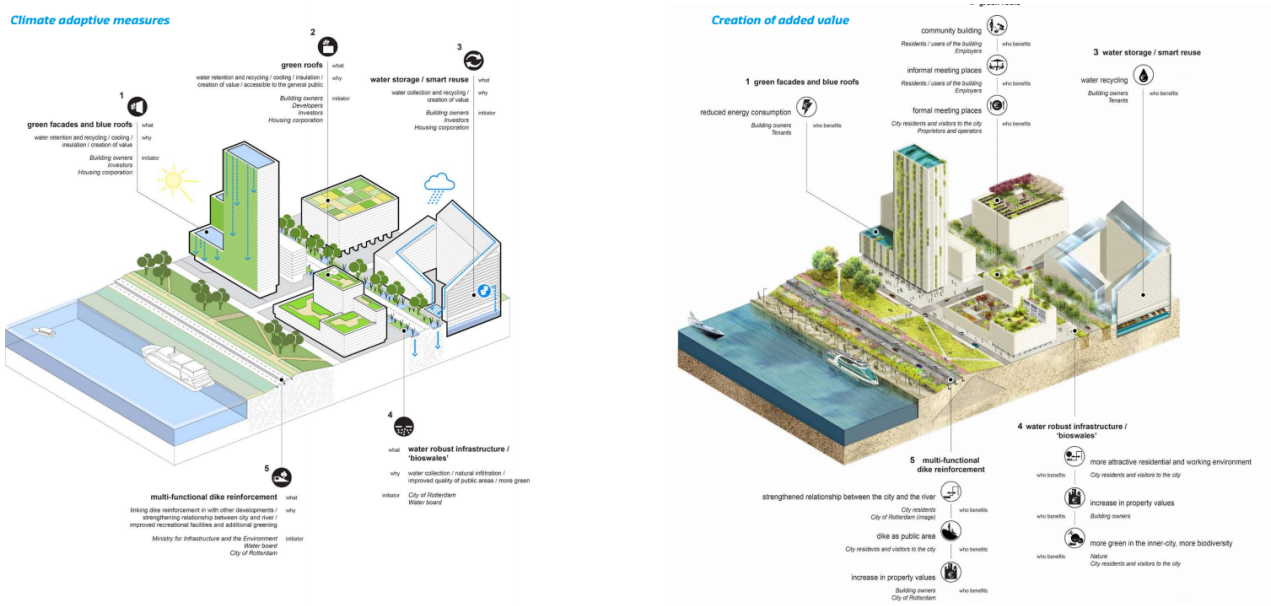


Figure 27. Perspectives for the compact city. Source: RAS.

A significant number of use cases on **water and water management systems, building management, intelligent infrastructure management and urban planning** can be drawn from the priorities identified within the RAS. Aligned with the strategy, there are already several ongoing initiatives capitalizing on Smart City technologies.

Case study. RainGain[17]: Fine-scale rainfall measurement and prediction to enhance urban pluvial water control

RainGain Rotterdam was part of a European Interreg project, which aimed to improve the prediction of pluvial floods in the urban environment. In Rotterdam, an innovative X-band radar was installed in September 2015, which enables highly

[17] See www.raingain.eu

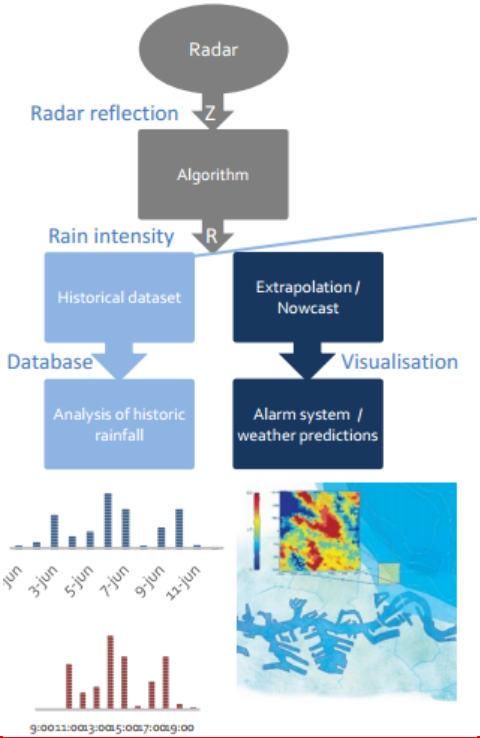
reliable and accurate precipitation measurements.

The Province of South Holland, Municipality of Rotterdam and Delft University of Technology participateed in the project, together with water authoroties which co-invested in the radar. The objectives were the following:

- To obtain detailed rainfall data at an urban scale („How much rain has fallen where?")
- To improve weather models by means of improved data quality.
- To enhance the knowledge on urban water system and thereby improve urban water management practice to make cities more resilient to rainfall induced floods.

The radar produces reflection images, which are being translated into rain intensity data through an algorithm. The intensity data can be used for two application purposes: 1) **historical dataset**, enabling analysis of historic rainfall data on specific locations (eg. 3Di sewage modelling tool), and 2) **extrapolation** / nowcast of rain intensity, generating rainfall predictions, albeit short-term (approx. 2 hr). Potential uses include:

- Integration with sewage modelling tool (3Di) for identifying bottlenecks in the hard core water system;
- Efficientizing the water systems based on higher quality rain data;
- Alarm systems for several stakeholders such as the Rotterdam airport, greenhouses (dynamic water management), urban mobility department (adjusting cycling flows, dynamic traffic management).



Requirements and interoperability considerations

For rainfall recording, a set of **rain gauges** with a 1-minute data sampling operated by the Rotterdam city and equipped with wireless real-time communication devices have been installed, together with the **X-Band radar**.

Sensors for water depth measurement in sewers have also been installed (pressure sensors equipped with wireless real-time communication).

The available municipality spatial datasets, a set of AHN-2 layers, which produced the Digital Terrain Model (DTM) using LiDAR of ground levels from an aerial platform.

Finally, a drainage urban pluvial flood model has been set up using Sobek-Urban[18], a Delft Hydraulics modelling software supporting the

[18] SOBEK - http://www.ipp-hydro-consult.de/visioncontent/mediendatenbank/090630132150.pdf , retrieved 29.05.2016

design of water systems and simulation of management problems in river and delta areas. Sobek-Urban uses the **OpenMI open interface standard** (OGC standard approved 2014).

According to Climate-KIC, Rotterdam is set to implement the Innovation Project **Smart Urban Water**, an extensive data network developed to collect data on sewer capacities in urban areas. **Smart Urban Water (SUW)** project facilitates local authorities to improve and provide better access to urban water management data networks. Therefore, it reduces water stresses associated with climate change, while generating business opportunities for SMEs[19]. The SUW is an example of a project in synergy with the prior initiative of RainGain. As Rotterdam is a lowland delta city with a sewer system which has very small slopes, it is prone to failures caused by small disturbances. The SUW project proposes better monitoring techniques, combined with advanced modelling, for an effective maintenance.

Potential Use Case: Standards for Smart Water Management

Across most of Europe and the world, current ICT systems for water management are proprietary and „ packed as independent products, support all management levels from the product development to the communication with management systems" (Robles, 2015)[20]. There is currently no common ICT reference model for water management processes, as local administrations and urban service providers use vendor-specific solutions which leverage on different methods, standards, data models and communication channels.

The heterogeneity of this particular city infrastructure management system is even higher, and the implications deeper, since for example in The Netherlands alone there are about 1500 companies involved in water technology. The Netherlands expects the costs for treating drinking water, managing the sewer system and treating waste water to rise to 4.4 billion EUR per annum by 2020[21]. The excessive market fragmentation in this particular sector further hampers the adoption of open standards and reference architectures.

Potential Use case definition

Developing a standard water management system, supporting interoperability with other applications such as GI Systems (the 3D City Model) and integration with city databases and informations regarding weather forecast, Rain Radar / Rain Sensor data, environment, soil information, land coverage (i.e. farms, greenhouses). The water management system should allow for remote management while providing a flexible system architecture which can be easily adapted to work with and integrate vendor specific solutions, thus making the transition smooth.

[19] Smart Urban Water project on the Climate-KIC Portal, retrieved 25.05.2016 - http://www.climate-kic.org/projects/smart-urban-water/

[20] Robles, Alcarria, Martin et.al, „An IoT based reference architecture for smart water management processes", Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, volume: 6, number: 1, pp. 4-23

[21] Holland Trade and Invest, retrieved 29 May 2016, http://www.hollandtradeandinvest.com/key-sectors/water/contents/water-technology

The digital city and the Rotterdam 3D City Model

Work on the Rotterdam 3D city model has initially started 7 years ago. The Model is based on the BAG (registration of addresses and buildings) and the elevation map (LIDAR) of the city . Every two years Rotterdam is scanned in strips using a helicopter . The city area has been scanned twice and therefore has a point density of at least 30 p/m2, while the port contains a minimum of 15 p/m2. The accuracy of the model is high, as 65% of the points are located within 10 cm of the actual position and 95% within 15 cm. The model is almost entirely created automatically, so the quality of the models is similar everywhere in the city.

In 2010, the 3D city model of Rotterdam was made freely available to anyone, online, via a download portal. The files are currently offered in the CityGML format.

Figure 28. The Rotterdam 3D city Model.

The 3D City Model is a stepping stone towards an information and communication platform open to interested stakeholders, on the topics of city development (and redevelopment). The further developments continue under two projects; Rotterdam 3D v2.0 and The Digital City Project. This last one represents the main use case identified by Rotterdam in their pilot workshop.

12.2.2. TARTU: Relevant initiatives for ESPRESSO use cases

There are several key best practice areas, especially pertaining to the Smart Governance and Participation sectorial system, and also new initiatives which can be further built on for the development of Standardization requirements:

12.2.2.1. Paperless Government (starting 2003)

38% of individuals interact with government services almost entirely online, and 95% of the 2013 tax declarations have been filed online. Within the parliamentary elections, electronic voting (implemented since 2006) accounted for more than 30% of all votes cast.

The technology behind the Estonian approach to personal data is **X-Road**, a secure data-sharing layer accessible through the internet and developed by Cybernetica AS, the privatised spin-off of the Institute of Cybernetics. All access to personal records is logged (under the principle „you own your data") and logs are secured using block-chain crypto-technology developed by another local technology company, **Guard time.**

The X-Road is open source and its security server source code is available on GitHub. One of the key elements of the e-Estonia paperless government system is the fact that the databases are decentralized, which means:

- There's no single owner or controller.
- Every government agency or business can choose the product that's right for them.
- Services can be added one at a time, as they're ready.

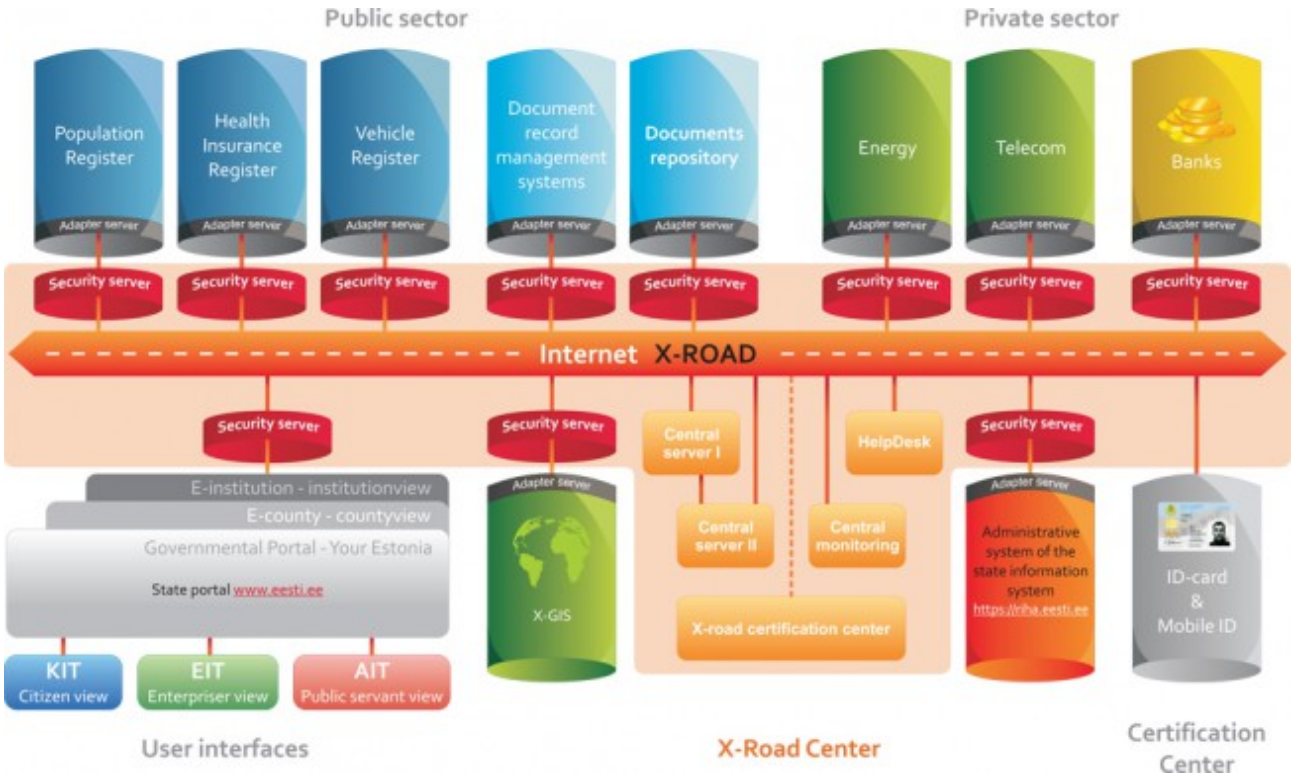


Figure 29. X-Road Architecture. Source: e-estonia.com.

Through this solution, a set of wide range of citizen-administration interactions are possible, such as: residence registration, checking personal data in the national databases, declaring taxes electronically, etc.

Smart Healthcare initiatives

Tartu University Hospital (the only medical care and training hospital in Estonia) and world-class research and development centres gathered around the University of Tartu (which belongs to the top 3% of world's best universities), strong private medical practices as well as biotechnology companies lay the basis for promising future developments.

Among notable initiatives, 4D Cities was an URBACT II project focusing on Health Innovation with an economic growth in the local context of the eight partners, Tartu included. Tartu is the centre of Estonia's medical and biotechnological landscape.

e-Health services in Estonia cover a wide array of services, under a three-layer development model of the Estonian Health Information System: Health insurance information, e-Prescription services, e-Ambulance services, Medical certificates, e-Laboratory, services for dental care, e-Consultation services, etc.[22].

The e-Estonia system allows **e-Prescription** as a centralized, paperless system for issuing and handling medical prescriptions. In 2015, 100% of all prescriptions in Estonia were being issued electronically.

The Estonian e-health strategy 2020 is in development, with the further key domains in focus:

- Quality of health data and infrastructure
- Orientation to person and personalized medicine
- Integral case handling and organizational cooperation
- Performance and quality of services evaluation / analytics
- Remote services.

Future developments envision an **„App Store"** as a user interface with the integration platform, integrating the eHealth central system and hospital information system.

Furthermore, an aspect which can be analysed in the ESPRESSO project is the topic of **Personalized Medicine:** the integration of the Estonian Genome Centre – University if Tartu (with over 50,000 donors in the database) with the e-Health Platform (1,000,000 citizens in the database) for the customization of healthcare - with medical decisions, practices, and/or products being tailored to the individual patient.

12.2.2.2. SmartEnCity Lighthouse project

SmartEnCity is a SCC Lighthouse Project approved under the EU Research and Innovation Framework Horizon 2020 started at the beginning of 2016, which partners Tartu, Vitoria-Gasteiz (Spain) and Sønderborg (Denmark). The pilot in Tartu aims to rebuild an existing city district with a Khrushchev-era planning into a smart and energy efficient area. The plan is to renovate 900 Khrushchev-era apartments in 23

[22] Artur Novek, Estonian eHealth Integration, https://www.mindtrek.org/wp-content/uploads/sites/7/2015/09/Artur-Novek-Estonian-eHealth-Integration.pdf

buildings for 8.2 million euros, and develop energy systems and an electric car network[23].

One of the main challenges is to **develop the smart city business models,** which are required to operate the new technologies, increase the efficiency of sensor technologies and implement the integrated planning model.

The Lighthouse project will offer a full solution package, interoperable between mobility, energy and building management systems and with pre-existing proprietary systems.

Given that the initiative is aiming at retrofitting and infrastructure renewal, there is a wide array of requirements stemming from materials, heritage protection, acceptance of new technologies, property ownership, social issues, logistics.

Figure 30. Pilot site of SmartEnCity in Tartu. Source: ECMI.

Figure 31. Representation of the SmartEnCities implementation in Tartu. Source: www.ubc.net.

[23] ECMI, „Smarten Tartu", 21 January 2016, https://ecmiindmath.org/2016/01/21/smarten-tartu/

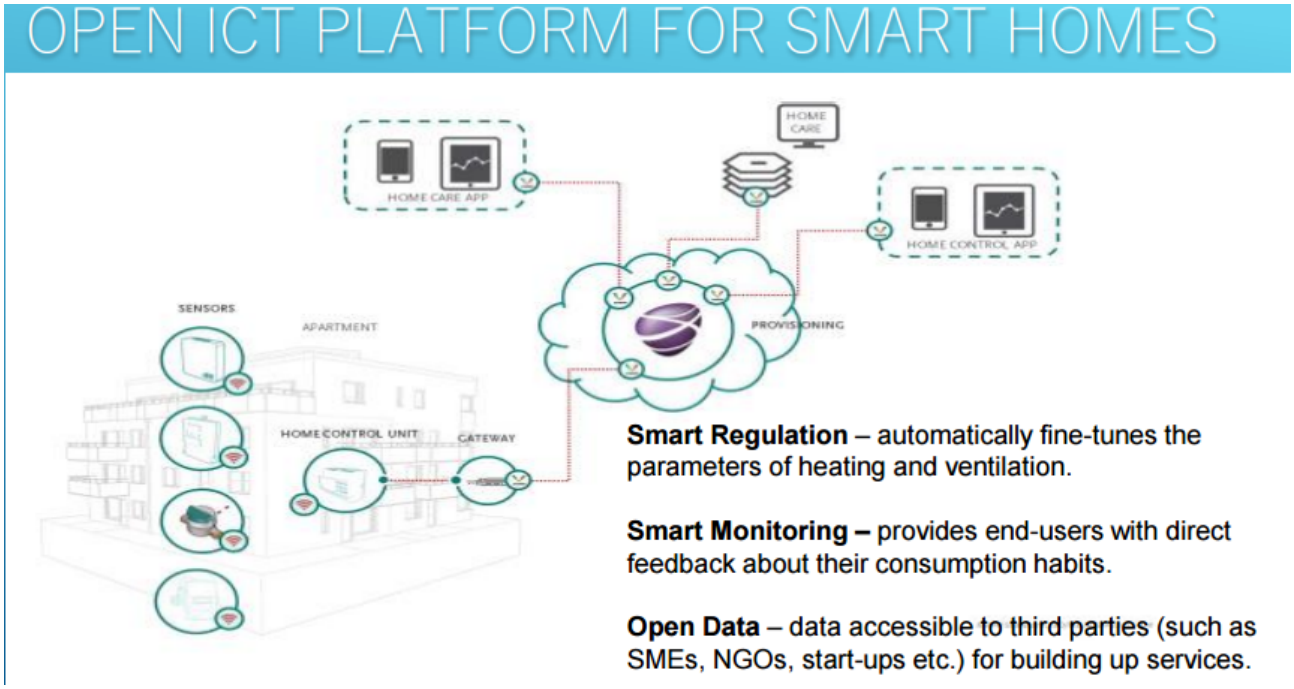


Figure 32. Reference architecture for the smart homes envisioned to be deployed through SmartEnCities, Source: www.ubc.net.

A first Use Case set for ESPRESSO to support the SmartEnCity project will be defined jointly by main Tartu Smart City stakeholders.

12.3. ANNEX 3 – ADDITIONAL CONSIDERED USE CASES

Participatory Urban Planning using scenario creation		
ID	**Sectorial System(s)**	**Subdomain(s)**
EUC-G-001	Smart Governance and Participation *(Primary)* Smart Urban Planning	
VERSION		
No.	**Date**	**Name / Affiliation**
01	25.05.2016	Sabina Dimitriu, ISOCARP
DESCRIPTION		
User Story description	*The City Hall planning department is developing a new integrated regeneration plan of one of its high-density residential neighbourhoods, a complex urban process which needs to rely on a participatory approach, including and consulting all relevant stakeholders on problem identification, solutions and concrete projects / visualizations. The Planning Department needs an online 3D platform to showcase the proposals, integrated with user interaction tools, which will allow citizens to view easy-to-understand visualizations and renders compare options, comment, leave feedback and consistently be kept updated with the proceedings.* *The City Hall Planning Department can login on the platform and upload the data pertaining to a new building and public space refurbishment project in one of the compact 1980s neighbourhoods, an area which will also host a newly-built day centre for at-risk children. Using a simple interface, they are able to identify and visually delineate the area of intervention, to insert the new proposed building structure of the kindergarten on-site and to modify the residential block facades to illustrate the proposed refurbishment aspect, colour palette, etc. The platform allows for a back-and-forth visualization of the present situation and the proposed one. It also supports interaction with the 3D objects, because the department needs to provide details in other forms as well: planning documentations, renders, sections, reports.* *Once the new proposal is integrated, an automatic alert is sent to citizens subscribed to the municipality's e-Planning platform. They are able to access the platform and visualize the proposals. They are also able to comment, share and provide feedback via the mobile and desktop application. For example, citizens may opt for different refurbishment materials and colours, or request that due to tree cut-downs on the future site of the kindergarten, the municipality should compensate by expanding a different green space or plant additionally in other areas.*
SCOPE AND OBJECTIVES		
Scope of Use Case	Citizen participation and involvement into the stages of design for large-scale urban planning and redevelopment projects becomes increasingly important to governments. Reaching out citizens through traditional workshops and meetings only proves ineffective as it leaves out certain	

	age groups, or incurs high costs otherwise. New participatory e-design and feedback tools would address this requirement and represent an effective method for collecting and processing user feedback and other data. Mixed reality technologies for planning are currently being developed separately from user interaction tools. **The scope of this UC is to bridge the gap between planning visualization tools and web-based open innovation and direct user interaction.**
Objectives	• To provide the municipality with an open interface supporting the showcase of new urban development proposals (renders, plans, reports); • To allow an open, transparent, real-time communication of planning solutions and proposals between the local administration (decision makers), citizens (beneficiaries of local community plans) and companies (stakeholders in the building industry, service providers, utility companies).
ACTOR LIST AND REQUIREMENTS	
Actors identified	• Local administration officials • Citizens and groups of citizens • Local organizations • IT Experts • Urban planners and professionals • Industries (construction companies, service providers)
Requirements	• Open Standards-built 3D model of the city supporting integration (addition, overlap) of proposals; • Able to work with just a web browser (optionally free plug-ins) and on low-end mobile devices available to most of the community; • Integration with commonly used virtual platforms or applications for user interaction; • Possibility for citizens to give feedback and leave comments (as registered „tickets") on proposals; • Possibility for user subscription and the sending of alerts / messages (i.e. to announce state of art, progression of proposal implementation, etc.)

Smart Participation through issue reporting interface

ID	Sectorial System(s)	Subdomain(s)
EUC-G-002	Smart Governance and Participation *(Primary)* *Transversal*	

VERSION		
No.	**Date**	**Name / Affiliation**
01	28.05.2016	Sabina Dimitriu, ISOCARP

DESCRIPTION	
User Story description	*A citizen wishes to report a non-emergency problem on his street (pothole, water pipe breakage, flooding, crossing signal missing, streetlight not*

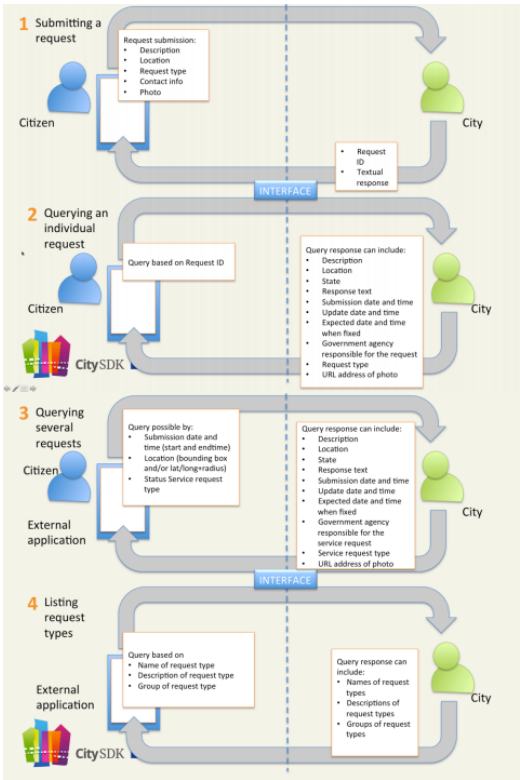
	working, etc.). Submitting a phone or in-person formal request to the municipality is tedious, requires more waiting time and is not accurate in terms of exact location of the problem, especially if the problem discovered cannot be identified by street numbers (i.e. as can be for example in a park). The citizen has the opportunity to download a municipal issue reporting app, which allows him to geolocation, describe and categorize the issue via a simple to use interface. After the submission, the citizen receives a unique issue ticket, so he can follow up or choose to be automatically informed when the problem is resolved. *The municipality can use the data from the submissions to 1) assess the problem, 2) send the appropriate intervention team,3) resolve the issue, 4) aggregate geolocation issues to determine underlying problems at urban scale based on location, type and frequency of reported issues. This way it can better understand either when a certain urban infrastructure becomes obsolete, or when services provided are insufficient (perpetual rubbish-on-street issues can pinpoint a problem with insufficient waste bins) and take the right countermeasures.*
SCOPE AND OBJECTIVES	
Scope of Use Case	Creation of an open interface which facilitates interoperable services, interaction and feedback loops between the citizens and the City Hall, as well as integration with pre-existing services and platforms of the municipality, open and legacy both (i.e. the BIM city model for statistical analysis of issue reports).
Objectives	• To source from citizens city-related issues and feedbacks through a unified and open interface • To geo-locate the reported issues and be able to effectively deploy resources where they are needed, as well as aggregate the data received and produce thematic maps using the city's GIS system and derive statistics • To integrate with web networks and social media and be able to instantly create accounts (i.e. `Sign in with Google`) for users which can be personalized with other contact information • To be able to interact with the citizen, record the issue, send push mobile messages • To allow for direct contact through other means directly via the mobile app (phone), "when all else fails" • To introduce a citizen buy-in system of `rewards` for problems reported
BEST PRACTICES AND REFERENCES	

The City SDK Project – Smart City Service Development Kit and its Application Pilots features a pilot on Smart Participation, which aims to create an open interface that acts as an issue-reporting channel between the citizens and the civil servants. The work is based on **the Open311 technology**, which is a standardized protocol for location-based collaborative issue tracking. The City SDK features a "meet-in-the-middle" approach, integrating current and future apps, existing services and the thematic pillars of the project (participation, mobility and tourism).

Other notable initiatives:

SeeClickFix (also using Open311 standard)

FixMyStreet (idem)



ACTOR LIST AND REQUIREMENTS	
Actors identified	• City hall and departments (public space administration, mobility and traffic, local police, city infrastructures, etc.) • Citizens • Service providers • IT experts • Local businesses • NGOs and other interested parties

Online participatory budgeting and expenditure maps		
ID	**Sectorial System(s)**	**Subdomain(s)**
EUC-G-003	Smart Governance and Participation	
VERSION		
No.	**Date**	**Name / Affiliation**
01	25.05.2016	Sabina Dimitriu, ISOCARP
DESCRIPTION		
User Story description	*The Municipality aims at moving the participatory budgeting processes online, via a public e-Budgeting platform open to the community, in order to ensure direct access to all stakeholder groups and an even participation in the decision. The platform needs to account for all stages of participation: submission of initial community concepts, display of developed proposals, platform for discussion, platform for secure voting.*	

	All information required on the projects lined up for funding needs to be ensured via the platform. *The e-Budget platform should be additionally connected to a municipal expenditure map, showing investments in key sectors across the city and neighbourhoods as well as their details (project fiche), stage of development / implementation, costs incurred. Voted participatory budgeting projects should be added to the map and the citizens should be able to receive alerts and information on the progress of implementation.*
SCOPE AND OBJECTIVES	
Scope of Use Case	To fulfil the requirement of the citizens to always be informed on the expenditure of the public budget for urban projects, and to provide a collaborative platform between the municipality and the citizens which will act as a community interest mediator, facilitating the implementation of participatory governance projects with the widest reach possible
Objectives	• To supply an open showcase platform for the city investments, integrating information coming from several municipal departments into one city model containing georeferenced information on projects and investments (both in deployment as well as proposed / future projects) • To allow citizen interaction with the platform and the possibility to upload comments and media with respect to the participatory budgeting projects considered • To allow secure e-Voting on proposals using a unique citizen ID • To allow an open, transparent, real-time communication of planning solutions and proposals between the local administration (decision makers), citizens (beneficiaries of local community plans) and companies (stakeholders in the building industry, service providers, utility companies).
ACTOR LIST AND REQUIREMENTS	
Actors identified	• Local administration officials, municipal departments • Citizens and groups of citizens • Local organizations, NGOs, advocacy groups • IT Experts • Urban planners and professionals
Requirements	• Open Standards-built 3D model of the city supporting integration (addition, overlap) of proposals; • Able to integrate georeferenced information coming from several municipal departments and to integrate with pre-existing vendor-specific software and solutions • Platform with a "public" part (i.e. content which all citizens can see and interact with) and "secure" part (the participatory budgeting secure e-Voting module, which lets only users registered with a unique ID to vote once in every PB round) • Able to work with just a web browser (optionally free plug-ins) and on low-end mobile devices available to most of the community;

	• Integration with commonly used virtual platforms or applications for user interaction;

Real-time mobility planning		
ID	**Sectorial System(s)**	**Subdomain(s)**
EUC-G-004	Smart Mobility *Transversal*	
VERSION		
No.	**Date**	**Name / Affiliation**
01	26.05.2016	Sabina Dimitriu, ISOCARP
DESCRIPTION		
User Story description	*The Municipality Planning and Transportation department needs a 3d visualisation tool that allows real-time monitoring of traffic flows and motion patterns in origin-destination matrices visualisation. The city has a 3d BIM and collects real-time information from public transport vehicles, sensors, and telematics devices.* *Sub scenario: They wish to further visualize the population distribution (including pedestrian) within the city centre using wireless cell-phone tracking to determine flows and accessibility.* *Sub scenario: They would like to integrate the mobility planning platform with the database of the culture and heritage department and touristic offices, in order to assess, based on flows and clustering, the attractiveness of public urban space, landmarks and infrequent events (i.e. open air festivals) and subsequently to optimise traffic during and immediately after large-scale events in the city centre.*	
SCOPE AND OBJECTIVES		
Scope of Use Case	Population distribution through mobile phone data, intra-urban accessibility and attractiveness	
Objectives	• To visualize and measure parameters and variations • To compare and evaluate proposals (assisted decision making) • To integrate parameters and open data sets available for the city • To display integrations of datasets • To run scenarios and identify complex problems and externalities of a given urban intervention • To assess impact and perform ex-ante and ex-post simulations	
ACTOR LIST AND BENEFITS		
Actor identified	**Benefits (direct / indirect)**	