European Commission

Leveraging the power of location information and technologies to improve Public Services at Local Level

Case Study Analysis

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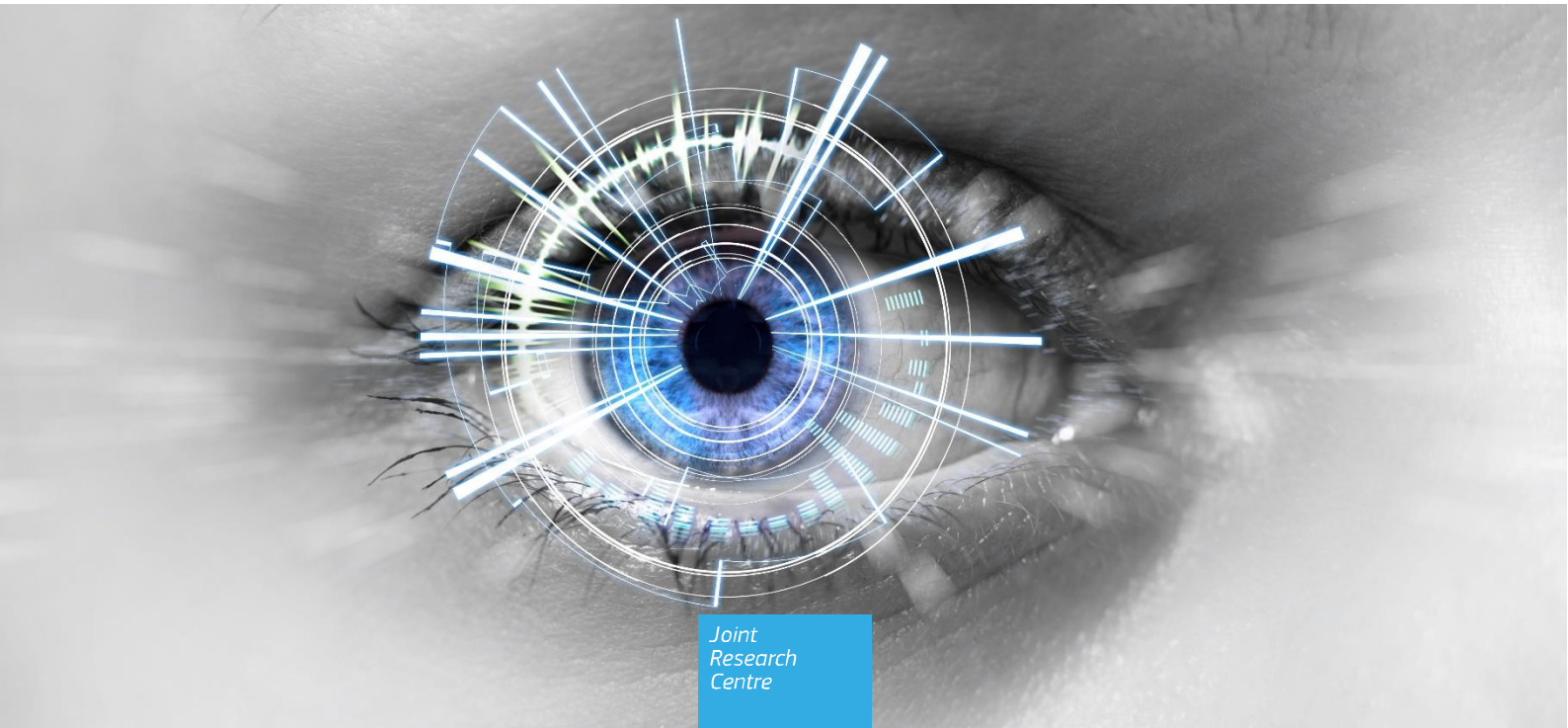

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Executive summary

The project "ELISE Lot 1 - Leveraging the power of location information and technologies to improve Public Services at Local Level: An EU-wide Analysis" is part of a broader effort of the European Commission's Joint Research Centre (JRC) and the Digital Economy Unit (JRC.B.6) in particular. It falls under the **ISA² Action ELISE**: European Location Interoperability Solutions for e-Government. Understanding how digital transformation influences the value generated by public services is crucial for public management.

As part of the ELISE Action, this work focuses specifically on the public value generated from location-enabled public services. These case study analyses follow a **state-of-the-art report** (Barker, et al. 2021) and **conceptual framework** (Vancauwenberghe, et al. forthcoming). This document aims at validating the conceptual framework by testing its core components and their relative importance in adopting and upscaling location-enabled public services.

Location-enabled public services "are defined as those that leverage location data and technology in a meaningful way to help strengthen public services by driving public service innovation and generating public value" (Barker, et al. 2021). These services are usually developed within the interplay of inter-institutional settings, capacity, and consensus. This document presents evidence of the test of the conceptual framework and provides valuable insights on determinants, implementation and value in real case studies across different European local and regional governments. It attempts to respond to the questions *How is the adoption and diffusion of location-enabled public services carried out? What influences their adoption and diffusion? What impact and value do location-enabled public services achieve?*

The **theoretical background** of this work lies into Yin (2008), which states that case-study analysis can be used to explain, describe, or explore events or phenomena in the everyday contexts in which they occur. These can help understand and explain causal links and pathways resulting from adopting location information and technologies to improve local and regional public services. Building on Bartlett and Vavrus, this part of our report adopts a "Comparative Case Study Approach [that] encourages simultaneous and overlapping attention to three axes of comparison [sic]: […] The horizontal axis compares how similar policies or phenomena unfold in distinct locations that are socially produced (Massey, 2005) and "complexly connected" (Tsing, 2005, p. 6). The vertical axis insists on simultaneous attention to and across scales (see also Bray; Thomas, 1995; Nespor, 2004, 1997). The transversal comparison historically situates the processes or relations under consideration." (2017, 914).

The **case studies** analysed in this report are:

- Machine Learning for Crop Recognition in the Autonomous Province of Bolzano; (Italy)
- Amsterdam Public Eye for Crowd Monitoring; (Netherlands)
- Limerick's Fight Against Noise pollution; (Ireland)
- Cascais Operational Control Centre – Covid War Room; (Portugal)
- Ravenna's Platform to Report issues in the city; (Italy)
- Ahrweiler Recovery after the Flood Through a different addressing system; (Germany)
- Public Domain Maintenance in the city of Leuven; (Belgium)
- Remote Areas Accessibility in Navarra; (Spain)
- Traffic Accidents Monitoring Service in Pilsen; (Czechia)
- Citizens' Science against Pollution in Brussels Region. (Belgium)

Within the conceptual framework, our research identified six components: context, inputs, transformation, outputs, outcomes, and evaluation. The **findings of our research** show that several factors within the framework positively influence location-enabled public service adoption and implementation, since location-enabled public services are usually developed within the interplay of inter-institutional settings, capacity, and consensus. Our research suggests that location-enabled public service adoption and implementation are positively influenced by both internal and external factors. First, the local agenda might refer to the urgency and relevancy of an issue and particular local characteristics that need to be adequately addressed. Second, past choices and digitalisation efforts are a decisive positive factor whenever they encompass past decisions of service digitalisation and technological capability strengthening. Third, the assignment of clear responsibilities for innovation and a clear

innovation strategy are fostering location-enabled public service adoption. Therefore, adopting location-enabled public services seems to prosper when competencies and innovation attitudes are already present. Adopting and implementing location-based data and technology does not generally seem to be a technical matter. The technologies vary widely in their positioning concerning the technological frontier from a technological perspective. Adoption and implementation of location-based data and technology are instead a managerial matter. They are the result of an organisation responding to a particular context, identifying needs, crafting appropriate objectives to address those needs, and generating value for its stakeholders. Organisations adopting and implementing location-based data and technology produce short-term related outputs that are usually efficiency-driven and produce operational value. Social and political value, on the other hand, are more difficult to measure and difficult to translate into operative measures.

Future research should therefore focus on the one hand on the difficulties in measuring impacts and the lack of a structured measurement culture to understand their roots and find potential paths to overcome them; on the other hand, limited citizens' involvement in these services shows that co-production is still poorly addressed. The role of users and, especially, of citizens should thus be analysed in a threefold perspective: the users' satisfaction, their experience and the usability of the service; the factors that are responsible for paving the way for co-production efforts; the characteristics of solutions that are fit-for-purpose in terms of public value creation. The first point will also be incorporated in future work of the authors, as the foreseen next steps include exploration of different methodologies, including potential focus groups, additional interviews and reviews of the feedback on certain apps. In parallel, a literature review will delve into some preliminary aspects of the second point, regarding current approaches to citizens' perspective from the digital government standpoint.

1. Introduction

1.1 The relevance of digital transformation in public services

Understanding how digital transformation influences the value generated by public administrations delivering services is fundamental - not just for civil servants governing their functioning, but also because the quality of public services is closely related to the trust in government and public institutions. In the European Union (EU), digital innovation at the regional and local level is having an increasingly important role (Chantillon, Crompvoets, and Casiano 2020; Living-in.EU 2019). Digital innovation and related digital transformation help the EU reach the goals and objectives set by both the European Commission and the Ministers responsible for Digital Transformation within EU Member States. In this context, the Berlin Declaration (2020) and the Tallinn Declaration (2017) affirm the importance of interoperability. Indeed, the European Interoperability Framework has contributed to launching the present work (EU Ministers in charge of eGovernment Policy and Coordination, 2020; Ministers in charge of eGovernment policy and coordination from 32 countries of the European Union and the European Free Trade Area, 2017). Besides those two Declarations, also the Digital Europe Programme, the Living-in.EU Join, Boost, Sustain Declaration, the European Strategy for Data and the Communication on "Building the data economy" (COM(2017)9) have been of crucial importance in shaping the trajectories of digital transformation in both public and private sectors.

Drawing on existing theories such as new public governance (Osborne 2006) and public service logic (Osborne, Radnor and Nasi 2013), we argue that effective digital transformation in public services' delivery derives from the pervasive exogenous force of digitalisation, public authorities' institutional capacity, and the values of communities in their context. Additionally, it is critical also for the interaction between the latter two factors. Often, previous research has failed to recognise that the public service delivery process includes users' voluntary or involuntary involvement with their values and beliefs throughout the whole public service delivery cycle. Their participation becomes even more fundamental with the digital transformation, which empowers service users to participate in and shape each step of the service delivery cycle from design to assessment (Nabatchi 2017). In addition, the interplay between providers with their institutional capacity and recipients plays an essential role in determining the success or failure of public services and the value generated by the latter. This is particularly relevant at the local level, that is responsible for the delivery of many services, being the closest level to citizens. Potential users of digital public services include several types of stakeholders, such as public sector employees, residents and other individuals that link with the territory in which the service is active, such as tourists or commuters, firms and intermediaries. For this study, we will use the term users when dealing with those stakeholders that use a public service – in this case, a location-enabled one – while we will use the term citizens when referring in general to any *lay actors* who are members of the public as citizens, clients, and customers with interest in public services (Nabatchi 2017).

While output goals are readily assessable, outcomes are challenging to measure, especially in the private sector. For example, in a model of market performance (Porter 1990), the measurement of the contribution of innovations to the performance of firms and their contribution to a country's GDP can rely on various economic and financial indicators (OECD 2005). In the public sector, assessing the value created by innovation is a challenge due to the absence of a single unified indicator shared across the public sector. Also, other challenges refer to the data collection processes when outcomes are observable and biased as over-estimation in the reporting on the organisation's innovations (Arundel, Bloch and Ferguson 2019, Cucciniello and Nasi 2014).

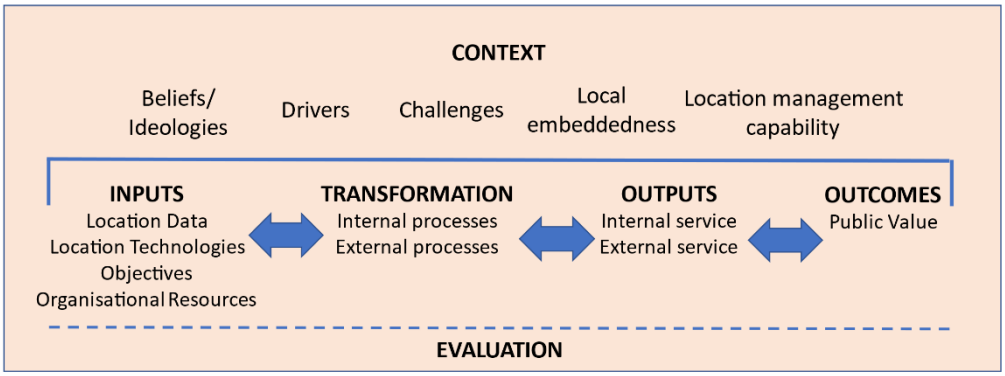
The objective of this work is to adopt a case study method approach on the use of location data and technologies in local or regional public services and to assess the replicability and scalability of the cases across local and regional governments in Europe. According to Yin (2008), case studies can explain, describe or explore events or phenomena in the everyday contexts in which they occur. These can help understand and explain causal links and pathways resulting from adopting location information and technologies to improve local and regional public services. , Ultimately, this research delves into innovation in public services as an instrument to achieve operational, social, or political public value and how to scale and replicate this achieved public value. Such analysis requires an understanding of the context of public services, as affected by wicked problems (Head 2008) that are present in complex and interconnected environments. A wicked problem is one for which each attempt to create a solution changes the understanding of the problem. Wicked problems cannot be solved linearly because the problem definition evolves as new possible solutions are considered or implemented, depending on the context. These problems cannot be solved with a unique one-way solution and, at times, are not solvable at all. For instance, the fight against climate change does not have a simple solution. It requires acting on several

policy domains in at least a majority of the world's countries. Every solution one can think of will undoubtedly generate resistance in some parts of the involved societies. Multiple stakeholders also characterise with multiple interests and expectations around the same issue and, in turn, have different preferences and judgements over public organisations' performance solving those issues (Boyne 2002, Cucciniello and Nasi 2014, Venkatraman 1986).

Additionally, this study aims at testing the validity of a (conceptual) framework (Vancauwenberghe, et al. forthcoming), developed earlier by the authors, that considers what public administrations have to govern successfully to introduce location-enabled technology in public service delivery. The conceptual framework further explained in the third section of this document allows one to understand the actual and potential impact of location-enabled services on public value creation via public services offered by local or regional administrations. Furthermore, given the embeddedness of the study in the ELISE Action, interoperability is of crucial importance since location-enabled public services are often embedded in a web of services based on similar location data. Therefore, the framework has to allow also an understanding of the scalability – the increase of service in size or scope - and replicability – the duplication of the service in another temporal or geographical location -of the services, and of potential barriers – which create public value – in other local and regional administrations. Therefore, the target audience of this framework, and this related report, are policy makers from European public administrations, including the local and regional levels.

The framework consists of six components: (1) context, (2) inputs, (3) transformation, (4) outputs, (5) outcomes, and (6) evaluation (see Figure 1). In particular, this study recognises that there may be several external and internal inputs, such as the objectives, the organisational resources, (location) data, and (location) technologies that may influence the implementation of technological innovation in location-enabled public services and the potential for public value creation. Location-enabled public services, including the case studies reviewed in this study, are "services provided by public authorities which depend on effective management or use of location information" (Boguslawski, et al. 2020). Therefore, their location component is essential to creating value. They can be services that regularly use location-enabled technologies or make innovative use of them.

Figure 1. Conceptual Framework: Relations between Context, Inputs, Transformation, Outputs, Outcomes and Evaluation. Source: *(Vancauwenberghe forthcoming)*



1.2 Scope of this document

Box 1. Introduction to the ELISE Lot 1

The project "ELISE Lot 1 - Leveraging the power of location information and technologies to improve Public Services at Local Level: An EU-wide Analysis" is part of a broader effort of the European Commission's Joint Research Centre (JRC) and Digital Economy Unit (JRC.B.6) in particular. It falls under the ISA² Action ELISE: European Location Interoperability Solutions for e-Government.

The ELISE Action is a package of legal/policy, organisational, semantic and technical interoperability solutions to facilitate efficient and effective electronic cross-border or cross-sector interaction between European public administrations and between them and citizens and businesses in the domain of location information and services, supporting Digital Single Market (DSM), Better Regulation (BR) and Public Sector Modernisation (PSM) goals. It is aligned with the proposed focus of ISA² on European public administrations, businesses and citizens, and with the need to ensure that best practice interoperable solutions are deployed across the European Union (EU).

In light of the above, the overall aim of our project is: "to provide practical guidance, convincing value propositions, and a list of priorities for further policy action, which help to improve the quality and delivery of public services by the meaningful and innovative use of location data and technology at local and regional level. Conduct an in-depth mapping and critical analysis of recent initiatives, emerging solutions and their possible impacts, thereby organically structuring the information available at local and regional level, and investigating new practices - together with their replicability and scalability potentials - and suggest possible future pathways for the evolution of public services in the EU".

The work presented here is based on a *state-of-the-art research* (Barker, et al. 2021) and a conceptual framework (Vancauwenberghe, et al. forthcoming) that considers what public administrations have to govern to introduce location-enabled technology in public service delivery successfully. It consists of six components: (1) context, (2) inputs, (3) transformation, (4) outputs, (5) outcomes, and (6) evaluation.

After the definition of the conceptual framework, this study is aimed at a case study analysis that builds on and refines the building blocks of the conceptual framework. The goals of this work are to adopt a case study approach on the use of location data and technologies in local or regional public services, test the validity of the conceptual framework, in order to draw broader findings insights with a view to the replicability and scalability of the cases across local and regional governments in Europe. Two actions are taken to achieve this goal: a content analysis of relevant documents collected from the selected case studies and interviews with stakeholders and experts.

1.3 Structure of this document

The following section (Section 2 – Methodological Approach) will outline the case study selection methods and selection results at the beginning. It will highlight the main elements of the methods for data collection, including the interview protocol. Section 3 - Case study analysis will delve into the case studies through a general overview and a detailed account of each case. Section 4 – Results from the comparative analysis will underline the main elements of interest derived from the comparative analysis. Finally, Section 5 - Conclusions will shed light on the policy implications arising from the research.

2. Methodological approach

2.1 An overview of case study analysis

As already underlined, according to Yin (2008), case studies can explain, describe or explore events or phenomena in the everyday contexts in which they occur. These can help understand and explain causal links and pathways resulting from adopting location information and technologies to improve local and regional public services.

A case study design is a fundamental task in conducting rigorous case study analysis. The methods for choosing and analysing cases can scarcely be separated. Some elements are fundamental to ensure a rigorous study of the phenomena under investigation, including the study's questions and propositions, the units of analysis, the logic linking the data to the propositions and the criteria for interpreting the findings.

The case selection criteria depend on the types of research questions that researchers want to investigate: descriptive, exploratory, explanatory. The questions of this study are exploratory, and they are aimed at investigating innovative solutions, their potential and actual impact, their replicability and scalability, and interoperability.

Building on Bartlett and Vavrus, this research adopts a "Comparative Case Study Approach [that] encourages simultaneous and overlapping attention to three axes of comparison [*sic*]: horizontal, which compares how similar policies or phenomena unfold in locations that are connected and socially produced; vertical, which traces phenomena across scales; and horizontal, which traces phenomena and cases across time" (2017, 914).

2.2 Design of this case study analysis

Authors defined a set of criteria to assess which cases could be the best object of the analysis - that is, which ones could bring the broadest and most profound understanding of the dynamics of location-enabled public services' implementation, replicability, and scalability. The authors defined eligibility criteria based on our previous work on the State-of-the-art (Barker, et al. 2021) and Conceptual Framework (Vancauwenberghe, et al. forthcoming), literature suggestions, and discussions among authors and the JRC. The criteria, clustered around relevant dimensions, were:

Innovation

Innovative use of (location) data, whether data are used in new ways within the organisation, the sector or the policy area (e.g., existing data used for new purposes, new types of data such as dynamic datasets, or merged datasets from different sources).

Innovative (location-enabled) technologies, that is, the level of adoption of cutting-edge technologies (Barker, et al. 2021)[1]

Maturity and Readiness

Maturity of the lead organisation in the use of the technology, can be classified as Pioneer, Follower, Late adopter, Laggard (Rogers 2003)[2]

Degree of disruption of location-enabled technologies, which is the level to which location-enabled technologies are embedded within the service delivery process (e.g., minimal use, support to processes, end-to-end technology adoption).

Interoperability

Interoperability, that is, the integration of systems to exchange data and improve service delivery.

[1] Within T1, these were aligned to the OGC geospatial tech trends and emerging trends and included Artificial Intelligence, Machine learning, Cloud Native Computing, Edge Computing, Blockchain, Immersive Viz: VR, MR, AR, Connected Autonomous Vehicles, UxS/Drones, 5G Cellular, Urban Digital Twin.

[2] This classification is based on the universe of location-enabled public services, not just to case studies.

Public Value

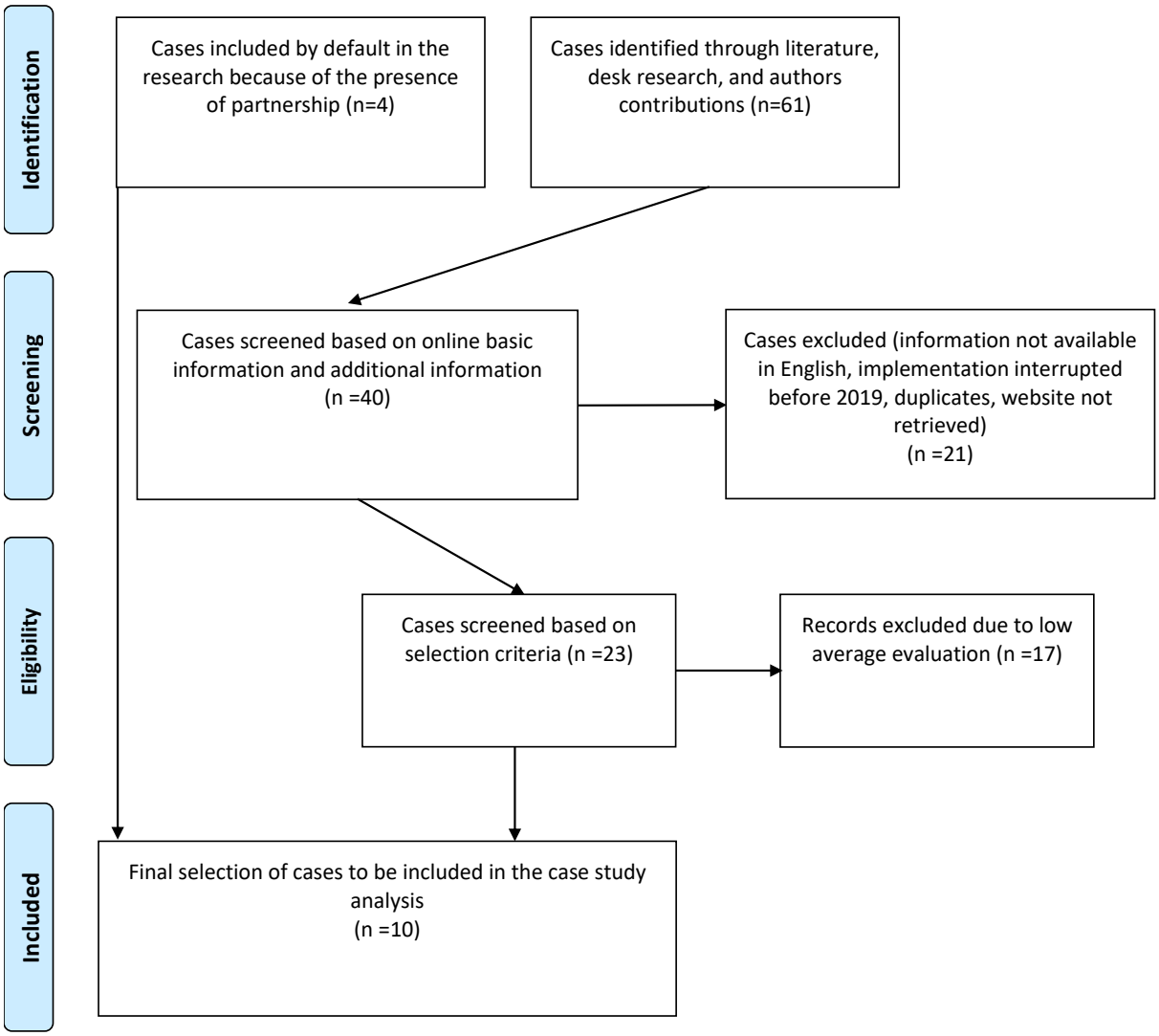
Value generated or destroyed[3], that is the actual or potential assessment of outputs, outcomes and value (i.e., the definition of Key Performance Indicators –KPIs-, use of methods, actual assessment and reporting).

Use, that is, the participation of the target population in the public service delivery as foreseen by the public service design (e.g., adoption rate, number of active accounts).

Citizen engagement, that is, the degree of participation of citizens in the design, production, and delivery of the service.

The complete list of cases to be evaluated through the outlined selection grid was built on a preliminary list developed by the authors throughout previous work (Barker, et al. 2021, Vancauwenberghe, et al. forthcoming). This list was consolidated with further suggestions from the authors and JRC. The final list consisted of 65 cases, of which 21 were excluded in the pre-evaluation phase for varied reasons, such as limited availability of online information, duplications and other reasons. Each case was evaluated on the basis of the selection criteria and further assessed through desk research, resulting in a final list of 10 cases. The full list of candidates and selection criteria are included as annexes to this document.

Figure 2. PRISMA flowchart representing the case selection process (Moher, Liberati, Tetzlaff, and Altman 2009)



[3] Note that the notion of "destroyed value" was included to allow for the selection of case studies that could be evaluated both as potentially successful or failed

2.3 Data collection protocol

The case studies are intended as practical applications of location data and technologies by local and regional governments to show possible pathways for replication and scaling. In order to get the desired information, in parallel with the case study selection, the authors drafted and discussed the case study protocol. This protocol had the purpose of:

- proposing a possible methodological framework (e.g., research question, criteria for selecting stakeholders, the structure of interviews);
- addressing the overall process; and
- presenting the following steps and deadlines.

As a first and preliminary step, the authors defined the research questions of this qualitative analysis:

"How is the adoption and diffusion of location-enabled public services carried out? What influences their adoption and diffusion? What impact and value do location-enabled public services achieve?"

The protocol envisaged two different methods of data collection in order to identify the multifaceted nature of these realities as they unfold and involve different actors, including:

- desk research: analysing documents produced within each case about the innovative solution adopted and its context, building on the evidence collected in the State of the Art analysis and the pillars of the conceptual framework;
- interviews: interviewing key actors at the study sites or remotely. Semi-structured interviews seemed the preferable option to get an overview of the cases and deepen our understanding of these critical issues, allowing for a certain degree of flexibility even in a pre-defined scheme of questions (see also Annex 1).

A total of 47 interviews were conducted, with the distribution presented in Table 1.

Table 1. Interviewee roles and number of interviews

Role	**Number of interviews across cases**
Project manager and/or service/process owner	15
CIO and/or technology officer	9
Supplier whose products and services are key determinants in the implementation processes and partners of the service under analysis	8
Street-level service manager	5
End-user	5
Other	5

3. Case study analysis

3.1 Overview of selected cases

As a general overview, the following cases were analysed:

Table 2. List of selected cases

Case Study Title	Policy Domain	Public authority	City/Region (Country)
Permit delivery for the use of public space in Leuven	Economic affairs- Transport	Municipality	Leuven (Belgium)
Remote areas accessibility in Navarre	Economic affairs – Other industries	Autonomous community/ Province	Navarre (Spain)
Traffic Accidents Monitoring Service in Pilsen	Economic affairs- Transport	Municipality	Pilsen (Poland)
Citizens' science against pollution in Brussels Region	Environmental protection – Pollution abatement	Region	Brussels (Belgium)
Machine Learning for crop recognition in the Autonomous Province of Bolzano	Economic affairs - Agriculture, forestry, fishing and hunting	Province	Bolzano (Italy)
Amsterdam Public Eye for Crowd Monitoring	Economic affairs - Transport; Recreation, culture and religion - Recreational and Sporting Services	Municipality	Amsterdam (Netherland)
Limerick's fight against noise pollution	Environmental protection – Pollution abatement	Municipality	Limerick (Ireland)
Cascais Operational Control Centre – Covid War Room	General Public Services n.e.c. - Emergency Services	Municipality	Cascais (Portugal)
Ravenna's platform to report issues in the City	Housing and community amenities n.e.c	Municipality	Ravenna (Italy)
Ahrweiler's recovery after the flood through a different addressing system	Public order and safety n.e.c.- Emergency Services	District	Arwheiler (Germany)

In order to discuss the results of the comparative case study analysis, we first extensively describe each case. We then outline the main points of interest, based on the components included in the conceptual framework (Vancauwenberghe, et al. forthcoming). In the conceptual framework developed within this study, the first

component is the Context. “The Context refers to specific features and dimensions of the local and regional environment that must be considered for the transformation and value creation of local and regional public services”. The context was further defined around five attributes: beliefs and ideologies, drivers, challenges, local embeddedness, location data and technology management capability. The next component is Input, which usually “refer[s] to attributes that the transformation process taking place within a local or regional public administration and focused on a local or regional public service delivery, can use”. They are location data, location technologies, objectives and organisational resources. Then, “Transformation refers to the approach of (re)designing and (re)developing public services in order to create public value, whereby there is a radical innovation instead of an incremental innovation (Osborne and Brown 2011).” One can distinguish internal processes, that include the governance, and external processes, that include the stakeholder involvement. The next component is output, that is “the products of the transformation process of local or regional public services”, that can be divided into internal and external services. Finally, “outcomes refer to results produced by transformation processes of public services at local or regional level. In contrast with outputs, the outcomes measure the value or impact of local or regional services”.

3.2 Case studies in detail

As underlined in the 2.3 – Data Collection, each case study included a desk research analysis of relevant documents and several interviews with key stakeholders. In both instances, the different environments in which the analysed cases were conceived and the various degree of organizational complexity have caused differences to exist among cases. For example, in some cases the number of interviewees was four because the project’s implementation did not include a large ensemble of individuals. We appreciate this diversity being part of the case study analysis, yet we also worked to guarantee sufficient comparability among cases.

3.2.1 Machine learning for crop recognition in South Tyrol

3.2.1.1 Introduction to the service and its context

South Tyrol is an autonomous province situated in the very north of Italy on the border of Austria that covers 2.5 % of the Italian territory. The population of 450.000 inhabitants (corresponding to 0.8 % of Italy's population) consists of 3 language groups: two-thirds German speakers, less than one-third Italian speakers and some 20.000 Ladin speakers.

Agriculture is an important economic sector for the province. South Tyrolean agriculture is currently organized in a highly professional way and effective in the fruit growing sectors, viticulture and forage growing. The collaboration between agriculture, craftsmanship and tourism is incentivised to enhance local agricultural products and the authenticity of the tourist experience. In South Tyrol, the total agricultural land amounts to 455,840 hectares, equal to almost 62% of the territory; however, due to the steepness of the land, only 209,232 hectares (i.e. 28%) are exploited as cultivated, grassland or pasture. Forests cover about half of the surface of the province. 22,000 owners manage the forest areas, with 53% privately owned forests, for the most part farmers. As a result of the difficult terrain, the average area per farm is 11.9 ha, which ranks well below the 16 hectares European average. Also, farmers that produce wine and fruit, with an average surface of 1.1 and 2.5 hectares, are significantly below the national average. Livestock farms usually cover larger areas. However, a considerable part of their useful surface consists of pastures and mountain pastures and is, therefore, less productive and cannot be cultivated using mechanical equipment. Grants and tax credits (either financing operating expenses or capital investments) are estimated to account for 9.3% of agricultural production, thus can make a real impact on the financial sustainability of farming businesses.

The provincial government has a high degree of fiscal autonomy from the national government, which requires provincial politicians and administrators to manage local taxes and national and European transfers responsibly. This includes the farming grants that need to be managed efficiently by tackling the risk and costs of overpayments (either generated by fraud or mistakes). The nature of the terrain and the fragmentation of farming businesses increases the complexity of inspecting the application of the law when it comes to eligibility for farming grants.

The provincial department of agriculture has a dedicated EU structural fund office that is in charge of coordinating the advisory, eligibility determination, approval, reporting related to paying farming grants, while the payments, once the eligibility is verified, and refunds/collection of overpayments are carried out by an

independent provincial agency. Farming grants are part of a broader provincial Rural Development Plan that aims to:

- stimulate the competitiveness of the agricultural and forestry sector and of the agricultural and food industry;
- ensure the sustainable management of natural resources and climate action;
- achieve a balanced territorial development of the economies and rural communities, including creating and maintaining jobs.

The total funding of the 2014-2020 rural development plan was approximately 360 million Euros; European funding coming from the European Agricultural Fund for Rural Development (EAFRD), the main financing vehicle for European farming grants, was about 21 million Euros per year in both 2019 and 2020.

Funding contributions to farmers vary depending on the size of the cultivated area and the type of crop declared by the owner of the farm. The correct allocation of public contributions to farmers living in South Tyrol is, therefore, a prominent issue that must be carefully handled to manage public money efficiently.

The primary objective of the AgriML project was to reduce the time required to assess overspending in farming grant management for the provincial Government. The award of grants requires the farmers to submit an application to the provincial Department of Agriculture, Forestry, Tourism and the Civil Contingency Office of EU Structural Funds. Once the application is approved, the funds are disbursed by a sister provincial agency in charge of all payments. This agency is still part of the provincial government but has a high degree of independence to comply with EU audit requirements.

By law, the provincial department needs to audit at least 6% of the application forms submitted by farmers. These can have a wide variety of mistakes, such as the wrong size of the fields, the wrong type of crops, and temporary structures built to store agricultural equipment that is not accounted for. These mistakes can happen because of the complexity of the submission, because of forgetfulness; in some cases it may be fraud, but it is very hard to detect. Out of this 6% of applications that get audited, the department of Agriculture can point out those that require field inspections. This triggers a workflow that issues an order to the provincial Forest Guard agency to carry out the inspections. If an inspection report proves that there were mistakes in the declarations, the payment agency then needs to claim back the overpayment. Historically, the overall process, from initial approval and disbursement to collection of overpayments, can take up to two years, which is inefficient because of the many paper-based handovers and it is ineffective because the overpayments could have been used for something else in those two years. This approach also makes it difficult to efficiently scale inspections beyond the minimum threshold of 6% of awarded payments.

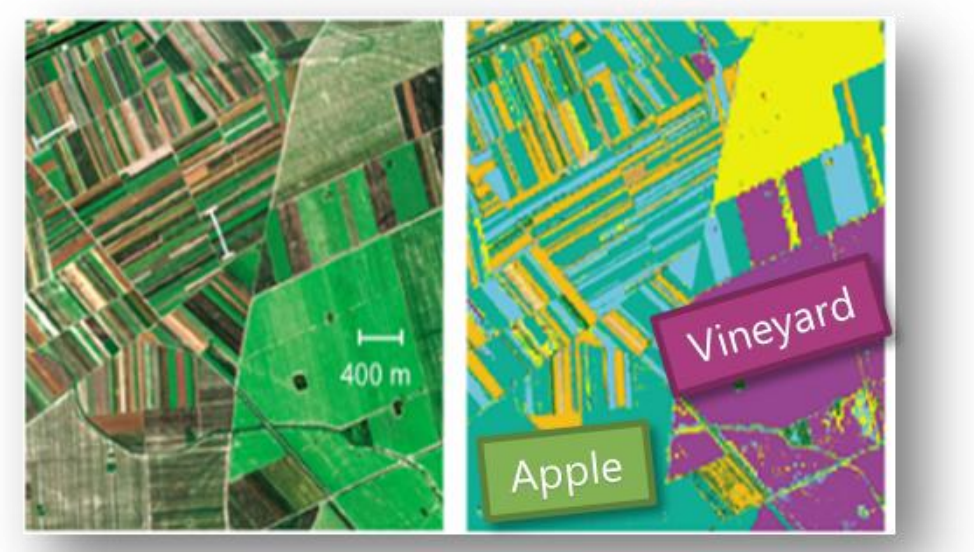
Therefore, the objective of the AgriML pilot project was threefold:

- Allow civil servants at the department of agriculture who intake the applications to check more than 6% of applications, for mistakes in the declaration of the type of crop, at the time of their submission;
- Prioritize inspections for the Forest Guard agency;
- Enable the payment agency, so that overpayments can be caught sooneror avoided altogether.

"Historically, the overall process, from initial approval and disbursement to collection of overpayments can take up to two years, which is inefficient because of the many paper-based handovers. This approach also makes it difficult to efficiently scale inspections, beyond the minimum threshold of 6% of awarded payments." Project Sponsor

The objective of the project was to test a Machine Learning (ML) algorithm that could automate the business workflow that the provincial department of Agriculture carries out to verify the eligibility for a grant once a farmer has submitted their declarations or to verify subsequent changes in the type of crop. Having these automatic controls available would make it possible for the province to have proactive control over agricultural land and to anticipate and optimize the inspections required by public funding procedures, thus enabling time- and cost-saving benefits and ensuring a higher quality of service for farmers that rely on these grants for both operational and capital expenditure.

Figure 3. Crop classification proof of concept – Source: SIAG and NTT



In partnership with NTT DATA, SIAG developed the Proof of Concept (POC) to demonstrate the feasibility of using ML techniques to detect different crop types present in South Tyrol's satellite images.

The satellite images used were a combination of high-resolution, one-shot images from Airbus and low-resolution time-series images from the European Space Agency (ESA) Sentinel project. Different ML approaches were applied to the two sets of images.

In the implementation phase, NTT DATA used anonymized crop polygons provided by SIAG, retrieving satellite images of the corresponding cultivated fields in the territory of the Autonomous Province of Bolzano. NTT DATA implemented and trained convolutional and recurrent neural network models to model the relationship between satellite images and the types of crops present in the corresponding polygon labels.

The AgriML project combined competencies and resources from SIAG, NTT DATA, and Microsoft. SIAG was tasked to provide NTT DATA with a sufficient number of polygons containing the type of crops declared by the farms, to accompany the process of creating the prototype so that it reflects the needs of the Autonomous Province of Bolzano, and to evaluate the results obtained. NTT DATA was responsible for selecting the infrastructure and architecture of the ML solution and implementing the solution. NTT DATA used Microsoft Azure for data-pre-processing/pipelining and Azure GPU (Graphics Power Units) virtual machines for the computation. The software code was based on open source.

In the prototyping phase, the solution reached 87% classification test accuracy for recurrent neural networks based on temporal low-resolution satellite images and 84% classification test accuracy for convolutional neural networks based on high-resolution satellite images.

The intended next step is to continuously improve the algorithms and scale the solution to embed the ML output into the business process and the supporting SAP grantor management system application; the architectural design already enables such integration and scalability. However, the system has not yet been scaled to full production, mainly because of organisational change challenges.

"Technical interoperability, either related to location data or other components of the solution, was not a major concern. Interfaces between existing farmland polygons, the existing grants management application software, and other systems are ready, or easy to build, thanks to the modularity of cloud solutions that deliver RESTful API integration capabilities out of the box." IT Provider

"Despite the fact that the Department of Agriculture was in principle interested in AI enabled automation, the public administration conservative attitude resulted in change management and organisational inertia that slowed down scaling the AgriML project" Project Sponsor

Analysed documents include:

- Final pilot project presentation produced by SIAG and NTT. This presentation provides an overview of the project's technical and organisational aspects, as well as the inputs (budget, technical resources, etc.), outputs and post-PoC expected outcomes;
- Province of South Tyrol Department of Agriculture website[4];
- South Tyrol 2020 Agriculture Annual Report authored by Eurac Research (Tappeiner, Marsoner and Niedrist 2020). This annual report analyses the key characteristics and economic indicators of the Agricultural Sector in the South Tyrol province;
- Annual report on the implementation of the South Tyrol Rural Development Plan (Autonome Provinz Bozen Süditorl 2020). This annual report presents the key performance metrics of the multi-year Rural Development Plan of the South Tyrol provincial government.

3.2.1.2 The service and the elements of the Conceptual Framework

3.2.1.2.1 Input

"Inputs refer to attributes that the transformation process taking place within a local or regional public administration and focused on a local or regional public service delivery, can use" (Vancauwenberghe, et al. forthcoming).

The provincial government maintains a GIS (Geographic Information System) database with the polygons of farming fields. This database archives all the information reported by the farmers in their declarations and the data collected during inspections. The agricultural land polygon database is based on the centralized infrastructure of the province, managed by SIAG. The geospatial information of the agricultural land polygons is used to measure the size of the area and record the type of cultivation, which determines the various forms of contribution that can be requested.

The government is also supporting farming field inspections with images from aerial/drone surveys, but these surveys are only carried out once every two years and they are very expensive. To make the farming grant eligibility and the audit process more efficient, the province needed a tool to review images more cost-effectively and in a timely manner. So, they started a PoC to apply ML to satellite image recognition to recognize the most common types of crop in the area: apple orchard, vineyard, or grass meadow.

They used two different techniques in parallel to determine which one was the most cost-effective[5]:

- They applied proven neural network methodologies (VGG16 and 19, ResNet) and trained them on high resolution, more expensive images bought from Airbus – these were images captured once at a point in time with 30cm precision;
- They developed a new neural network approach exploiting capsule layers[6] to process the spatial information and LSTM[7] and an attention mechanism[8] to learn from the temporal sequences of the satellite images of Sentinel-2 taken over the course of one year;

The service built during the PoC includes two environments:

- A training environment built on local servers used to train the ML algorithms on the satellite images. The training process is very resource-intensive (the training took approximately 12 hours on an Nvidia K80 GPU);
- An inference environment built in the cloud where the satellite image recognition is matched with the Shapefile input coming from the provincial GIS database. The end-user (Department of Agriculture agent) can select one or more polygons from the agricultural GIS using select and identify tools. Based on the selected fields on the map, an automatic process is invoked, which produces an

4 https://www.provincia.bz.it/agricoltura-foreste/Default.asp

5 Capsule Layers: https://arxiv.org/abs/1904.10130; Self-attention Transformer: https://arxiv.org/abs/1910.10536; Convolutional Neural Network: https://www.nature.com/articles/nature14539 ; VGG16/19: https://arxiv.org/abs/1409.1556

6 https://en.wikipedia.org/wiki/Capsule_neural_network

7 https://en.wikipedia.org/wiki/Long_short-term_memory

8 https://machinelearningmastery.com/attention-long-short-term-memory-recurrent-neural-networks

output Shapefile. This Shapefile is passed to the REST API exposed by NTT Data, which delivers a prediction of the crop type present in the various fields in the Shapefile, crop coverage and confidence associated with the Shapefile key. At the end of the processing, the result obtained by the REST API is displayed on the map, showing the coverage and the type of cultivation predicted by the Machine Learning algorithms with different colours;

For both the training and the inference environment there are two separate data pipelines, one for the high-resolution and one for the low-resolution images.

The cloud environment was set up by NTT using Microsoft Azure capabilities:

- Azure Functions as the programming, deployment and cloud management environment;
- Azure Data Factory for the data pipelining and orchestration;
- Azure ML Studio for ML algorithm deployment and delivery. The ML algorithm development was based on open-source platforms Tensorflow and Python;
- Azure SQL Server to archive the computational output.

The PoC budget amounted to approximately €250,000.

SIAG's input included:

- Applying its farming grant domain knowledge to build the business case for the PoC;
- Identifying NTT Data, a long-term partner of SIAG, as the right supplier to build and co-fund the PoC;
- Leading the project management for the PoC, including communication with the provincial department of Agriculture and benefits realization;
- Providing NTT Data with access to the GIS containing the farmland polygons;
- Defining the strategy for an as-a-service target operating model, where an external provider would run the computational inference capabilities to deliver back the output to be integrated with the SIAG-owned grant management application.

3.2.1.2.2 Transformation

“Transformation refers to the approach of (re)designing and (re)developing public services in order to create public value, whereby there is a radical innovation instead of an incremental innovation (Osborne and Brown 2011).” (Vancauwenberghe, et al. forthcoming).

SIAG is the main driver of digital transformation in South Tyrol. It was set up in 1992 and operates as a public corporation owned by the provincial government (78% of shares), the regional government (1%) and the consortium of the province's municipalities (21% of shares). In 2020, SIAG had an annual turnover of approximately € 45 million, as a result of the continuously expanding role it plays in designing, procuring and operating IT solutions for the provincial government, many municipalities and related agencies in domains like healthcare, education and public transport. SIAG is essentially the intelligent nexus between the public administration technology needs (demand) and the variety of partners that offer IT solutions (supply). It is organized around two main lines of business, the "Run" line of business responsible for infrastructure and operations and the "Production" line of business responsible for solution design and development, which houses core vertical expertise for the different areas of the administration. Staff functions like service management, project management and supply are responsible for strategic coordination, dissemination of best practices and alignment with end-users in provincial departments and municipalities.

SIAG engages with its customers in two ways, by responding to new requirements from the public administrations, which it serves, or by spearheading new developments where it sees opportunities to help improve the efficiency and effectiveness of the public administration. SIAG's proactive development of novel solutions is a major source of innovation, such as in the case of AgriML. In fact, SIAG, because of the domain knowledge acquired by operating the core grant management application software, identified the potential for the provincial department of Agriculture to realize the benefit of a new ML-based solution to recognize the types of crops. SIAG's proactive approach to innovation tends to encounter resistance because there is a lack of innovation mindset in the provincial government; hence to succeed it would require better coordination across the end-to-end process life cycle. The provincial government tends to overestimate the risks and underestimate

the benefits of new technologies, thus preferring to fall back on tried and tested practices, even if the business case is in favour of the innovation.

Even though the Department of Agriculture was in principle interested in AI-enabled automation, the public administration conservative attitude resulted in change management and organisational inertia that slowed down scaling the AgriML project. In particular, it became apparent around three main factors:

- There was a lack of understanding of the end-to-end process across inter-institutional networks. Since the Department of Agriculture is only responsible for intaking applications and auditing the compliance of at least 6% of them, they do not have an incentive to apply a technology that could benefit the payment agency, which incurs the brunt of the cost, trying to recover the overpayments. The Department also has a limited incentive to help Forest Guards prioritize their field inspections more efficiently;
- The Department of Agriculture was afraid that machine learning would impose a sort of "control" on business operations, while the intent was to help them become more efficient and effective;
- The civil servants within the department were afraid of losing their jobs because, for some of them, one of the main daily tasks is to manually check the farmers' applications, and they felt they would have to change job if the AgriML was scaled;

As a result of this organisational resistance, SIAG is planning to re-start the conversation with the Department of Agriculture, while trying to avoid speaking about AI and automation and instead applying a "Google approach", where SIAG owns the technical knowledge and builds alignment with civil servants by discussing the outputs and outcomes of innovation, instead of its features and functions.

3.2.1.2.3 Output

Outputs refer to the products of the transformation process of local or regional public services" (Vancauwenberghe, et al. forthcoming), which can be divided into internal and external services. The main output of the proof of concept phase was the validation of the machine learning algorithm capabilities to recognize the right type of crops:

- 87% classification test accuracy on temporal low-resolution satellite images;
- 84% classification test accuracy on high-resolution satellite images.

3.2.1.2.4 Outcome and evaluation

"Outcomes refer to results produced by transformation processes of public services at local or regional level. In contrast with outputs, the outcomes measure the value or impact of local or regional services" (Vancauwenberghe, et al. forthcoming).

The direct beneficiary of the application is intended to be the agents at the Department of Agriculture who carry out verification checks on the type of crop present on a field with apple orchard, vineyard, or grass meadow and embed the ML output into the grant eligibility verification business process. The main expected outcomes are related to operational efficiency:

- Being able to audit 100% of applications in quasi-real-time, instead of auditing only 6% after the payment has already been issued;
- Shorten the time required to trigger an inspection;

The indirect beneficiaries are expected to be for:

- The payment agency, because they will have fewer refunds to process;
- The forest guards, because they can better prioritize field visits;
- The farmers, who will benefit from a more accurate and efficient allocation of funds.

3.2.1.2.5 Replicability and scalability

The solution is not replicated elsewhere, but it could easily be applied to any other region of Europe; however, the algorithm would need to be retrained on different sets of images for the specific location/terrain/crop. To extend the solution to different types of crops, NTT estimated about €27,000 and two months to re-train the

algorithm. This estimate has been elaborated considering 6 types of crops and assuming that the crops can be identified based on satellite images. Furthermore, it is assumed that the labelled data (polygons of the fields and label with the type of cultivation) are available and that they are sufficiently numerous (in the order of thousands for each type of cultivation) and well balanced (equally distributed for each type of cultivation).

SIAG and NTT estimated that to scale the solution to full production for the South Tyrol Department of Agriculture, the additional investment would be €150,000 and the annual operating costs would be €15,000.

3.2.1.2.6 Lessons learnt

The AgriML pilot provided multiple lessons learned on both the organisational change and technology fronts.

From an organisational change standpoint, AgriML highlighted the gap between technology innovation driven by SIAG and risk-averse business users in the provincial government, in this case in the Department of Agriculture. This lack of alignment showed aspects of inter-institutional dependence, culture and skills.

- Inter-institutional dependence requires the inclusion of stakeholders in all stages of the technology innovation process, from design to benefit realization; one stakeholder can take leadership of the project orchestration and execution, based on competencies and resources that they have available, but continuous strategic alignment must be ensured;
- The coordination among stakeholders will also help uncover business interdependencies, such as the relationship between the Department of Agriculture's responsibility for grant eligibility and the payment agency's responsibility for disbursement and refunds, so that all direct and indirect benefits can be mapped;
- Dialogue among stakeholders and documentation of all benefits and risks will also accelerate the identification of gaps in mindset and skills early on, so to invest the appropriate amount of money and time in communication and training to affect change;

From a technological innovation standpoint, the AgriML project can be considered an early adopter of ML among public administrations in the field of satellite image recognition and agriculture, thus providing lessons learned both for the development and training of algorithms and for the solution architecture to deliver them.

- The high performances of low-resolution ML models were achieved thanks to the combination of spatial and temporal information from the free imagery available from the Sentinel-2 provider. Such spatial and temporal combination was not feasible, due to the limitations of availability for the commercial imagery for this PoC, but should be considered. The models underwent various cycles of testing and optimization to exploit the information coming from all the available bands, especially in the non-visible spectrum (e.g. infrared), to enhance the discriminative power of the solution and to identify and remove the cloudy instances of the satellite images of Sentinel-2 and focus on the interesting and informative observations;
- The cloud-based architecture set up for computational purposes prioritized simplicity and modularity over pure performance. In fact, by deploying three complementary layers of capabilities - (1) data pipelining, (2) algorithm development and delivery, and (3) orchestration and administration - instead of building a vertically integrated stack or running machines in parallel, the architecture makes integration of new capabilities much quicker, affordable and scalable; for example, it allows to ingest data sources into the data pipeline, to deploy retrained/updated algorithms, and to update operating systems, database and security patches. Of course, the risks of this approach are a higher dependency on cloud services and skills (in this case Microsoft Azure). For usage scenarios that require dynamic, real-time updates of the algorithm training, additional cloud services and skills could be necessary, because such a training environment would require higher performing GPU-based computational resources to be deployed in the cloud.
- Technical interoperability, either related to location data or other components of the solution, was not a major concern. Interfaces between existing farmland polygons, the existing grant management application software and other systems are ready, or easy to build, thanks to the modularity of cloud solutions that deliver RESTful API integration capabilities out of the box.
- The machine learning algorithm optimization is the only area where specific investment was necessary to deal with different types of satellite images, which required investments in new skills

and testing of different types of algorithms. All other lessons learned from the project point to critical success factors that are common to many other digital transformation projects, whether location data and technology-related or not.

3.2.2 Amsterdam Public Eye for Crowd Monitoring

3.2.2.1 Introduction to the service and its context

The city of Amsterdam has a population of approximately 740,00 people within the city centre and 1,160,000 in the urban area. This number is dwarfed by the large number of annual tourists. Before the pandemic, the city received an average of 5.35 million international visitors and up to 17 million visitors when including day-trippers and Dutch locals. The city also has permit requests for approximately 300 civic events per year for over 5000 people. While Covid-19 has dramatically impacted the tourism and event industry, the industry is starting to rebound.

Tourism and large events are significant contributors to the city's economy. According to Amsterdam's Economic Affairs Department, before the pandemic, in 2019, the tourism tax represented €133.6m in income for the city, generated a total economic value of 18.6 billion, and fueled 10% of the city's jobs. However, this high level of tourism has also led to a series of social and environmental challenges, including reduced livability for residents, unsafe situations due to overcrowding as well as risks to the city's historical sites, including the UNESCO world heritage listed canal system.

> *"Amsterdam is a very crowded city with lots of tourists, which can lead to some unpleasant but also sometimes unsafe situations" – Project Manager for Smart Mobility, City of Amsterdam's Chief Technology Office*

When the Municipality began planning for the 2020 UEFA European football championships, they decided to pilot a new crowd management tool to help monitor large public areas to promote safety, ease mobility, and re-shape tourism. The city already had a crowd monitoring technology in selected areas of the city – the Crowd Monitoring System Amsterdam – to measure footfall; however, due to technological limitations, the existing system could only be deployed in small areas such as individual streets.

It is within this context that the Municipality initiated the Public Eye Project. The project was developed by the Municipality's Chief Technology Officer (CTO) in partnership with the smart city design cooperative Tapp and the consultancy Life Electronic. The Public Eye system is one tool in the city's crowd-management and mobility toolkit.

The objective of the project was to pilot a privacy-by-design crowd monitoring system compatible with the city's ethical data values (Tada-waarthe) and Amsterdam City Data Strategy 2021-2022[9]. The Strategy is composed of 18 actions and focuses on giving citizens greater control over their data and minimizing data collection to that which provides public value. After having reviewed other potential location-based technologies, such as Wi-Fi access monitoring, the project team decided that a video analytics solution was most appropriate.

While the project was first initiated to manage large events, the scope of the project gathered speed and was expanded in the context of the Covid-19 pandemic. Despite the sharp fall in tourists and large-scale events, the city realized that the tool could be used to support public health management and measures to promote social distancing. This also helped to generate additional internal and political support for the location-enabled service.

The Public Eye tool uses the city's existing traffic management CCTV cameras and applies an algorithm to monitor crowds in selected public spaces. The video footage streamed from these cameras is processed by a video classification AI algorithm, which generates data on location (coordinates), size, speed, density, and direction of crowds. In the piloting phase, the solution reached 95% classification accuracy. The algorithm turns the video feed into numbers and heatmaps. This means that citizens are not identifiable. The camera footage is not saved or recorded, apart from a small number of images at the outset for algorithm training. The data generated is processed on a city-owned encrypted network.

The Public Eye Project was developed to provide an *internal* service for the city administration, as well as an *external* service for citizens:

[9] https://www.amsterdam.nl/innovatie/data/amsterdamse-datastrategie

(1) Service for the Municipality

The service has been developed primarily for the Public Space and Mobility Department. The data from the Public Eye sensor is connected directly to the department's broader Crowd Monitoring System Amsterdam (CMSA). Additionally, a dashboard has been created, which includes heat maps for the different pilot locations and flags when areas or facilities are overcrowded or, in the context of the pandemic, the level of social distancing breaches. This dashboard is used by the municipality as an operational tool to support proactive mobility management so that staff can act before a situation escalates or becomes unsafe. For example, if an area becomes too busy, staff can take action to disperse the crowds, such as implementing one-way measures.

Other departments, such as the public health authorities and the police department, can also access this data; however, they are not the primary user or owners of the tool and the platform. Further, Public Eye provides an API that can be shared with facility managers and event organizers to help them effectively manage their events and properties.

A new dashboard is also being developed to provide insights based on historical data, including the development of a predictive model. Once completed and sufficient historical data generated, these spatial insights are expected to be useful for strategic planning, both for the Public Space and Mobility Department but also for others in the Municipality, such as the Planning and Sustainability Department.

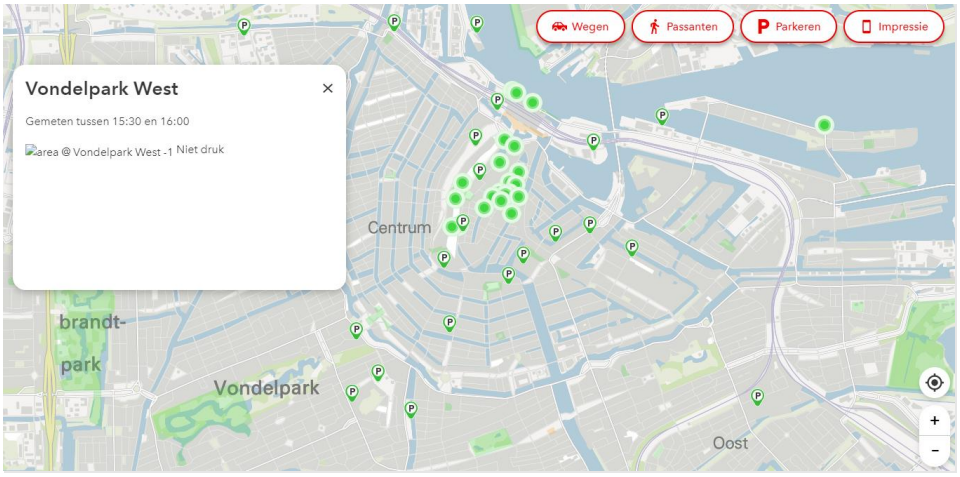
(2) Service for Citizens

A Busyness Application has also been developed to provide the general public with information on how busy public spaces are based on a traffic light system. The objective of the service is to help citizens plan their journey and avoid overcrowded areas. This is available both as an app and online.

This information is also being communicated to citizens in public spaces through digital kiosks. Further, in response to the Covid-19 pandemic, the project team decided to pilot a new communication system in outdoor fitness areas in Marineterrein. If the Public Eye system detected people were too close to each other, LED strips would turn blue, and if the space was at full capacity the strips turned red. This feature was added to help the public make risk-informed decisions rather than to police or enforce Covid-19 restrictions.

"We don't want to use these technologies to police or punish people at all. They're more just for insights and helping the public to make the right decision." Project Manager, Tapp

Figure 4. Public Busyness Webpage and App – Source: https://druktebeeld.amsterdam.nl/



Public engagement is also a key part of the Public Eye Project. Information is displayed under each camera to explain the project. The Project also included a research project with the Responsible Sensing Lab, which equipped the cameras in the Marineterrein Living Lab with shutters that open and close to show when sensors are active – some of the cameras also had a button that the public could press to temporarily 'opt out' and close the shutter. The objective of this supplementary experiment was also to encourage the municipality to be more mindful about whether the cameras need to be on indefinitely.

Since its initiation, the project has been piloted in the Marineterrein historical naval dock (a privately-owned designated smart city living lab), Johan Cruijff Boulevard near the city's football stadium, Vondel Park, and Dam Square. The pilot phase has now concluded, and the Public Eye system will remain operational in these locations. The next step of the project will be to scale the system to other city hotspots. Further, the CTO is continuing to innovate and explore additional functionalities that can be added to the tool, including counting cyclists. They are also piloting other tools to add to the broader CMSA, including the use of radar technology to monitor crowds.

The Municipality has also taken steps to share the solution. The AI algorithm is open source and has been added to the city's Algorithm Register to promote transparency and make the solution available to other cities across the Netherlands and beyond. To date, the solution has not been replicated; however, the Municipality has noted growing external interest in the Public Eye Project.

Analysed documents include:

- Amsterdam Data Strategy 2021-2022[10]. The Amsterdam Data Strategy was developed by the Municipality of Amsterdam and includes principles for the storage and use of data about citizens and the city.
- Public Eye Information Pack, 2021 (Municipality of Amsterdam, Tapp and Life Electronic 2021) produced by the Municipality of Amsterdam, Tapp and Life Electronic; this presentation provides an overview of the project, including a description of outputs, user profiles, and pilot locations.
- Johan Cruijff Arena Living Lab Program Website[11]; this website provides an overview of the Living Lab Program at the Johan Cruijff Arena. The Public Eye Project was piloted as part of this Program.
- Marineterrein Amsterdam Living Lab Website[12]; this website provides an overview of the Marineterrein Living Lab. The Public Eye Project was piloted in this test-bed environment.
- Amsterdam Smart City Website[13]; this website provides an overview of the Amsterdam Smart City (ASC) organisation which is part of the Amsterdam Economic Board. ASC is involved in the Marineterrein Living Lab and acted as an advisor to the municipality for the Public Eye project.
- Public Busyness Webpage[14]; this webpage is one of the dashboards available to visualize data collected from the Public Eye system. The webpage is available to the public and can be used to determine how busy certain parts of the city are.
- Amsterdam Sensor Register[15]; this webpage provides a map and register of all the sensors deployed by the municipality across the city. The register is there to promote transparency and includes the CCTV cameras leveraged in the Public Eye Project.
- Amsterdam Algorithm Register[16]; this webpage provides an overview of algorithms used in the City of Amsterdam. The register is still under development, but the objective is to promote transparency and enable peer review and scrutiny of algorithms deployed.

3.2.2.2 The service and the elements of the Conceptual Framework

3.2.2.2.1 Input

“Inputs refer to attributes that the transformation process taking place within a local or regional public administration and focused on a local or regional public service delivery, can use” (Vancauwenberghe, et al. forthcoming).

The Public Eye system leverages the municipality's existing CCTV camera network. The Public Eye system is currently connected to the CCTV cameras located in the pilot sites. The AI algorithm works on the video streams already being sent to the city's data system. Using existing hardware not only minimized costs but also limited

10 https://www.amsterdam.nl/innovatie/data/amsterdamse-datastrategie
11 https://www.johancruijffarenainnovation.nl/home
12 Marineterrein Amsterdam Living Lab (MALL), https://www.living-lab.nl/
13 Home - Amsterdam Smart City, https://amsterdamsmartcity.com/
14 Druktebeeld - Een beeld van de drukte in regio Amsterdam - Gemeente Amsterdam (in Dutch), https://druktebeeld.amsterdam.nl/
15 https://sensorenregister.amsterdam.nl
16 https://algoritmeregister.amsterdam.nl/en/ai-register

interoperability challenges - technical, semantic, organisational, legal, or cultural[17] - in connecting the hardware to the city's data system. During the pilot phase of the project, the Public Eye team connected the video stream to a separate data system dedicated to innovation projects.

The location data generated from the algorithm includes the count and location of people as well as their speed, direction of travel, and the density of the crowd. This data is then processed to generate insights that are displayed on internal-facing dashboards for the municipality and an external-facing dashboard for citizens. The data is also linked to the city's broader Crowd Monitoring System Amsterdam (CMSA), which pools crowd monitoring data from different sources across the city. The CMSA has been built on maps of the city developed and maintained by the spatial sector of the city of Amsterdam and is a fundamental input underpinning the feasibility of the location-enabled service.[18] These maps are available through the central data portal of the city of Amsterdam.

An API has also been developed so that anonymized data such as occupancy rates and crowd density levels can be used by other parties. This data can be viewed on multiple devices, including smart screens in the municipality, PCs and laptops, smartphones and tablets, as well as public info points and kiosks.

The CTO's input included:

- Dedicating two staff members to oversee the project, including an Innovation Officer from the Digital Safety team and Smart Mobility team. They dedicated their time, expertise, and technical and organisational knowledge.
- Identifying Tapp and Life Electronic as the right supplier to co-develop the Public Eye solution. While the CTO has an AI team, they needed to augment these skills with additional resources.
- Providing access to the city's CCTV cameras, testbed data platform, and central data platform.
    - Coordinating with the MPSD, which following the pilot phase, became the solution owners. This included defining the respective roles of the CTO and MPSD strategy for service operation and maintenance (see further discussion 3.2.2.2.2 - Transformation).
    - Coordinating with Smart City Amsterdam, who provided some strategic guidance for the development of the solution.
    - Mobilizing funding and political support. The project was not supported by a federal grant, so the budget had to be identified at the city level.
    - Coordinating the process of going open-source and documenting the relevant information.

3.2.2.2.2 Transformation

"Transformation refers to the approach of (re)designing and (re)developing public services in order to create public value, whereby there is a radical innovation instead of an incremental innovation (Osborne and Brown 2011)." (Vancauwenberghe, et al. forthcoming).

The City's prioritization of innovation, including its drive to be a leader in the global smart city arena, was critical for the Public Eye project. In 2016, the city was awarded the European Capital of Innovation. This *innovation mindset* is reflected in the city's institutional setup. The Municipality has a dedicated Chief Technology Office (CTO) responsible for driving innovation across the administration. Further, innovation projects are also led by Amsterdam Smart City, a public-private partnership and innovation platform.

When the need for a new crowd monitoring solution was identified, the CTO decided not to buy an off-the-shelf solution from a technology vendor and opted instead to develop the solution in-house in collaboration with local Small Medium Enterprises (SMEs). This decision was taken because, at the time of project kick-off, the CTO determined that there was not an appropriate off-the-shelf solution available. Further, they decided to run the project in-house so that the CTO could ensure alignment with the city's ethical data principles and enable the city to lift the lid of the solution, including the algorithm, to contribute to its design, increase the internal

[17] Connecting the EIF with Smart Cities and Communities (EIF4SCC), https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framework-observatory/news/connecting-eif-smart-cities-communities-eif4scc

[18] https://maps.amsterdam.nl/?LANG=en

understanding and capacity of the CTO. The project, and the decision to develop the solution in-house, benefited from political support from the Mayor and Alderpersons (deputy mayors).

Tapp acted as the project manager and formed an agile innovation team with Life Electronic and the CTO. This effective collaboration, and the shared innovation mindset, were key success factors for the project. The team was able to develop a rapid prototype, test the solution in a sandbox environment and iterate quickly. Once the quality and effectiveness of the solution were verified, they then took the necessary technical and administrative steps to integrate the solution into the municipality's formal organisational and technical structures.

From a technical perspective, this approach yielded very effective results. The algorithm has a 95% rate of classification accuracy. The city organized a friendly competition with another crowd monitoring provider in one of the main squares of the city and tested their respective algorithms. The Public Eye solution had a higher accuracy level.

"The solution is very disruptive to the market…we have an ethical, responsible crowd monitoring solution that is open source and free to any other city that wants to use it." Project Manager, Tapp

However, this approach also had some limitations. The primary intended internal user of the Public Eye solution was the MPSD. The Department was looking for an off-the-shelf solution that could be quickly deployed, externally operated, and maintained. They did not have the same objective of opening the 'black box', rather, they needed a solution to an operational challenge. The in-house approach resulted in additional work for the CTO and MPSD.

Further, the respective roles of the CTO and MPSD were not defined at the outset of the project. The CTO expected to hand the project over to the MPSD once the innovation stage had been completed, however, the MPSD expected their continued involvement to maintain the solution. The departments have now come to an arrangement whereby the CTO has sustained a 'light touch' engagement to help maintain the solution and provide additional functionalities as needed. To bring the MPSD onboard with the project and approach taken, it was critical to demonstrate the business case and cost savings.

The ability to test the solution in a sandbox environment was an important facilitator of the project. The Living Lab at Marineterrein provided a privately governed site to test the solution, hardware such as CCTV cameras and IoT lamp posts, and a network of knowledge partners, including Amsterdam Smart City, the AMS Institute, Marineterrein Amsterdam, and the NMO Science Museum. The team also involved the municipality's legal departments from an early stage and was provided with a temporary regulatory holiday to test the solution. Finally, the solution was also originally tested in a separate data platform dedicated to innovation projects; this allowed them to conduct the necessary security, safety, and ethics checks before taking the technical and administrative step of connecting to the municipality's central data system.

3.2.2.2.3 Output

“Outputs refer to the products of the transformation process of local or regional public services” (Crompvoets, et al. Forthcoming), which can be divided into internal and external services. The main output The main outputs of the project include:

- An algorithm that has achieved 95% classification accuracy.
- Dashboards that provide spatial insights to the MPSD and other municipal departments.
- The Busyness webpage and public kiosks, which provide information to citizens.
- An API that can be used by additional interested parties such as facility managers, event organizers, civil society organisations, and academia.

3.2.2.2.4 Outcome and evaluation

“Outcomes refer to results produced by transformation processes of public services at local or regional level. In contrast with outputs, the outcomes measure the value or impact of local or regional services” (Vancauwenberghe, et al. forthcoming).

The direct internal beneficiaries of the location-enabled service are the MPSD. The main outcomes are related to operational efficiency and effectiveness. The Public Eye System is now operational, and the insights generated are being used by the MPSD to manage the flow of people in the public spaces.

> *"It's really nice to see that if you know where the crowds are, you really know how to act, and also when not to act. When it is still comfortable enough, there's enough space. You don't have to act on everything. So, it really helps you to be effective but also to be efficient with the means you have." Head of Traffic Management, Municipality of Amsterdam*

The Public Eye system is also helping to increase the resilience of the city against the Covid-19 pandemic. The data generated is being used by health authorities as well as external parties such as facility managers and event organizers to monitor social distancing and the density of crowds so that they can take preventive action to make spaces safer and keep them open to the public.

> *"The city was more resilient because the technology was there, the spatial insights helped to keep people safe." Project Manager, Tapp*

The Public Eye System is currently mostly used for responding to situations in real-time. When the new dashboard is completed, with historical insights and a predictive model, the department is planning to use this data for more strategic planning. KPIs were not established to evaluate the effectiveness of the service, however, qualitative feedback was collected by the CTO to validate the effectiveness of the tool.

The overall intended outcome of the project is also to increase the quality of life for citizens and visitors, re-shape tourism, and improve the safety of public spaces. However, the municipality has found it difficult to measure the direct impact of the solution on these social and environmental outcomes due to challenges in attribution.

The main *external* beneficiaries of the Public Eye system are the general public as well as asset managers and event organizers. For the general public, the intended outcome of the service is to provide citizens with information on how busy different locations across the city are to inform their journey planning and avoid crowded areas. This was seen as particularly important in the context of the Covid-19 pandemic to provide citizens with information to make risk-informed decisions about how and when to use public spaces. While quantitative data is not available on the uptake of the service by the general public, qualitative research conducted as part of an academic research project suggests that there is limited awareness of the service amongst the public[19]. This will be discussed further in the lessons learned section.

As noted above, event organizers and asset managers have also reported using the service. For example, event organizers are using the data to monitor the number of people attending events, and asset managers are using the data to report occupancy rates of properties. The project team hopes that additional groups will start to use the dashboards and connect to the API to leverage the data and insights for their own purposes.

Another intended outcome of the project was to initiate dialogue with the public on the use of emerging technologies such as AI and video analytics. As discussed in the service description, the project team particularly experimented in the Marineterrein Living Lab, piloting different mechanisms to engage with the public, such as smart noticeboards, the playful addition of the camera shutter and button, tours and demos, and public discussion events. However, despite these initiatives, qualitative research conducted highlighted that few of the citizens using the space were aware of the experiment. This highlights the broader challenge of engaging the public in the development of digital solutions.

The project did, however, increase the capacity and knowledge of the Municipality, particularly the CTO, on the design and implementation of privacy-by-design advanced algorithms. The internal capacity gained as a result of this project will support future digital transformation programs and the development of future public services.

3.2.2.2.5 Replicability and scalability

The solution has not yet been replicated elsewhere, but it could easily be applied to another local government in Europe. The algorithm was intentionally created and published as open-source so that it can be replicated in other locations: this was part of the business case and objective of the project. The Public Eye project team has been presenting the solution to other cities and publishing information in the press. There are no significant

[19] PhD student researching the Public Eye Tool for their research thesis conducted interviews with members from the public in the Marineterrein Living Lab.

technical barriers to replication or up-scaling, for example, technical or semantic interoperability; however, there are some potential organisational barriers, including:

- Several cities are also motivated by being centres of innovation and generating new and innovative pilots and projects rather than replicating existing solutions;
- Other traffic management departments may be looking for an off-the-shelf solution rather than an in-house project (see 3.2.2.2.2 - Transformation);
- Video analytics technologies can be contentious, and the project team is engaging with partners to discuss the privacy-by-design principles at the core of the solution.

Going forward, the Public Eye team believes that there may be an increase in demand for the solution when tourism re-bounds to its post-pandemic level. They also believe that there is a higher likelihood that the solution will be replicated in other municipalities and provinces in the Amsterdam Metropolitan Region due to existing regional networks and inter-dependencies.

3.2.2.2.6 Lessons learnt

The Public Eye Project provided multiple lessons learned related to organisational change, technological innovation, and public engagement.

From an organisational standpoint, Public Eye demonstrated the value, but also the challenges associated with authorities developing in-house solutions. It also demonstrated the need for alignment between technology innovators and service users.

- Digital projects led by a government's technology or innovation team can have the benefit of agile design and delivery, however, it is critical to ensure that the primary user of the service is involved from the outset and that there is alignment on the objectives, potential value, and business case of the project.
- An agreement between all stakeholders on respective roles and responsibilities will lay the ground for more effective project implementation. An aspect that is often left out of budgeting and project design is the cost and responsibility associated with maintenance. This can be a barrier to moving projects from piloting to production.
- Co-developing AI projects with specialized partners can help the institution gain a greater understanding of how the solution works and ensure that it is aligned with the ethical and privacy principles of the institutions. This does not mean all projects need to be designed in-house. Public sector institutions are often limited by their internal digital skills and delivery capacity – it is difficult to keep pace with the rate of innovation and emerging technologies. But the process of co-developing projects helps to build institutional knowledge, which can be applied to future procurement of services.

From a technical standpoint, the Public Eye Project can be considered innovative in that the algorithm achieved a 95% classification accuracy rate – this was higher than many commercial solutions available with a higher cost.

- The city made the algorithm open source and published it in the Amsterdam algorithm register. This helps to promote transparency and trust related to emerging technologies. There is a move in some cities and countries towards encouraging, and in some instances mandating, the publication of algorithms used in the public sector – Amsterdam is an early adopter.
- One of the challenges experienced in the project was interoperability with the city's central data system and CSMA – this was a time-consuming process from a technical and administrative perspective. Connecting new location data streams to existing systems and GIS platforms will likely not be a straightforward step for other authorities undertaking a similar project.

From a public engagement perspective, the project demonstrated the challenge of engaging the public in debates related to emerging technologies as well as promoting the uptake of services available through citizen applications.

- The Public Eye project piloted different mechanisms to engage with the public, such as smart noticeboards, the playful addition of the camera shutter and button, tours, demos and public discussion events. However, qualitative research demonstrated low awareness and limited interest in the solution. The team is continuing to innovate in this space and will launch new initiatives with the Responsible Sensing Lab to continue the dialogue with the public.

- The qualitative research highlighted an ambivalence to discussions surrounding privacy. While some citizens voiced discomfort at the idea of being watched (despite the fact that their images aren't stored by the PublicEye algorithm), people generally voiced the opinion that they 'have nothing to hide' and accept crowd management and CCTV as an acceptable price to pay to use a public space. Further, the pilot site was seen to be a relatively safe area, therefore, the solution did not address a pressing or visible need of the citizens.
- Quantitative data are not available to measure the uptake of the service amongst the public. Therefore, it is difficult to assess the extent of public value generated from the external-facing service provided. Qualitative research suggested relatively low awareness and usage, however, the sample size was limited. For similar projects, it will be important to set KPIs and collect data to determine the impact of the project.

The majority of lessons learned from the project point to critical success factors that are common to many digital transformation projects, not just those exclusively focused on location data and technology.

3.2.3 Limerick's fight against noise pollution

3.2.3.1 Introduction to the service and its context

We often think of pollutants in terms of where they can be detected - air, water and soil pollutants. However, there are also very specific types of pollution that can harm people and wildlife. At least one in five Europeans is currently exposed to road traffic noise considered harmful to health[20]. The number is even higher in urban areas, and the problem is common in most European cities. According to a recent EEA noise report analysing road, rail, aviation and industrial noise, road traffic is by far the main source of noise pollution in Europe. The choice of such sources for analysis is in line with the Environmental Noise Assessment and Management Directive, which does not cover, for example, noise from households and workplace noise.

Many people may not know that prolonged exposure to noise, even at the levels we are used to in urban areas, has a significant impact on our health. In most European countries, more than 50% of inhabitants in urban areas are exposed to road noise levels of at least 55 decibels during the day, evening and night. According to the World Health Organisation (WHO), long-term exposure to such noise levels can have negative health effects[21].

Drivers:

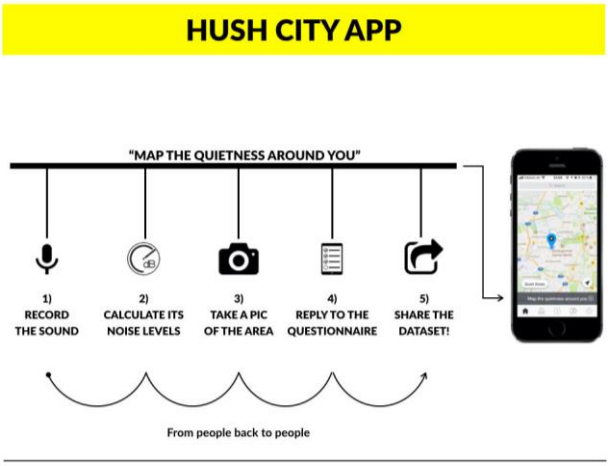
In order to tackle noise pollution, various initiatives started to occur, especially on a local, city level. Hush City app is one example, which was invented by Dr. Arch. Antonella Radicchi.

It is a free mobile app that enables citizens to identify and assess quiet areas, shared by the community, in cities in order to create an open-access, web-based map of quiet areas[22]. Hush City is aimed at increasing civic awareness of the importance of safeguarding quiet areas in cities. One of its main goals was also "to exploit data collected through the Hush City app in integrated city planning processes, in order to develop policies and planning guidelines grounded on people preferences, and therefore filling a gap in literature" (Radicchi et al. 2018).

Hush City app is a mobile application which runs on both the iOS and Android operating systems. It is designed to be used outside, in public spaces, and it has open access to everyone. It is a crowdsourcing app, so users are encouraged to download the app, choose their favourite quiet space and use Hush City to assess and document the quietness around them. Figure 5 shows the steps that are included in mapping the quietness.

20 https://www.eea.europa.eu/publications/environmental-noise-in-europe
21 https://www.tandfonline.com/doi/full/10.1080/23748834.2020.1821980
22 https://www.opensourcesoundscapes.org/hush-city

Figure 5. An overview of how the Hush City app works - Source: http://www.antonellaradicchi.it/portfolio/hush-city-app/

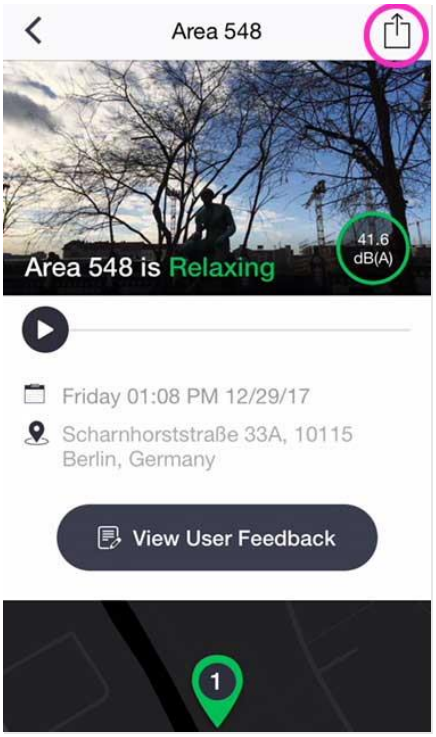


Mixed data is collected, including audio recordings and pictures. The data collection process is standardised as all data collected by citizens has the same characteristics. An audio recording is meant to be 30 seconds. The sound pressure levels are calculated and displayed by the app as numeric scale values and they are A-weighted (i.e. 45 dB (A)), Leq (equivalent continuous sound level), Lmin (minimum sound level) and Lmax (maximum sound level). Pictures are collected at a maximum resolution of 6MP and 24bit colour[23].

Figure 6. Step 1: Recoding the sound of the quiet place where the user is and measuring its sound levels – Source: https://apkpure.com/hush-city/com.hushcity.app

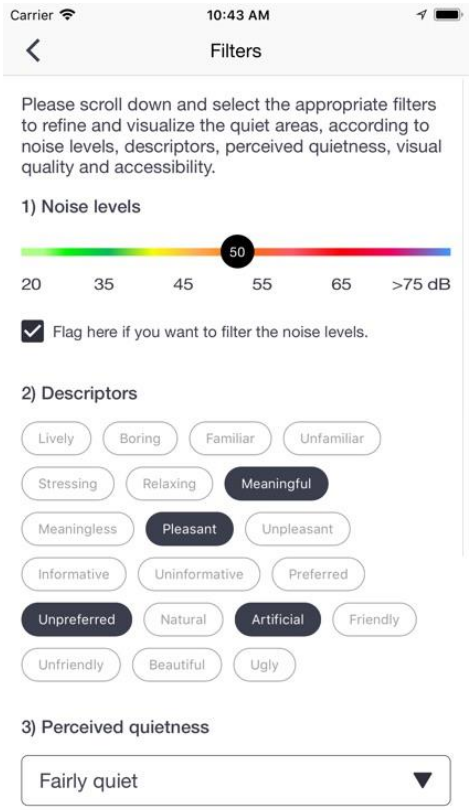
23 https://www.opensourcesoundscapes.org/hush-city

Figure 7. Step 2: Taking a picture – Source: http://www.antonellaradicchi.it/new-version-of-the-hush-city-app/



When the citizens use Hush City, they also respond to 20 questions in a questionnaire about environmental quality. The questions relate to acoustics quality and emotions associated with it, the activity in the area, the number of people in it, the cleanliness and the sense of security. It is mapped in real-time on the app, and it asks the user whether they are a local, a tourist or live in the area.

Figure 8. Step 3: Answer the questions addressing the environmental quality of this quiet place – Source: https://apkpure.com/hush-city/com.hushcity.app



Users can also use the app to find the quiet areas around them by the descriptors used to tag them, the perceived level of quietness, the overall quality and the accessibility.

Hush City App has also been used to conduct soundwalks. A soundwalk is "any excursion whose main purpose is listening to the environment"[24] . The app can be used to explore the map and evaluate the quiet areas along the soundwalks' route. It is aimed at the collaboration of citizens and raising acoustic awareness among the public at large.

Hush City was launched in 2017 within the context of a pilot study in Berlin, and is now used internationally[25] and available in 5 languages: English, German, Italian, Spanish and Portuguese. Hush City is adopted by the City Councils of Berlin (2018) and Limerick (2020-2021) within the context of creation of the Quiet Area Plans, recognised by the Environmental Noise Directive as an important step to protect the European soundscape. With its wide geographical range and adoption by two city councils, Hush City has the potential to frame plans and policies for healthier living in response to issues framed by European environmental policies, e.g. the Environmental Noise Directive[26].

Since climate action is being pushed up in the agenda of the local council in Limerick, sound is also more recognized in the organisation as a critical issue to address. While the appreciation of outdoor areas has increased since Covid, at the same time notice of noise among citizens has increased. Citizens of Limerick realised that the centre is loud and, given the historical environmental significance of the city, there are further goals of creation of new open green spaces, improvement of existing ones and protection of wetlands. Hush City is one of the tools that allow to achieve that goal and understand the benefits of quiet areas. Even though the European Noise Directive does not prescribe the measures to achieve those benefits, it is important for local councils to educate themselves further on the importance of addressing noise pollution.

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24 http://www.antonellaradicchi.it/portfolio/soundwalks

25 It is used in all continents and the visual map of where it has been used is available here: https://map.opensourcesoundscapes.org/view-area

26 https://www.opensourcesoundscapes.org/hush-city

From a technological standpoint, Hush City does not require much, as users just need a smartphone. However, there are certain legal and ethical considerations that play a role. From the ethical standpoint, there are both positive and negative aspects: on the one hand, there are people that might find the use of the app intrusive, but on the other hand, there is a possibility of citizens looking at sound in a different way. The legal concern relates to data sharing, as users need to enable tracking in order to map routes and register the locations they are at.

In the context of Limerick, Hush City is being used as an initiative against noise pollution and is still at its early implementation stage. Due to the pandemic and the shift in some priorities, Hush City is still in limited use and is more of a concept in the local council strategy. It falls under the city council plans and strategies in relation to air noise and water quality, including the development of a Blue-Green Infrastructure (all-natural and semi-natural landscape elements that could form a green-blue network in the context of an urbanised environment)[27]. There are already certain initiatives in place in Limerick, such as noise monitors installed in the relevant parks. However, sound walks, in the context of Hush City, would add extra value and highlight travel routes through parks to designate additional quiet paths and quiet areas tapping into citizen knowledge and insights.

In order to understand this case study, its background and implementation, the following documents were analysed:

- Environmental noise in Europe – 2020, EEA; this report presents the latest assessment of the population exposed to high levels of environmental noise and the associated health impacts in Europe, based on the new WHO recommendations.
- "Sound and the healthy city"; this research article addresses the topic of urban sound and health.
- "Citizens as smart, active sensors for a quiet and just city. The case of the <<open source soundscapes>> approach to identify, assess and plan <<everyday quiet areas>> in cities"; this research article addresses the field of smart acoustic solutions addressing the issue of urban quiet areas.
- Draft Limerick Development Plan 2022 - 2028; more specifically, the chapters relevant to Blue-Green Infrastructure that provided the baseline for the Hush City initiative
- Environmental noise in Europe - 2020 (Municipality of Amsterdam, Tapp and Life Electronic 2021) produced by the Municipality of Amsterdam, Tapp and Life Electronic; this presentation provides an overview of the project, including a description of outputs, user profiles, and pilot locations.
- Hush City App; this website provides an overview of the app, its features, impact, and geographical coverage.
- Soundwalks; this section of the online portfolio of the founder of Hush City addresses a concept of a walk whose main purpose is listening to any sound of the environment
- The new version of the Hush City app; this section of the online portfolio of the founder of Hush City presents new updates to the app.

After the desk analysis, four stakeholders were interviewed. Firstly, we spoke to a local council member in order to understand the plans and strategies in relation to air noise and water quality. Secondly, we spoke to the founder of the app and the software developer of Hush City. Lastly, we spoke to an external stakeholder familiar with Hush City and other location-enabled public services.

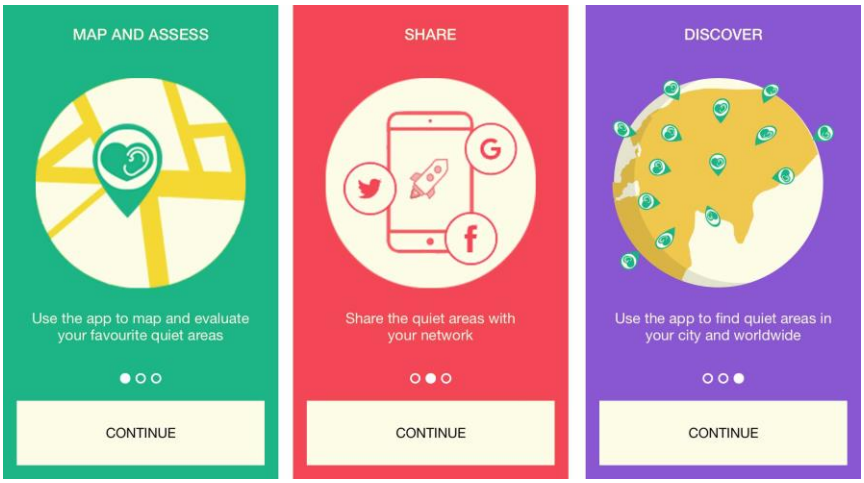
3.2.3.2 The service and the elements of the Conceptual Framework

3.2.3.2.1 Input

"Inputs refer to attributes that the transformation process taking place within a local or regional public administration and focused on a local or regional public service delivery, can use" (Vancauwenberghe, et al. forthcoming). For the measurements and for compiling the maps on quietness, precise user location is needed. Various technologies are used to determine user location, including IP address, GPS, and other sensors, which also feed into the app in addition to the citizen-sourced data. The app allows for mapping the quiet areas, sharing them with the community and exploring the quiet areas around the users (as shown in Figure 9 below).

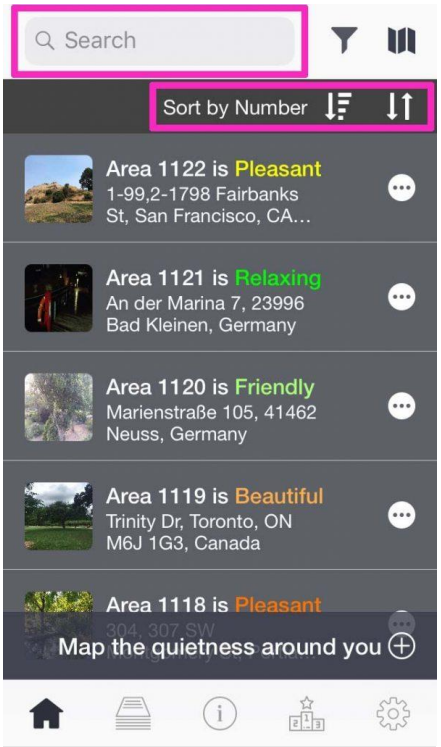
[27] https://green4grey.be/en/green-blue-infrastructure/what

Figure 9. Onboarding screens of the Hush City App – Source: http://www.antonellaradicchi.it/new-version-of-the-hush-city-app/



The users can search for quiet areas around them by using a "Filter" feature, which can be applied individually or in combination. Users can filter the everyday quiet areas according to their noise levels, the descriptors used to tag them, the perceived level of quietness, the overall quality, and the accessibility.

Figure 10. An option to search for a quiet area – Source: http://www.antonellaradicchi.it/new-version-of-the-hush-city-app/



3.2.3.2.2 Transformation

"Transformation refers to the approach of (re)designing and (re)developing public services in order to create public value, whereby there is a radical innovation instead of an incremental innovation (Osborne and Brown 2011)." (Vancauwenberghe, et al. forthcoming).

Governance:

The Limerick City and County Council had a noise action plan aimed at protecting quiet areas and reducing noise exposure where it negatively impacts the local communities. However, the council was poor at assessing and protecting the quiet areas, so it was actively looking for a solution. This is a clear example of a case where a vision

of a policymaker has an impact, as the Limerick local council members were open to innovation and to experiment with a new solution on how to assess sound. A local council member found an article written by the creator of the Hush City app and saw the Berlin action plan, which led to the app being adopted by the council (2020-2021) within the context of creation of the Quiet Areas Plans.

"We chose Hush City as an initiative against noise pollution because we saw it already being implemented in Berlin, and we wanted to reduce noise exposure where there is a negative impact on local communities."
City Council Executive

With the pandemic in place, priorities shifted slightly. There was an initial plan of running an intense communication campaign to citizens about soundwalks and the use of Hush City, especially during the European Green Week 2020, but it was not possible with COVID. A communication campaign is a crucial step, as the most important role in this location-enabled service is the public that does the data collection. In addition to the citizens, the local council, and the creator of the app, there are also schools, universities and healthcare professionals that could be involved in further collaborations and promotion of the implementation of the app in Limerick.

3.2.3.2.3 Output

"Outputs refer to the products of the transformation process of local or regional public services" (Vancauwenberghe, et al. forthcoming), which can be divided into internal and external services. The main output of this location-enabled public service is the designation of quiet areas thanks to the use of the Hush City mobile app. The quiet areas tie in the Blue-Green Infrastructure of Limerick, which "can be broadly defined as a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity, in both rural and urban settings[28]. The Hush City app will further enable that creation and hopefully will become a tool that people use to protect the designated areas.

3.2.3.2.4 Outcome and evaluation

"Outcomes refer to results produced by transformation processes of public services at local or regional level. In contrast with outputs, the outcomes measure the value or impact of local or regional services" (Vancauwenberghe, et al. forthcoming). Currently, there are three areas of measurement of impact of Limerick's initiative against noise pollution through Hush City: policy, science and society.

Public value:

On the policy level, it is assessed how the framework is used for Limerick's plan and strategy. Given the novelty of the framework, another way to measure impact is how many publications of scholars there are with references to the Hush City framework, and how many invitations to different conferences etc. the creator of the app has received. Finally, while there is not in place yet a formal assessment of Limerick's initiative against noise pollution through Hush City, the more general assessment of the app itself takes place via looking at the geographical scale of the data and data collected in general.

"The goal is to rework the platform in order to implement a service for municipalities and community groups to process the data on the platform, so they can have the data already processed and use it in the context of other projects." Hush City Founder

Hush City as Limerick's initiative also has an impact in three respective policy areas – operational, political and social. On the operational side, the Hush City framework on quiet areas is being used by the local policymakers to reach the European environmental policy requirements. On the political side, the potential improvement of

[28] https://mypoint.limerick.ie/en/consultation/draft-limerick-development-plan-2022-2028/chapter/chapter-5-environment-heritage-landscape-and-green-infrastructure

services in Limerick can lead to further economic growth in the city. Finally, on the social aspect, the reduction of noise will eventually lead to a better quality of life for citizens.

3.2.3.2.5 Replicability and scalability

Hush City app is already used internationally as an initiative against noise pollution, therefore it can be used everywhere. Soundwalks are already being conducted in Dublin, as well as studies with academics in Barcelona. Hush City has also been adopted by the City Council of Berlin, and it has the potential to be implemented by more cities. From the creator of the app perspective, the scalability should take place systematically by involving different municipalities with additional support from the European Commission by potential promotion and increased visibility on JoinUp or a similar platform.

> *"It is location agnostic. But it always takes people on a local level to influence the implementation on a local level." CIO and tech officer*

While the EU regulations can give extra motivation for local administrations to apply methodologies such as Hush City, it fully depends on the local administration. This methodology is especially useful for small cities, where noise levels are high and can't reach quantitative criteria of sounds, therefore a more qualitative approach is more appropriate. The next steps for the Hush City platform are to implement a service for municipalities and community groups to process the data on the platform to provide statistics or short reports, so the local administrations don't have to do the analysis themselves. This step would allow for further reuse of data in the context of other projects

3.2.3.2.6 Lessons learnt

Solving noise problems requires long-term strategies for cities. In order to tackle that issue, some cities install noise barriers along roads and railways; others think strategically and invest in urban infrastructure. Despite these efforts, experts warn: as long as there is no political will to guide the planning decision and there are no restrictive rules and penalties for failure to enforce them, these small city actions will do little on a global scale.

The example of Limerick's initiative against noise pollution through Hush City shows that it always takes local authorities to influence the implementation of various initiatives on a local level. The creation and identification of quiet areas can provide residents with a break from environmental noise. In some cities, those areas can be found in the form of parks, courtyards, gardens and recreational areas, but what this initiative also shows is that a Hush City offers a means to socially define quiet areas rather than only touching on the heterogeneity of personal definition.

Public participation and engagement in implementing Blue-Green Infrastructure have been crucial in order to raise public awareness of ownership of the plan that will shape their local communities. While the principles of walkability and liveability are being implemented into future city development plans based on European Commission requirements, the main lesson is that they will only be successfully implemented with the right innovation mentality of the local authorities and citizen participation. This initiative showed how important citizen engagement is in order to make this service work for both the city and the citizens.

Beyond lessons learnt on how to potentially fight against noise pollution on the local level, the use of Hush City also provides lessons in terms of technological innovation. While the app and the platform have data already harmonized and structured, there are no ready reports generated by the app itself that could be used further by individual municipalities or groups for research or other projects. This shows that sharing of data is an important aspect when it comes to location-enabled public services. While in Limerick, the level of usage is currently low, in Berlin, since 169 quiet areas were crowdsourced as of 2018, the Municipality of Berlin requested to use the data collected through the Hush City app for the development of the Berlin Noise Action Plan (2018-2023)[29].

[29] https://thecityateyelevel.com/stories/hush-city

3.2.4 Cascais Operational Control centre – Covid War Room

3.2.4.1 Introduction to the service and its context

The City of Cascais is located 15 miles west of Lisbon and extends over 97km231. It is home to over 214 000 residents and is visited by over 1 million tourists annually. Cascais has become a hotbed of prototyping and scaling innovative smart city solutions that enhance the quality of life for residents and visitors.

Challenges:

COVID-19 has raised uncommon challenges and accelerated the implementation of a central response mechanism to prevent and contain the pandemic, integrated into the operational management of the municipality. The Covid War Room and its digital platforms (powered by CitySynergy - Deloitte's Smart Places Operating System) enabled a unified vision and platform to manage the pandemic response and the municipal services associated with the process[30]. The model for providing this concept and services was based on the concept of Software as a service (SaaS). The main technologies and systems were based on AWS as a cloud and connectivity provider, taking into account the business continuity plan guaranteeing remote work of all the employees. The implemented system was based on the already existing facilities:

- A platform allowing users to perform root-cause analysis and escalate issues for resolution
- Command Centre displaying dashboards with real-time data about the city's status
- Executive Dashboard with access to real-time data about the city through decision makers' devices
- Citizen and Field Management App that can be used by citizens to report issues that need to be solved and would generate events in the platform [31]

Location management capability:

The emergency of the situation has forced the relocation of municipal teams and certain city management services to meet the needs of the moment. The CitySynergyTM COVID War Room was implemented in May 2020, two months after the start of the pandemic, and after the first population confinement measures. It has had a favourable evolutionary trajectory and as a process required less effort from the services involved. Cascais collaborated with a network of local partners, ensuring the communication and integration of information on the population's infectiousness levels through the local National Health Service systems. In addition, the municipality facilitated access to testing of the population through partner clinical centers, strengthening communication channels with citizens for this purpose.

Considering that the operation supporting system already had some maturity and evolution, the identified requirements, alignment and implementation were very fast.In order to increase local resilience and drive the recovery of the municipality, new operational modules were integrated into the COVID War Room:

- Integrated Crisis Management, promoting the centralization of requests and responses reported both by citizens and by other municipal services (e.g., testing in cultural and sports organizations, collection of donations and support to the population in difficulty, actions of road disinfection);managing and improving the level of services provided, organizing teams, and responding effectively to all requests;
- COVID19 Suspicious Case Monitoring, through real-time data visualization and integrating information from the Civil Protection, Firefighters, and other actors of the Health System;
- COVID19 Test Scheduling and Result Management, promoting effective and real-time management of test scheduling, visualization of ongoing processes, and real-time reporting of results;

Outcomes have included:

- A holistic overview of the entire COVID-19 management process in one single platform (suspicious cases, test schedules and results, infections, maps showing the spread of infection);

[30] CitySynergyTM COVID War Room, Solution Brochure 2020, Deloitte, https://www2.deloitte.com/content/dam/Deloitte/pt/Documents/public-sector/CitySynergy%20COVID%20Brochura_ENG.pdf

[31] CitySynergyTM COVID War Room, Solution Brochure 2020, Deloitte, https://www2.deloitte.com/content/dam/Deloitte/pt/Documents/public-sector/CitySynergy%20COVID%20Brochura_ENG.pdf

- Maximum efficiency of health, emergency and related resources;
- Engagement by citizens in the fight against COVID-19, promoting clear communication channels;
- National and international perception of confidence and security, a key to restoring the city's tourism-based economy.

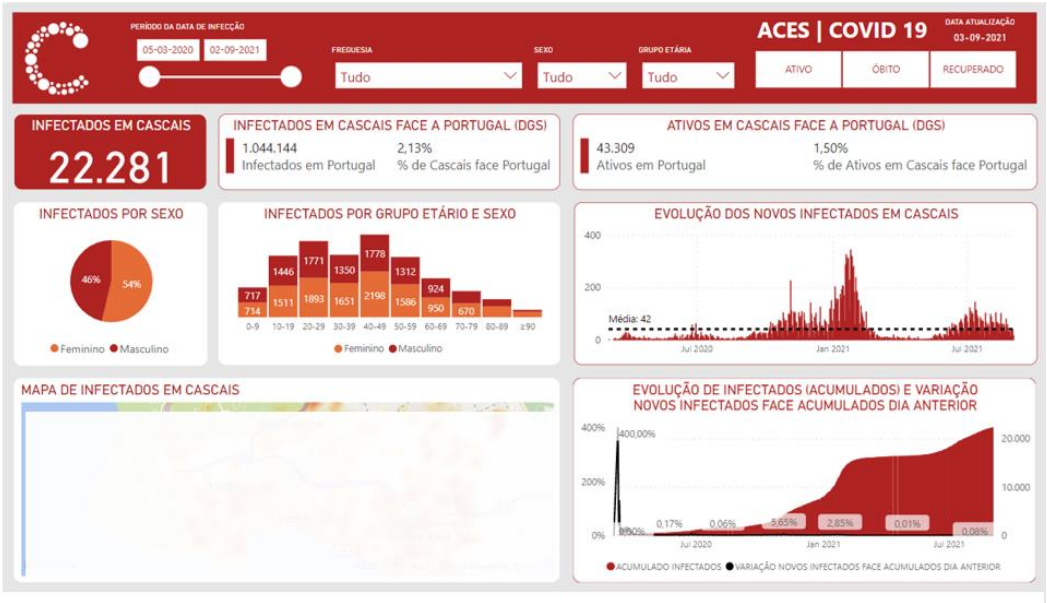
The city has become a role model for managing the pandemic and the only one in Portugal to adopt such a strategy. In May 2020, the Cascais City Council (Câmara Municipal de Cascais) announced a programme for mass testing of the population for coronavirus antibodies, covering all 200,000 inhabitants[32].

Values

Cascais was not only a pioneer in testing the population, but also in collecting Personal Protective Equipment (PPE), showing an example for neighbouring municipalities and ensuring that PPE can be distributed to neighbouring municipalities. By February 2021, more than 56,000 tests had been scheduled and managed through the platform (a 91 per cent test realisation rate), which had ten call centre operators working on the health crisis. In order to offer broader coverage than the national government's policy at that time, Cascais also announced in 2021 a plan to test students in all schools within the municipality. In addition to testing, Cascais focused on community-based knowledge sharing and health education initiatives[33].

At the beginning of the project, the location of the main outbreaks of suspicious Covid cases was crucial for the "surgical" allocation of available resources, becoming more effective and efficient. In the second stage of the project, according to the known demographic dispersion of the municipality, the main facilities of the chosen lab partners were identified for carrying out serological and PCR tests. This step prevented the large gathering of people, including queues, in line with the main NHS rules.

Figure 11. A screenshot of the dashboard used to monitor the evolution of infected citizens



Based on this dashboard, created by a data analysis team, several strategies have been adopted to act in the territory, according to the evolution of Covid trends. When connected to the monitoring dashboard, the aggregated results from all testing points were collected.

Drivers:

Given the unusual situation of the COVID-19 pandemic, the Cascais municipality did not avoid looking for solutions to control the pandemic, even with associated monetary costs. The demonstration of Cascais' pioneering and responsive attitude towards the problem and the involvement of the local health services was crucial for the development of the adopted solution. Other factors that influenced the implementation of the

32 Urban Future With a Purpose: 12 trends shaping the future of cities by 2030, Deloitte, https://www2.deloitte.com/global/en/pages/public-sector/articles/urban-future-with-a-purpose.html

33 Ibid.

Covid War Room included the ethical factors to ensure respect for the processing of statistical information that may be sensitive; therefore, relevant georeferenced information was anonymised. Additionally, governance factors, like the analytical response, determined more assertive actions in the territory and showed that some locations needed more intervention by municipal technicians.

> *"This couldn't have been done if some other things weren't already in place - the strong digitalization process, a centralised database of citizens and the physical space of Cascais Cockpit. Cascais was already in the problem-solving mode. We were able to tackle it within a week (with the set-up) and started creating the service for tests, the integration with the central health department and dashboards with the heatmaps. The teams were already in place to do that, and the application of the intelligence was the service to the population". Key Decision Maker*

In addition to various factors inside the organisation that influenced this implementation, there were drivers and challenges with regard to the location-enabled component of the project. The main challenge was the integration of new data elements, as the data model was not standardised and the design of the platform was done from scratch. The main driver was the political support to provide the service to all citizens. In such special times like the pandemic, there was a need to educate the citizens about the situation, make people feel safe, and provide them with access to testing. Furthermore, there was a strategic alignment, as well as a collaborative and trusting relationship, with stakeholders to share data.

The analysed documents that allowed for a better understanding of this case study included:

- CitySynergyTM COVID War Room – Deloitte[34]; This solution brochure provides an overview of the solution that supports city operations by combining the capacity to define work processes with the ability to integrate and visualize data.
- "Urban Future with a Purpose 12 Trends Shaping the Future of Cities[35];" This report addresses 12 main trends affecting urban living in the future. Cascais is presented in the context of City Operations Through AI.

After the desk analysis, five stakeholders were interviewed. Firstly, we spoke to two different project managers to get an overview of the project overall. Secondly, we spoke to two suppliers to understand the technology and system behind the case. Lastly, we spoke to a street-level manager to understand the implementation on a local level.

3.2.4.2 The service and the elements of the Conceptual Framework

3.2.4.2.1 Input

"Inputs refer to attributes that the transformation process taking place within a local or regional public administration and focused on a local or regional public service delivery, can use" (Vancauwenberghe, et al. forthcoming). In order to create a monitoring and response system to Covid in the Cascais, anonymised infectious disease data and population testing was used. It was possible to cross-reference several types of information, including suspicious Covid cases reported by hospital emergency entities, location of the user who requested PCR Testing, location of the user who requested a serological test, reporting of the results (positive/negative) but anonymized, identifying only date/time and postcode. The teams involved with the project were specialized both in software implementation and in data processing and associated information. The technologies used were the test appointment management software and analytical tools (PowerBI).

> *"The analytical response determined more assertive responses in the territory and showed that some locations needed more intervention by municipal technicians." - Project Manager*

[34] https://www2.deloitte.com/content/dam/Deloitte/pt/Documents/public-sector/CitySynergy%20COVID%20Brochura_ENG.pdf

[35] https://www2.deloitte.com/global/en/pages/public-sector/articles/urban-future-with-a-purpose.html

3.2.4.2.2 Transformation

"Transformation refers to the approach of (re)designing and (re)developing public services in order to create public value, whereby there is a radical innovation instead of an incremental innovation (Osborne and Brown 2011)." (Vancauwenberghe, et al. forthcoming).

Stakeholders:

While the Covid War Room became a priority to manage the pandemic response and municipal services, Cascais already had the innovation mindset embedded. That allowed for easier implementation and re-design of technology solutions. Cascais opted for a proactive governance model, which did not depend on the totality of responses from the central government to be able to act in accordance with the needs of the territory. It was necessary to understand the scope of information shared between central and local governments and how the intervention of the municipalities supported or contradicted the strategy taken at a national level. The municipality established a local partnership with the national health services that was essential to the success of the project. There was a further redefinition of services and allocation of resources as needed by the project. Since the platform was adapted to, for example, track hotspots of infections in the city, it has allowed for direct response services to operate in a more effective way in the territory, such as buses for testing the population, information stations about the virus and the support such as food collection boxes for solidarity purposes.

"The technology was crucial for us to achieve agile scheduling and simple data handling, given the quality of the data loading." Street-level service manager

Governance:

Legal constraints had to be considered in order to ensure compliance with current legislation regarding the GDPR and the protection of health data, working with partners to ensure that this stage of the process was met at the beginning of the cycle and that the information already obtained was in an anonymized form and with parameters that respected statistical confidentiality. Lack of interoperability was another factor taken into account when it came to the implementation of the service, as a number of manual processes were involved because there was no form of interoperable communication between the local health services and the municipal information systems.

3.2.4.2.3 Output

"Outputs refer to the products of the transformation process of local or regional public services" (Vancauwenberghe, et al. forthcoming), which can be divided into internal and external services. The main output of this location-enabled public service was managing information that allowed the municipality to understand the Covid situation at the time. The platform was a tool to facilitate stakeholders' activities, and it made it easier to achieve the organisation's goals.

3.2.4.2.4 Outcome and evaluation

"Outcomes refer to results produced by transformation processes of public services at local or regional level. In contrast with outputs, the outcomes measure the value or impact of local or regional services" (Vancauwenberghe, et al. forthcoming).

The project developed allowed Cascais to validate the need to establish complementary responses between local and central health services, in order to respond better and faster to the population. It reinforced the role of the municipality to also create localized and targeted responses for its population, of which they are more knowledgeable. It reinforced the competencies of the municipality and highlighted its area of action. This case study clearly shows that location data and technology can be leveraged to drive public service innovation through strategy, capacity and operations, as identified by Chen and others (2020).

The indicators (see Table 3) allowed the municipality to understand the percentage of the population tested, the evolution of the pandemic in the county, and the level of reinforcement in terms of safety and security equipment needed. This was achieved by analysing the indicators themselves on the dashboard, given that the main objective was to decrease the number of infections by COVID.

In the operational policy area, the impact of this location enabled public service was very high, as the teams got together and collaborated, did things differently and designed services with immediate high scale impact while

under pressure to deliver quickly. In the political policy area, the impact was also high due to higher trust in government and the data being key for designing and providing service to people. On the social side, it definitely increased inclusiveness, as everyone could have access to testing to be able to work from the office and continue travelling, not only the rich and powerful. The response was also felt to help the tourism industry that had been hit hard by the pandemic.

Table 3. A list of performance indicators

Name	**Description**
Evolution of the newly infected in Cascais	Chart with new infected over time and the variation of new infected vs accumulated infected of the previous day; there is also the possibility to see by period of the date of infection
Evolution of the incidence rate in Cascais	Graph with the evolution of the incidence rate in Cascais over time, there is also the possibility to see by period of the date of infection
Infected per age group and gender	Chart with the distribution of the infected per age group and within them the number of infected males and females. Circular chart with the percentage of infected males and females, there is also the possibility to see by status (Active, Death or Recovered), age group, gender, parish and by period of the date of infection
Infected according to sex	Chart with the total percentage of infected males and females, there is also the possibility to see by status (Active, Death or Recovered), age group, gender, parish and by period of the date of infection
Map of Infected in Cascais	Map with the location of the infected per parish, there is also the possibility to see by period of the date of infection (anonymised information)
Evolution of the active in Cascais	Graph with the number of active cases over time, there is also the possibility to see by period of the date of infection
Deaths	Total number of residents living in Cascais infected with Covid19 who died
Infected	Total number of residents living in Cascais infected with Covid19, regardless of status (Active, Death or Recovered)
Comparison of incidence in Cascais, Portugal, North Region and ARSLVT, Neighbouring Council	Graph comparing the evolution of Covid19 incidences in Cascais, Portugal, North Region and ARSLVT, neighbouring councils, there is also the possibility to see by period of the infection date
Infected in Cascais versus Portugal (Directorate-General of Health)	Card with the total of infected in Portugal (data from DGS) and the percentage that the infected in Cascais represents in relation to the total of infected in Portugal, there is also the possibility to see by period of the infection date

Deaths in Cascais versus Portugal (DGS)	Card with the total number of deaths in Portugal (data from DGS) and the percentage that the obits in Cascais represent in relation to the total of obits in Portugal, there is also the possibility to see by period of the date of infection
%Vaccinated in Cascais vs Portugal (DGS)	Card with the percentage of vaccinated people in Portugal (data from DGS) and the percentage of vaccinated people in Cascais
Schedule: Covid-19 responses in the county	Chronogram that shows the evolution of the strategies adopted by the municipality to help fight the pandemic
Rapid tests made available	Total number of rapid tests made available
Entities Involved	Number of entities to whom tests were delivered
	Possibility of analysing by type of entity and by results and parish
Entities Reported	No. of entities that reported the performance of tests.
	Possibility of analysing by type of entity and by results.
Scheduled Serological Tests	Total number of scheduled serological tests
	Number of new serological tests scheduled on the current day
Analysis of Serological Tests	Card with:
	Test performance rate - Percentage of tests performed against the total number of tests scheduled by the reference date
	No show rate - Percentage of tests not performed, due to no show, against the total number of tests scheduled by the reference date
	Reactive Rate - Percentage of tests with Reactive results against the total of tests performed until the reference date
	There is also the possibility of viewing this data by test result, Laboratory, Parish and by period of the infection date
Map of Serology Tests Performed in Cascais	Map with the location (postal code) of the residents who performed tests (anonymised information); there is also the possibility to see by test result, Laboratory, Parish and by period of the infection date
PCR Tests Performed	Number of PCR tests carried out at the Covid Test Centres in Cascais (Germano de Sousa and Joaquim Chaves) regardless of whether or not they are residents of the municipality.
Percentage of Positive PCR	percentage of positive PCR tests carried out at the Covid Test Centres in Cascais (Germano de Sousa and Joaquim Chaves) regardless of whether or not they are residents of the municipality.

Map of the Positive PCR tests	Map with the location of the citizens who tested positive in the PCR tests (postal code); there is also the possibility to see by parish and by period of the reference date (anonymised information)
Scheduled PCR tests	Number of PCR tests scheduled at the Covid Test Centre in Cascais (Germano de Sousa and Joaquim Chaves) regardless of whether or not they are residents of the municipality
Antigen Tests Scheduled	Total number of antigen tests scheduled
	Number of new antigen tests scheduled on the current day
Tests Performed	Number of tests performed by type of entity (resident or municipal worker)
Positive Tests	No. of tests performed that were positive
Citizens Tested with Positive Results	No. of citizens, workers and employees in municipal entities who have already performed rapid tests and tested positive, regardless of the number of tests performed
Test Evolution	Evolution of tests performed per date
Mask Dispenser Map	Location of the mask dispensers, with the description of the place, there is also the possibility to see by parish
Total Mask Dispensers	Total mask dispensers distributed by the municipality.
	Possibility to see by parish.
Solidarity House Location	Location of the Solidarity Houses, with reference to the address, location of the house and associated supermarket chain, there is also the possibility to see per parish.
Support Houses Map	Location of the Local Support Points (community project = local service points), with reference to the address, the Entity or Association involved and the neighbourhood, there is also the possibility to see per parish.
Total Support Stores	Total of Local Support Points (community project = local service points) existing in the municipality.
	Possibility to see by parish.
Location of the Cascais Jovem Volunteers' Posts	Location of volunteering posts (local posts + solidarity boxes) Cascais Jovem, with reference to the volunteering project and location, there is also the possibility of viewing by project or parish.
Posts by Project	Chart with the number of existing volunteering positions (local positions + solidarity boxes) by Cascais Jovem volunteering projects, with the possibility of viewing by project or parish.

3.2.4.2.5 Replicability and scalability

Almost all local or central governments with the capacity have adopted a system for controlling the pandemic. However, it is not known how many have incorporated georeferenced systems into the process. When it comes

to the scheduling system for mass population testing, it is unlikely that other municipalities relied on a structure as robust as the one set up by Cascais.

"Interoperability is a prerequisite. It only happened because we were able to integrate different systems." Key Decision Maker

The overall model of a shared operation between the municipality and local entities could be replicated by any local governing body, provided good partnerships are established with key entities, overall motivation of all stakeholders, and expert resources in data analysis and quality. However, everything depends on the nature of the ecosystem and how individual entities correlate with each other.

3.2.4.2.6 Lessons learnt

Cascais' Covid War Room showed how a pioneering, innovative mindset of local authorities allowed for quick adaptation to an extreme situation, such as the pandemic. Thanks to the right infrastructure and mindset being in place, the municipality accelerated the deployment of an operational control centre that enabled a unified vision and platform to manage the pandemic response and municipal services.

The Covid War Room functions of the platform are no longer in action as the Covid-19 rate is low, although they can be re-activated easily. As a result, the platform is being extended to:

- Provide other preventive health services, such as colon cancer testing
- Analyse and visualize data regarding the performance of the new health services: teleconsultations, digital health booth, family doctors for all, etc.
- Correlate with complementary data already being collected, regarding the promotion of quality of life and well-being of citizens: e.g. environmental, meteorological and air quality data, traffic management.

The platform is a foundation for future evolution towards building a digital twin, and it shows how technologies can be adaptable to different situations once the foundation is in place.

The example of the Covid War Room also shows how integrated systems play a key role in delivering public services. Without already existing technologies, mindset and partnerships, this service would not have been successful and beneficial to the end-users.

From a citizen's perspective, it meant that there was already a level of trust in the local government, but it only increased and showed its results in the political elections. What it means for other location-enabled public services is the fact that a pioneering mindset does not get automatically adopted by citizens, but it takes time, and this example showed that with positive results, a greater level of trust in new innovations and technologies might also appear.

3.2.5 Ravenna's platform to report issues in the City

3.2.5.1 Introduction to the service and its context

Ravenna is an Italian municipality in the region of Emilia-Romagna, and it hosts, as of 2021, 156.463 inhabitants. Since 2012 Ravenna has exploited a location-based service that allowed users to signal any problem they encountered throughout the city, such as potholes in the streets and other public infrastructure needing maintenance. The system, called Rilfedeur, was a public-owned one, built by Emilia-Romagna's ICT company and provided to all the municipalities within the region. Before Rilfedeur, the municipality had a system with similar scope, yet it did not use location-enabled technologies. However, in 2016, the regional government decided to stop guaranteeing software updates for Rilfedeur, and Ravenna had to decide if and how to provide a similar solution to its community. The software was initially challenging for internal users and provided a poorly designed user experience. For example, most reports came through a web form and not the app, whose interface was not optimized. After two years of evaluating possible alternatives, in which the old system was kept in place, the municipality chose to sign a 6-month contract – renewed periodically up until the moment in which this case is being written - with Comuni-Chiamo to start using their service. The need at the basis of this decision,

notwithstanding the substitution of the previous software, was related to building a stronger connection with citizens. Therefore, the new platform would allow bi-directional and seamless interaction to take place.

Comuni-Chiamo started its journey in 2011 as a start-up seeking to provide public administrations with innovative digital instruments to optimise resources and improve public area management through citizen participation. As one of Comuni-Chiamo's managers stated, "when the company was born, there was no technology in the Italian public sector". The name "Comuni" in Italian means "Municipalities", while "Chiamo" literally means "I call". The name hides a wordplay since the Italian "Comunichiamo" can be translated as "We communicate", highlighting the circling back of information between the two involved actors. As of 2021, Comuni-Chiamo is active in 110 municipalities, mostly in Northern Italy, among which Ravenna is the biggest in terms of population. Not only is Ravenna their biggest client, but it is also "at the forefront of the service", as one of Comuni-Chiamo's managers outlined.

The case study began with an analysis of relevant documents provided by the case stakeholders. In particular, we analysed:

- The management plan of the municipality in the section related to the Office for Organisation, Quality and Training, responsible for Comuni-Chiamo's adoption (Comune di Ravenna 2021);
- The "determinazione dirigenziale", an administrative act of one of the municipality's managers, that approved the purchase and activation of Comuni-Chiamo in Ravenna (Comune di Ravenna 2018);
- Reports related to the activity of Comuni-Chiamo in the municipality of Ravenna (Comuni-Chiamo 2021);
- The website of Comuni-Chiamo[36];
- The website of the Municipality of Ravenna[37];
- The website of Emilia-Romagna, on the page related to Rilfedeur[38].

After the desk analysis, we interviewed six stakeholders. First, we interviewed two managers from Comuni-Chiamo, one being the process manager and the other being the ICT manager. Then, from the municipality, we interviewed two employees that supervise the implementation of Comuni-Chiamo in Ravenna from the Office for Organisation, Quality and Training, and another municipal employee dealing with public works, interviewed as an internal end-user. Finally, we also interviewed a manager from the municipality's software provider.

Comuni-Chiamo technically is a SaaS service delivered through software. On the front-end, Comuni-Chiamo is a digital platform and connected app that allows users to share with their municipalities information about any issue related to public spaces, such as street potholes, public garden maintenance and non-urgent security concerns. On the back end, Comuni-Chiamo allows municipalities to have an automated and streamlined process to manage and tackle the raised problems and exploit the information they provide, while also keeping them informed about the actions undertaken by public employees and contractors. This realises an informative circle, going from the citizens to the municipality and vice-versa, allowing everyone to take care of common goods, creating "a permanent channel of communication between citizens and the municipality", as Ravenna's municipal employees described it. As one of Comuni-Chiamo's managers declared:

> *"The main goal was to convert citizens into partners, creating a spirit of cooperation by through improving user experience, increasing quality perception and decreasing discontent."*

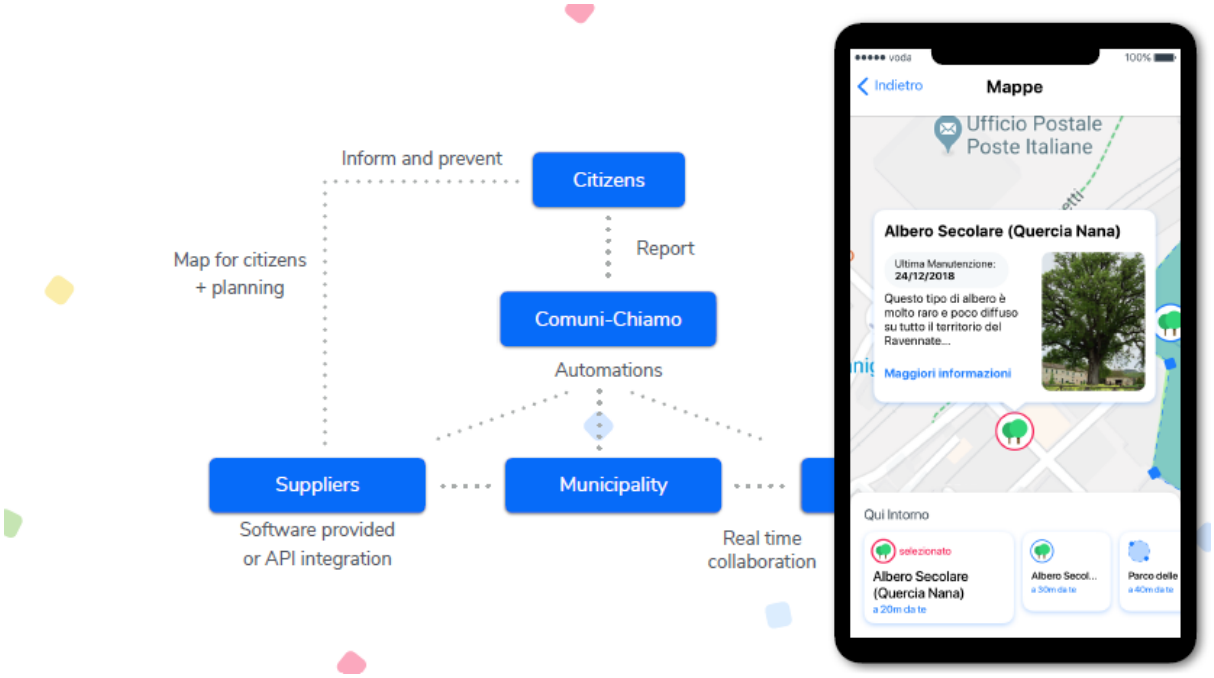
Ravenna's needs to allow users to report issues of concern were partially unique compared to other Comuni-Chiamo clients. Implementation required an additional effort by the company to ensure interoperability with existing solutions operating at different levels of the public work management process. Clear responsibilities covering the municipal territory also needed to be addressed, as well as improving employees' collaboration. In the first six months of 2021, Ravenna's users had produced 5,602 reports in the middle of the pandemic, half of which related to potholes and road signs. Compared to 2020 data, Ravenna did not experience a surge compared to previous years– with Rilfedeur -, but the share of reports filled via the app has increased steadily. The

36 https://comuni-chiamo.com
37 https://www.comune.ra.it
38 https://autonomie.regione.emilia-romagna.it/polizia-locale/organizzazione/tecnologie/rilfedeur-descrizione-e-funzionalita-1

pandemic, especially in 2020, may have reduced instances when users could experience and report an issue in public spaces, and foreseen usage was lower because the planned rollout with school pupils did not take place.

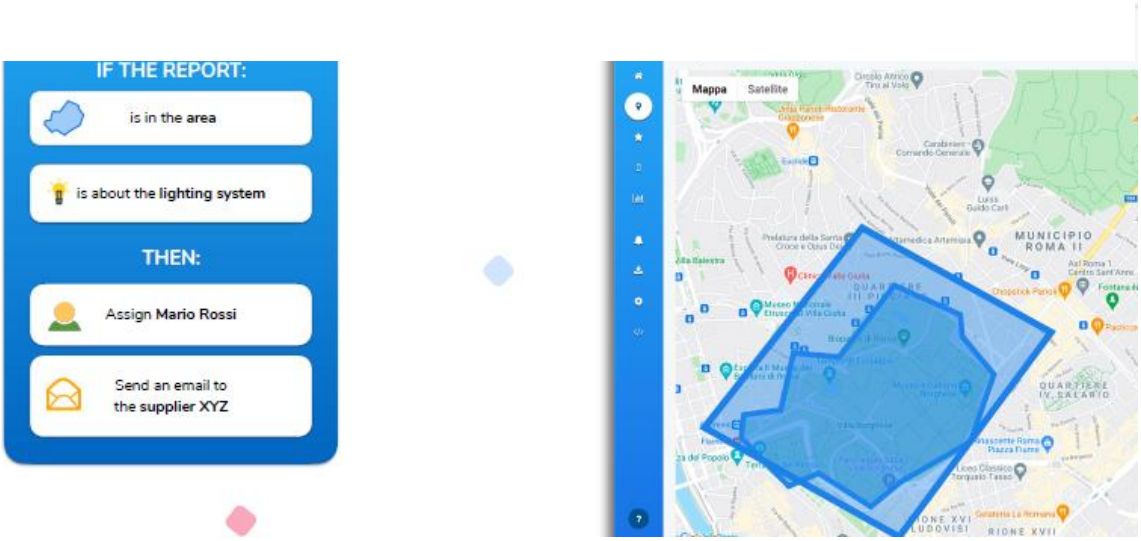
Comuni-Chiamo connects citizens with public authorities and their suppliers, allowing real-time inter-institutional and intra-institutional cooperation. As shown in Figure 12, users can fill out a report via the Comuni-Chiamo mobile application. The software automatically and immediately sorts and assigns the report to internal municipal offices and external providers with API integration. Users can, in turn, receive information on the status of their requests and even get direct messages from the municipality. Moreover, Comuni-Chiamo allows the municipality to connect with users autonomously or provide location-based information, such as the schedule for green area maintenance. This mechanism works both as a way for the city to send notifications to the user as well as through location-based information that appears when opening the app about nearby points of interest.

Figure 12. Comuni-Chiamo stakeholders' relationship – Source: Comuni-Chiamo



The tool is also flexible and user-friendly in the backend, where municipal employees can build new automated criteria for assigning responsibilities on incoming reports. As shown in Figure 13, this is a form of triage based on

Figure 13. Comuni-Chiamo automation interface - Source: Comuni-Chiamo



location and subject matter that is linked to the management process. This solution was specifically developed by Comuni-Chiamo to address Ravenna's distribution of responsibilities across its organization. Ravenna's internal organization is based on issues types (e.g., responsibility for the lighting system, responsibility for green areas management, …) crossing with different areas of the city, which is divided into several areas of intervention. However, this has not yet been used as a form of "business intelligence" understanding the differences in reporting across areas and addressing them with targeted actions.

Internal end-users verify new reports and ask for additional information from the user who filed the report. Then, they share the report with internal field operators, from the interested division, or with the external organization that is legitimate to intervene (e.g., the local water utility when a water pipe bursts). Periodically, they verify open issues, particularly those open for more than 30 days, and ask for feedback from the operators. The office responsible for Comuni-Chiamo adoption, in turn, verifies if every office is responding to its reports and if there are significant delays, intervening and asking for clarifications when needed.

In the conceptual framework, "the Context refers to specific features and dimensions of the local and regional environment that must be considered for the transformation and value creation of local and regional public services" (Vancauwenberghe, et al. forthcoming). The context was further defined around five attributes: beliefs and ideologies, drivers, challenges, local embeddedness, location data and technology management capability, as outlined below.

Beliefs and ideologies

Regarding beliefs and ideologies, the search and adoption of a new service were driven not just by the public employees responsible for innovative projects but also by the Smart City Deputy Mayor. The primary value that they hope to strengthen through the new tool was safety, initially "a local police theme", according to one of the municipal employees. Within this context, there were no incentive programs to adopt Comuni-Chiamo, making non-monetary drivers crucial in its adoption. A key incentive was pursuing the user-friendliness of the tool, shifting paradigm from the previous solution that did not incorporate any.

> *"In public services, there is rarely enough resource to generate user-friendly services, both for digital native generations and for more mature targets" – Comuni-Chiamo manager*

Drivers

A notable driver for the adoption of Comuni-Chiamo in Ravenna was the administrative history of Rilfedeur and its well-established practices, as the way of working was already in the mindset of users before moving to an improved system.

Challenges

Looking at potential challenges, the social and technological risk of excluding the older population – surprisingly – was not considered a critical factor after a first analysis. Multiple interviewers underlined that the solution is as easy to use as widely used social media platforms. As a municipal employee stated, "the platform allows municipal employees to input reports directly if they came from other channels," such as mail or email, mainly produced by non-digital native citizens, such as older people. Another potential challenge could be the economic aspect. Yet, the solution does not account for a remarkable share of a municipal budget and the technological infrastructure since a SaaS does not require physical or digital support.

Contrarily, some of the main challenges are ethical, legal, and technological. Comuni-Chiamo generates an extensive amount of data, and there are no "secondary business activities with data" (Comuni-Chiamo manager) such as reselling, where there is a need to protect users' privacy and guarantee cybersecurity. The company is indeed currently working on reducing the number of non-essential and personal information collected. For instance, Comuni-Chiamo rejected Ravenna's request to connect the reporting users to the municipal registry data since "a leak in the reported data would be much more critical if leaked data are related only to street holes when compared to a leak in the registry". From the municipal perspective, every other collection or use of data needs to be carefully evaluated, mostly through external legal consultants. Recently, privacy concerns have arisen within local authorities. Another legal challenge is the compliance of the solution with relevant regulations. Comuni-Chiamo "follow[s] evolution instead of planning it", and the improvement process in Ravenna was slowed down due to a need to better understand regulation before considering compliance because "municipalities, especially after the GDPR, are increasingly concerned about the legal aspects and their reluctancy

increased" (Comuni-Chiamo manager). The most recent instance of this theme is determining if access to Comuni-Chiamo needs to use the Italian Public System for Digital Identity (SPID), as this has become compulsory for public authorities and public service providers. The response could heavily affect the platform since only part of the population has its own Digital Identity, excluding some users and potentially reducing traffic and interactions.

One institutional challenge that the company had to tackle related to public sector specificities:

> *"Public authorities, particularly if they are small or medium ones, require specific know-how and a greater deal of agility. Often you have no counterpart that can fully understand your activities" - Comuni-Chiamo manager*

This was not the case with Ravenna, where the technological discourse was already in place. To underline the exceptionality of this readiness, one of Comuni-Chiamo's managers highlighted that usually public sector has "a certain fear of risk and failure and a parallel lack of entrepreneurial culture".

Local embeddedness

The local embeddedness aspect was particularly relevant for Ravenna since, before choosing Comuni-Chiamo, they, at the political and bureaucratic level, discussed formally and informally with geographically close municipalities, such as Cesenatico, that shared similar problems and needs. This closeness "leads to interest and, ultimately, adoption" (municipal employee) since municipalities usually share experiences and knowledge.

Location data and technology management capability

Finally, concerning location data and technology management capability, interviewers underlined that the presence of a champion of the process is vital to guarantee a smooth process, particularly in the case of Ravenna, where the manager was simultaneously in charge of personnel management, informative systems and innovation.

3.2.5.2 The service and the elements of the Conceptual Framework

3.2.5.2.1 Input

"Inputs refer to attributes that the transformation process taking place within a local or regional public administration and focused on a local or regional public service delivery, can use" (Vancauwenberghe, et al. forthcoming). They are location data, location technologies, objectives and organisational resources. As already highlighted, at first, the objectives were a contextual one, namely substituting the older system, and two strategic ones, namely increasing safety and perceived security and improving user experience.

The data are collected directly by users via a mobile device and can be personal data regarding an individual who is reporting details related to the reported issue (e.g., the type of problem classified according to a controlled vocabulary, a description and its urgency), automatically collected coordinates – when possible - of the problem; and a photograph picture of the problem. In addition, the processing of data by the municipality and its contractors produced other data, such as the status of the issued report, who is responsible for managing the problem, messages to the user and, in some cases, even a picture of the implemented solution. In this case, the used location technology is highly diffused, namely the GPS built into smartphones and similar devices. The municipal employees and contractors can access the platform via their personal computer, smartphone, tablet or other devices. As underlined by the external software provider, the innovative aspect is that street-level workers started to be trained and were provided with mobile devices, such as tablets, to locate problems quickly and to report the status of an intervention on a reported issue during their work directly.

From the software standpoint, interoperability is a pivotal aspect of fulfilling the municipality's needs. Therefore, Comuni-Chiamo guarantees integration with other services and systems, building a "library" of integration resources with their work in each municipality. In fact, "Comuni-Chiamo has standard protocols (API) that integrate automatically with most software" (Comuni-Chiamo manager).

3.2.5.2.2 Transformation

"Transformation refers to the approach of (re)designing and (re)developing public services in order to create public value, whereby there is a radical innovation instead of an incremental innovation (Osborne and Brown

2011)." (Vancauwenberghe, et al. forthcoming). One can distinguish internal processes, that is, governance, and external processes, that is, stakeholder involvement.

Internally, Comuni-Chiamo allowed the municipality of Ravenna to rethink and improve project management around public works. For the municipality, the change of software triggered a review of their organisation and the functioning of the offices. However, adaptation to the software was considered an opportunity more than a forced requirement. In fact, "the simplicity of the tool required [us] to also simplify some processes" (municipal employee), such as staff responsibilities and the internal administrative steps separating a reported event from its solution, as well as moving reporting entirely online (including adding input from offline sources). This digitalization has been particularly useful during the Pandemic since working from home policies slowed down the processes of organisations that still relied on in-person communication and paper-based information. From the point of view of Comuni-Chiamo, the remarkable change fostered by the platform was the need for municipality staff to take responsibility and make decisions in uncertain and unclear situations, where reports would, otherwise, have remained stagnant due to siloed processes with unclear responsibilities.

Externally, several interviewees underlined that, unlike other municipalities, Ravenna has an organisational culture that fosters stakeholder involvement. Every institutional actor, namely Comuni-Chiamo, the municipal offices, software providers and public work contractors, was involved from the beginning of the project. Putting together needs and experiences, highlighting the possible use of the new tool, made everyone aware of the potential benefits of a "product-people fit", avoiding any organisational resistance (Comuni-Chiamo manager). With regard to citizens, they were not involved directly in the creation or revision of the service functioning, at least in Ravenna. Apart from the common in-app feedback, Comuni-Chiamo is planning to start a more structured process of citizens' involvement. Looking beyond the public work management processes, citizens usually consider the municipality the ultimate entity responsible for local issues. They used the app to report issues that were legally the responsibility of other bodies (e.g., water pipe ruptures are the responsibility of the local water provider). The adoption of Comuni-Chiamo, therefore, pushed the municipality to become a pivotal element of a network of public authorities of Ravenna, including the Province of Ravenna and the Emilia-Romagna region, as well as local specialized agencies and public service providers.

3.2.5.2.3 Output

"Outputs refer to the products of the transformation process of local or regional public services" (Vancauwenberghe, et al. forthcoming), which can be divided into internal and external services. Therefore, it can be said that Comuni-Chiamo has a double focus.

Interviewees underlined that the objectives at the basis of Comuni-Chiamo were a greater degree of user-friendliness, both towards internal and citizens-users, and a need to increase safety, security, and, more generally, the decorum of the city, namely guaranteeing a tidy and clean city minimising, for instance, street potholes and well-kept green areas. However, when asked about "the main output" of the service implementation, most of the interviewees, especially the internal ones, identified both an internal effect and an external one, without the second being predominant. Specifically, the internal service underlined that Comuni-Chiamo increases efficiency, freeing up organisational resources for other purposes. It also provided a more transparent and homogeneous set of data that was more manageable than the previous multi-source reports coming from social media, email, mails, and other forms of communication. Externally, rationalising these communication channels has a similar effect on public sector providers, other public authorities, and citizens.

3.2.5.2.4 Outcome and evaluation

"Outcomes refer to results produced by transformation processes of public services at local or regional level. In contrast with outputs, the outcomes measure the value or impact of local or regional services" (Vancauwenberghe, et al. forthcoming). The public values generated by the adoption and roll-out of Comuni-Chiamo in the city of Ravenna can be firstly defined as operational. As already highlighted, Comuni-Chiamo fostered more nuanced user orientation and collaboration with citizens while also increasing the efficiency and effectiveness of citizens-public authorities' relations. It is interesting to note that, while political and social values were extensively pointed out as the reason to adopt Comuni-Chiamo in Ravenna, the first public values expressed during the interview were focused on operations, something that was mainly inward-looking. When delving into other public values, stakeholders underlined participation as well as accountability and transparency, since users can verify a report's status on the platform. Social values were the least important, yet interviewees stressed the relevance of stronger relations between citizens and their authorities, namely greater trust. Surprisingly, quality of life was not identified as an outcome during the interview, maybe signalling that more reports and relative

solutions are needed to have a perceivable impact on the city's quality of life. This outcome, nonetheless, is difficult to measure in general, and clear causal links between such a service and a city's quality of life outcomes are also difficult to demonstrate. Despite the different perspectives and relevance attributed to public value, as one of Comuni-Chiamo's managers underlined, one needs "to build and work for all the three categories of value to generate a true impact".

Concerning the evaluation of the impact, "there seems to be still a loose connection between actual data [produced by Comuni-Chiamo] and policy choices" (Comuni-Chiamo manager) since the measurement is related to the number of reports, solving times, and report categories. However, it does not include any real-time feature or evaluation of users' satisfaction with the service. Anyway, Comuni-Chiamo is planning to roll out both. Moreover, currently Comuni-Chiamo data are not used to evaluate public employees and contractors.

3.2.5.2.5 Replicability and scalability

Comuni-Chiamo is currently replicated in more than one hundred municipalities across Italy. However, replication in the EU poses some additional challenges, even if, at least in principle, the tool could be easily replicated both from a technical and language standpoint. According to Comuni-Chiamo interviewees, the first issue relates to financial barriers, which would increase substantially in case of a cross-border expansion.

> *"On average, it takes two years to reach a deal with a client, in addition to two or three years before a margin. Replicability outside Italy seems out-of-reach resource-wise" - Comuni-Chiamo manager*

The second problem is regulatory: "it is the normative scalability that we consider problematic, not the technological one" (Comuni-Chiamo manager). Different norms and rules pose an obstacle that Comuni-Chiamo does not want to face at this moment of its evolutionary trajectory. They underlined that the Italian strict bureaucratic constraints faced in their day-to-day activities discourage them from even thinking about entering another EU country's market. This could be understood as a legal and cultural interoperability, where different social and legal norms discourage actors from extending their area of activity beyond national boundaries.

3.2.5.2.6 Lessons learnt

Concerning its future evolution, Comuni-Chiamo provides a quick state-of-the-art application that also helps to build or fix internal processes in the short term. However, in the long-term, foreseen data collection and software integration might lead to more complex and innovative processes (e.g., machine learning artificial intelligence, ML, AI) that still require a specific scale of activity to be fully implemented and certain patience to learn and arrive at desired outcomes. "Ravenna is unusually faster, but Italian Public Sector is lagging" (Comuni-Chiamo manager).

From an organisational standpoint, Ravenna's experience shows that transparent and decisive governance can steer change towards the desired outcome. In this case, the early involvement of different actors, such as the external software providers, the personnel and ICT manager of the municipality, and the public maintenance managers, was a key to implementing the innovation without significant organisational resistance. Interoperability is a critical factor from the organisational perspective since it allows this multi-stakeholder governance to be reflected in system connections. Moreover, interoperability is also a critical factor in reaching public value, both for the operational value generation (i.e., to rapidly process reports and solve them, going directly to the public contractor) and for the social and political value generation (i.e., giving feedback to the user about the results of the process after reporting).

From a technical standpoint, the innovative aspects are related to the simple user interface, which is rarely deemed crucial in public sector platforms, and to the technical side. In addition, automation is embedded in internal processes. From a public engagement perspective, Ravenna's platform, which has existed in different forms for a long time, suggests that engaging citizens as users of a digital public service is not easy and is not merely related to the usability and functionality of the tool. Yet, the ability and technical possibility to keep people informed of the status can build confidence in usage and an appreciation of how long it takes to address identified issues. It introduces notions of openness, accountability and education on how the municipality operates and seeks to have good collaboration with users. These factors are prerequisites on which public authorities should actively build engagement programs, such as school meetings to teach students the value of reporting a problem in the city and make them aware of the tools available from the public sector. In Ravenna, one should also mention the role of political communication, since local politicians have invited citizens to use

the app to report any problem in the city. The strong political heritage in Ravenna, which has been governed by left-wing or centre-left mayors since 1946, seems to have avoided major forms of resistance towards the application or any political use.

3.2.6 Ahrweiler's recovery after the flood through a different addressing system

3.2.6.1 Introduction to the service and its context

This case study is related to the emergency flood response and recovery in the valley of Ahrweiler, a district (*landkreis*) in the German *Länder* of Rhineland-Palatinate. The area was heavily hit in mid-July 2021 by the floods that ravaged an area between Germany, the Netherlands and Belgium[39]. The flooding killed 180 people across Germany, 133 in the valley, which is home to around 130,000 people. This case study investigates the flood response and recovery process, particularly the use of what3words – an innovative addressing system. In that period, local and non-local teams were facing several challenges related to response and recovery: the need to coordinate many thousands of volunteers that did not know the area and that had a rapid turnover; the need to remove waste produced by the flood, in more significant quantities and peculiar locations if compared to the *status quo*. The value sought through the adoption of what3words in the processes of response and recovery was the rapid and easy communication of location in times when standard systems are not working correctly (e.g., missing street names or numbers) or are difficult to use with a broad audience (e.g., volunteers might not understand coordinates or be familiar with the area).

The name of what3words already includes a reference to the functioning of the service: the company "divided the world into 3-metre squares and gave each square a combination of three words"[40]. For example, the real-world location/address "Piazza del Duomo in Milan" can be shared as "///fanali.filetti.dipinto" or, in the English version of the tool, "///packing.yawned.next" for the square located at the North-East corner of the Vittorio Emanuele the Second monument. The location could also be described by the coordinates "45.464259, 9.189383" that identify a spot within the 3-metre square more precisely, yet a human being would be prone to errors when communicating them. what3words aims to allow human beings to share location data more easily, especially when the conventional addressing system fails to identify a single place univocally. For instance, a place on a public beach, in a parking lot, or simply in a big square, like Piazza del Duomo, fails to be identified by the addressing system.

> *"In general, location in emergency services does not seem a problem since Advanced Mobile Location (AML) technology should easily trace the location of the caller. Yet sometimes this fails to provide one, and street addresses might be problematic as well, and it is in this gap that what3words seeks to become a new additional global standard for addressing." - what3words manager*

A number of emergency centres internationally use what3words to support their operations. The company has not fully pictured the number of emergency centres that currently use what3words within their normal operations whenever locating an emergency with ordinary systems is difficult or impossible. This is because "organic [i.e., usage of the platform via its open channels – app and website – without connecting with the company] usage is remarkably high" (what3words manager). Furthermore, due to its societal value, the company has decided not to charge a fee in this particular sector. Nevertheless, the company acknowledges that Germany and UK are the most mature markets:

> *"The solution is currently adopted by 90% of emergency call centres in the UK and is expanding across Europe. For instance, in Germany, it could be as high as 30%" – what3words Manager*

Beyond emergency services, several other use cases include what3words service use. This includes mobility and transport, operations and deliveries, and as an alternative addressing standard, like in Ivory Coast. As highlighted in our previous research (Barker, et al. 2021), such a service could be useful potentially in large, overcrowded locations without significant reference points, such as refugee camps.

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39 https://news.sky.com/story/germany-floods-rebuilding-begins-in-ahrweiler-where-at-least-117-were-killed-12359369

40 https://what3words.com/about

This case is peculiar because the use of the tool was organic and not pre-planned or integrated into the city's operations before the flooding. Therefore, emergency units did not use what3words to save people during the emergency. On the one hand, civilians hit by the floods did not have the time or energy to learn to use the tool; on the other hand, the area had no electricity for the first two weeks: as the interviewed field coordinator said, "the only working maps were paper ones", and, even if and when electricity was available, digital services were often unavailable due to poor signal. The first documented usage of what3words was driven by the civil protection agency THW (*Technisches Hilfswerk)*, which used the system to locate tents and other points of interest for its personnel. At the time, other organisations did not incorporate such a tool in their processes. Instead, the tool started to be widely used to support quicker recovery from the flood. Multiple interviewees pointed out that streets were not visible and communicating location was complex for locals and non-locals. In particular, the floods produced an unprecedented quantity of waste that needed to be identified, located and transported:

> *"The issue of waste from flood damage exploded. We usually have 7,500 tonnes of bulky waste a year in our county. Due to the flood, we had 350,000 tonnes in two days. We tried to separate the waste and transport it for recycling. The what3words addresses were helpful" – Field coordinator*

> *"You do not have an easy way to locate some debris that is on top of a tree when the flood dries. what3words also helped in these cases" – Researcher*

There were usually 80 people involved in waste collection. They increased up to 300 in a few days, in addition to thousands of non-professional volunteers from other areas of Germany. However, this created a permanent problem with training and coordination since "they needed a simple addressing aid to find the places where they were working" (field coordinator). This need was continuous since volunteers' stay lasted only a few days each. The tool also helped local engineers report damage to the water and wastewater infrastructure through an easy means of communication, both in written and spoken form.

The case study began with an analysis of relevant documents provided by the case stakeholders. In particular, we analysed:

- what3words website[41], particularly looking at "How to use what3words", "Emergency services", "Emergency services in Germany, Austria and Switzerland are using what3words to improve response times";
- The technical protocol for location data exchange that was used, before the crisis, to connect location data of the local civil engineering platform LocalExpert24 with what3words (German Institute for Standardization (DIN) 2020);
- The website LocalExpert24[42], the local platform that used what3words before the emergency and allowed a rapid roll-out after the emergency;
- The website of Thinking Circular[43], a German think-tank that is studying the flood response from an environmental and waste collection and disposal perspective.

After the desk analysis, we interviewed four stakeholders: two managers from what3words, a researcher (who was also a former local politician) and a civil engineering expert involved in the flood response.

In the conceptual framework developed within this study, "the Context refers to specific features and dimensions of the local and regional environment that must be considered for the transformation and value creation of local and regional public services" (Vancauwenberghe, et al. forthcoming). The context was further defined around five attributes: beliefs and ideologies, drivers, challenges, local embeddedness, location data and technology management capability. In this case, beliefs and ideologies seem not to have had a particular role in driving adoption.

Drivers

41 https://what3words.com/about
42 https://localexpert24.de/home
43 https://thinking-circular.com

Among the drivers, the simplicity of use is one of the most critical factors that allowed adoption since the service requires only basic digital skills. Furthermore, from an organisational point of view, what3words does not charge any fee for emergency services. Finally, the possibility of the "organic" use, without registration or subscription, allowed a fast and easy rollout. However, the latter would not have been possible had what3words not been already used in the Ahrweiler area, thanks to a local team of engineers.

Between challenges and drivers, stakeholders highlighted the network dynamics that characterise such a service: "adoption triggers adoption" both at the user and provider levels (what3words manager). As a result, its value increases disproportionally for every additional user, where at a certain threshold, the tool becomes valuable for the whole organisation or society.

Challenge

Furthermore, a particular challenge that impedes the early adoption of such a service is the lack of "knowledge and awareness" (researcher) related to the unknown possibilities of catastrophes. In other terms, "you need a culture of emergency response" (field coordinator). The absence of this substratum affects the probability of adopting services that would only be needed in times of emergency of this magnitude. After the flood, Ahrweiler started to train youngsters in climate change topics, including training in the use of what3words. At this time, it seems unlikely that other communities that were not hit so heavily by the floods have started similar programs. Nonetheless, other use cases encompass the use of the app (e.g., commercial deliveries and car navigation systems), so this may form a knowledge base for future use in emergency situations and might build people's awareness and adoption (in other terms, the download and knowledge of the app) that could come to hand in case of emergency.

3.2.6.2 The service and the elements of the Conceptual Framework

3.2.6.2.1 Input

"Inputs refer to attributes that the transformation process taking place within a local or regional public administration and focused on a local or regional public service delivery, can use" (Vancauwenberghe, et al. forthcoming). As already underlined, the tool was already embedded thanks to a local team of engineers. The group developed a GIS-based platform (LocalExpert24) for managing civil engineering projects and decided to integrate what3words into the platform a few months before the floods. They sought to have a more precise identification of places that also supported ease of use since what3words only needs smartphones to function. The integration of the two systems was made through the DIN Spec 91419 standard. This technological infrastructure allowed the Ahrweiler area to have a ready-to-use reporting system connected with what3words during the flood response.

3.2.6.2.2 Transformation

"Transformation refers to the approach of (re)designing and (re)developing public services in order to create public value, whereby there is a radical innovation instead of an incremental innovation (Osborne and Brown 2011)." (Vancauwenberghe, et al. forthcoming). One can distinguish internal processes, that is, governance, and external processes, that is, stakeholder involvement.

Given the unstructured nature of the implementation process, the use of what3words acted as a resource to enhance and support coordination mechanisms and a common language for a diverse set of actors:

> *"Emergency response involved multiple actors, such as the Red Cross, volunteers, Caritas, and the Army that communicated via different means: phones, emails, …" – Researcher*

The coordination required each of the involved actors to undergo some adaptation and training to include what3words as one of their "languages". This mechanism was also a decentralised and multi-centric one, since each actor shared the tool with others without centralised direction or control/checking. If "in normal times the tool would need to be embedded in a larger digital transformation process" (what3words manager), the emergency situation made it possible to deviate from this paradigm. This coordination model does not envisage clear ownership and direction: in an emergency, the rapid rollout of innovative solutions can be, as in this case,

more manageable in terms of faster decision-making and loosening legal constraints. However, in normal times, a similar process could be complicated by multiple actors without a unified agenda and a shared priority.

3.2.6.2.3 Output

"Outputs refer to the products of the transformation process of local or regional public services" (Vancauwenberghe, et al. forthcoming), which can be divided into internal and external services. The use of what3words in the flood recovery process can be thought of as a case of external service, albeit within its peculiarity. Though not provided directly by a public authority, it was a crucial element in a web of relations among public and private actors involved with different roles in the emergency. It was a platform to help the collaboration of several governmental and non-governmental actors, whose collaboration, however, extended beyond the tool. Interestingly, the identification and adoption of a tool in times of emergency could not come from a centralised approach but, instead, from the network of involved actors. It was precisely the early adoption and knowledge of the tool within the web of stakeholders' relations that allowed for such a quick roll-out.

3.2.6.2.4 Outcome and evaluation

"Outcomes refer to results produced by transformation processes of public services at local or regional level. In contrast with outputs, the outcomes measure the value or impact of local or regional services" (Crompvoets, et al. Forthcoming). The first values generated within this experience are operational since it guaranteed ready communication and a more effective way to tackle the problems related to organising volunteers and identifying waste: "in a situation in which waste was on top of trees and houses and street addresses were not sufficient to remove it rapidly" (researcher). Furthermore, the effective involvement of volunteers and civil society organisations in the provision of post-disaster response is a particularly relevant generated political value. Finally, with regard to social values, it is possible to highlight the provision of environmental clean-up and waste management, provided effectively by multiple actors and individuals.

3.2.6.2.5 Replicability and scalability

This case has already been replicated. Some EU countries already show a certain degree of coverage in emergency services that have incorporated what3words in their processes. The organic use of the platform highlighted a gap in the emergency response system that can be leveraged in the future and scaled. With the increase of catastrophic events expected with climate change, extreme natural events will likely happen more often. Institutions often act only after emergencies. Tools such as what3words, and other services that are needed only in case of emergency, are first experienced in case of emergency. Yet, institutions should plan their adoption and upscaling to other areas before the next emergency happens.

3.2.6.2.6 Lessons learnt

The Ahrweiler flood recovery provided multiple lessons related to organisational change, technological innovation and public engagement.

From an organisational standpoint, this case highlighted the rapid rollout of new solutions that come with emergencies, yet also the challenges of a coordination model that does not envisage clear ownership and direction:

- Emergencies add complexity, yet they also remove layers that are usually challenges for the rapid rollout of innovative solutions. The emergency status allowed rapid decision-making and loose legal constraints in this case.
- A solution such as what3words, which can be considered more of a language than a service, allows actors to independently adopt it and exploit networking dynamics, where most of the value of such solutions resides. However, in normal times, such processes could be complicated by multiple actors seeking solutions without a unified agenda or shared priorities.

From a technical standpoint, what3words is a solution that can be embedded in a location-enabled service. Its use in Ahrweiler, as we note in our previous research (Barker, et al. 2021), is innovative in terms of the development of an alternative geocoding system. Furthermore, it clearly shows that the existing infrastructure, namely the portal LocalExpert24, is a key input for fast implementation, even if not public-owned. Local and regional government bodies are only two of the stakeholders involved in projects and initiatives to drive and deliver public service innovation. The majority of public service digital transformation projects include the involvement of a broad ecosystem of stakeholders. As noted by Chen, Walker and Sawhney (2020), new models

of public governance generally include more of an "external innovation locus, where" they observe that an ecosystem of actors has become increasingly important for public service innovation "due to the complexity of modern, wicked problems that require cross-sectoral collaboration."

From a public engagement perspective, the case clearly shows that services based on network dynamics need ways to involve potential users (the volunteers in this case), train them, and increase the adoption rate. Indeed, Ahrweiler's children are already trained in climate change and emergencies, including what3words usage.

3.2.7 Permit delivery for the use of public space in Leuven

3.2.7.1 Introduction to the case and its context

Spotbooking is a location-enabled public service implemented and used by the City of Leuven. It builds upon, and is linked to, the location-enabled public service GIPOD (Generic Information Platform Public Domain) offered by the Flemish Administration for the whole Flemish territory, providing an overview of all the public locations (streets, squares …) where hindrance might occur due to works or events.

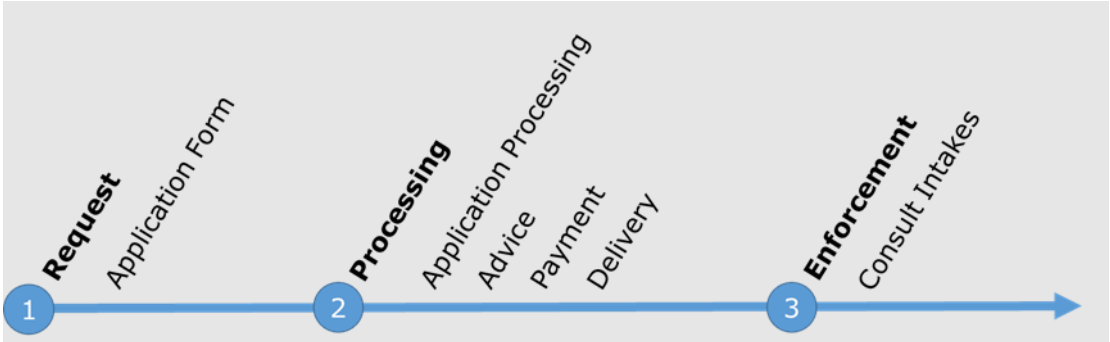
Spotbooking allows citizens and businesses to request a permit online for the usage of 'public space', for example, one or more parking places in a street to put a container, or the use of part of a square to organise a market. The user must provide administrative information but can also draw the particular area that will be occupied. The environment is visible through an easy-to-understand detailed map (indicating streets, pedestrian sidewalks, parking spaces, etc.). The system automatically checks against other planned events in the vicinity and detects potential conflicts by connecting to the GIPOD database. The system automatically informs the relevant departments that should provide advice. This aspect created added value from the beginning in terms of more streamlined and faster workflows, as well as a clear division of tasks. Moreover, external stakeholders should know about the request for their own activities (e.g., the need for re-routing bus lines).

A private company, Geosparc, has developed Spotbooking. Other companies offer similar solutions. Spotbooking was initially developed for, and with, the City of Kortrijk in 2014. Since then, other cities and municipalities have implemented it: Hasselt, Lier, Ninove, Asse, Hamme, Kapellen, Keerbergen, Wingene, Stabroek and Zonhoven. Although the service is organised and offered by the respective cities/municipalities, the private sector remains the host of the solution, i.e. they host and manage the service and the data collected as part of the permit request (data from the Flemish SDI are accessed through API's and web services). The permit 'dossier', including information about the requesting party, pictures of the public space, and information on the permit itself, is managed by the city. This means that the city can focus on the process itself, i.e., the handling of the request for the use of the 'Public Space'.

The City of Leuven has set up the service to liberate staff from the administrative (analogue) burden related to the legal obligation of collecting information on potential hindrances in the 'Public Space' via GIPOD. By offering citizens and businesses an online solution to formulate and document a request for using 'Public Space', public officers can spend time on other tasks. The ultimate objective is – by automatically checking potential conflicting requests and by informing all stakeholders – to minimize (potential) hindrance. In that way, it also indirectly creates a positive impact on the environment and social and economic activities.

In summary, Spotbooking is a service that supports the process of delivering permits for the use of 'Public Space'. Any citizen or business can initiate the process. It entails three stages: 1) the request, 2) the processing of the request (back office), and 3) enforcement in the field. The enforcement is supported by a mobile app that allows city employees to check whether the intake of public space is implemented correctly. They can make notes with the app and e.g. check the progress of the works or the event concerned, observe damage, cross-check the correct use of signages, etc. The app allows to see all the active requests and exchange information with the back office. Also, citizens can use the app to see and exchange information regarding their request.

Figure 14. The process of permit delivery for the use of 'Public Space'



The Context refers to specific features and dimensions of the local and regional environment that must be considered for the transformation and value creation of local and regional public services (Vancauwenberghe, et al. forthcoming). The Context includes various attributes that could affect the choices for planning and implementing public services at the local and regional level, such as: Beliefs/Ideologies, Drivers, Challenges, Local embeddedness and Location management capacity (Christopoulou, Ringas and Garofalakis 2014, Estevez, Lopes and Janowski 2016). We briefly describe the different attributes as identified in the desktop analysis and/or confirmed by the five interviews.

Beliefs / ideologies:

Although the interviewees did not explicitly mention the set of (most important) beliefs, values and ideologies, they can be derived from general publications and promotion campaigns from the City of Leuven as a whole. These include, for example, the city: being an innovation hub[44], going for a climate-neutral future (Leuven 2030[45]) and being a centre for economic development.

Drivers:

Several drivers can be distinguished. Firstly, the existence of a set of legal instruments that makes the request for a permit for the use of 'Public Space' and the information exchange on the use of 'Public Space' mandatory triggered the use of GIPOD and the development of the Spotbooking service that connects to it. Secondly, the fact that staff working for local authorities are – due to the high number of permit requests – overloaded with administrative paperwork in the analogue process pushed for the implementation of a fully-digital version of the service. Thirdly, the existence of a rich Spatial Data Infrastructure (SDI) with location data at a very detailed level[46] (including the Central Reference Address Database CRAB, GRB), the necessary access services and APIs made a quick development of the service possible. Fourthly, the City of Leuven had already a lot of experience in implementing and using location data and technologies, with a strong management capability and a well-developed capacity with good basic infrastructure used in various administrative and decision-making processes (planning, managing green areas, transport and mobility …). Finally, the open mindset of the city to allow reuse and further development of the solutions developed for them, and the entrepreneurship mindset of private sector players, made innovative development of the service possible[47].

Challenges:

Several challenges were encountered in this case. Firstly, the existing location-enabled technologies were too 'heavy' and complex. Adaptations to the internal GIS platform would have required too much time and some of the required functionality was not possible within existing solutions, meaning a new type of service needed to be developed and implemented. Secondly, there was some internal 'resistance' to the new service because it changed the 'habits' of some administrators, although end-users (citizens, businesses) were happy, and personnel adapted quickly.

> *"In the beginning, some resistance from the lower-skilled civil servants doing the manual handling of the requests of the use of the public*

44 https://ec.europa.eu/info/news/leuven-european-capital-innovation-2020-2020-sep-24_en

45 https://www.leuven2030.be/english

46 Including the Central Reference Address Database (CRAB), and the Large Scale Reference Database (GRB). See https://www.geopunt.be/catalogus/datasetfolder/0894e08f-a78f-4360-bb00-bee3dce1e94e and https://www.geopunt.be/catalogus/webservicefolder/4a889731-bee2-4a3b-b8f9-9e929a46c9af respectively.

47 There exist similar solutions from other companies that are doing more or less the same.

domain. However, this resistance decreased quickly" – Technology Officer, City of Leuven

The third challenge was related to the end-users being accustomed to the old type of application (mostly manual and on paper), as there was now a new graphical interface and the possibility to delineate proposed (parking) spaces to be used[48]. Fourthly, the former (analogue) service was highly centralised, in a front office that applicants could visit in person, but the process was not always clear and needed to be streamlined. Finally, many different stakeholders had to be involved (the Region, the public transport company 'De Lijn', the Fire brigade, the Association of Cities and Municipalities, etc.), so there was an inter-institutional challenge to bring them together and agree on the process and contributing to the definition of the system's specifications.

The Spotbooking Case Study started with a preparatory phase. First, relevant documents and websites were consulted. Then, the service was tested. Important documents in this preparatory phase were:

- The decrees that form the legal basis for collecting information regarding potential hindrance in 'Public Space' (Flemish Government 2014, Flemish Government 2016, Flemish Government 2017);
- The website of Geosparc[49], the developers of Spotbooking, including a downloadable description of the service and a video[50];
- The service itself as implemented in the City of Leuven, which is accessible both as 'guest' (without login) and through the use of an eID[51];
- The geoportal 'Geopunt'[52] where the data and web services used in Spotbooking can be found, including their description (metadata), as well as the GIPOD application[53]. In addition, the APIs are documented and can be found on the webpages of Information Flanders[54].

One of the team members carrying out the study used the service some time ago as a real end-user (preparing works at his house). This helped to understand the service from an end-user perspective. In a second stage, a series of five interviews were organised.

3.2.7.2 The service and the elements of the Conceptual Framework

3.2.7.2.1 Input

According to the Conceptual Framework, this covers several aspects, including clearly defined objectives (related to the intended transformation process), organisational resources, as well as (location) data and technologies. They are used to perform the transformation process and to generate the outputs and outcomes.

Objectives:

- To simplify and streamline the process of permit delivery for the temporary use of 'public space', thereby working more efficiently and effectively, and providing faster response to citizens and businesses;
- To help minimise the hindrance that such use might have on traffic, activities of citizens and society at large (public transport, emergency services …).

Organisational resources:

- The staff of the local authority is still involved as before (manual process), but they (should) have less of a workload compared to how the previous process ;

48 By drawing an area and/or by selecting one or more vehicles and the space they would occupy.
49 https://www.geosparc.com/en/about-geosparc
50 https://youtu.be/CiJ5CuNOiB8
51 https://leuven.spotbooking.be/#/aanvraag/new
52 https://www.geopunt.be
53 https://overheid.vlaanderen.be/en/producten-diensten/generic-information-platform-public-domain-gipod
54 https://overheid.vlaanderen.be/webdiensten-ons-api-aanbod

- The service should be (and is) self-explanatory and easy-to-use with an intuitive user interface that guides the users through the permit-requesting process. No training is required and many steps are automated;

"We found (in the development phase) that for users it was not easy to use a graphical interface, so the solution had to take 'habits" from users into account. For example, it was not easy to 'draw' on a map, hence we introduced pre-defined objects (e.g. cars). Also, we found that the abstract representation (e.g. of streets, buildings, parking spaces, cars) was not so easy for the user, and neither was the combination of information layers" - Developer of the service

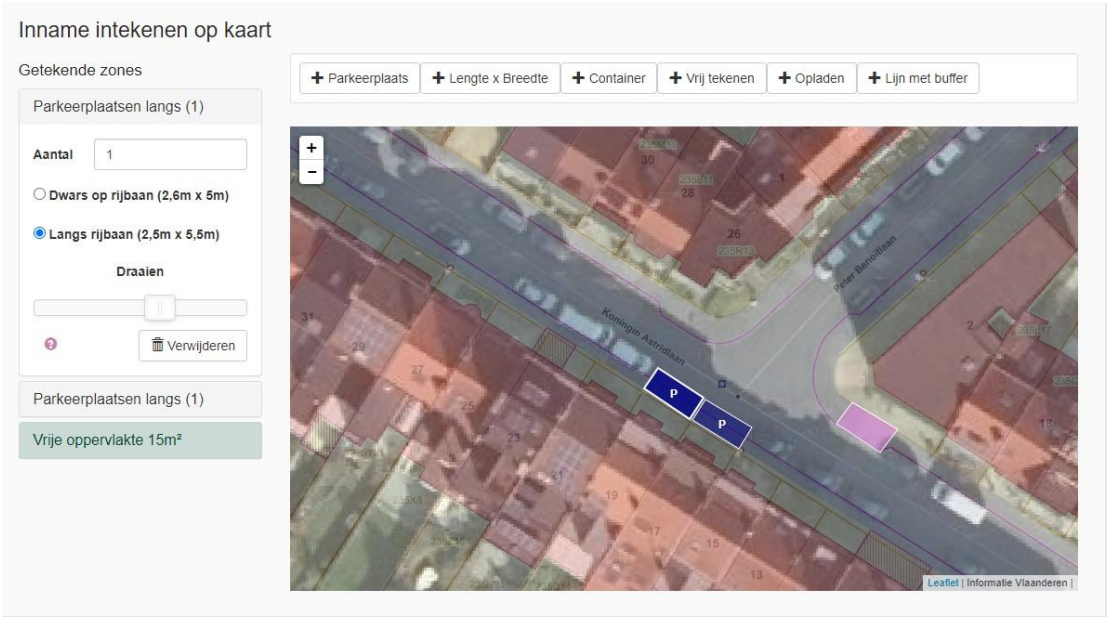
(Location) data:

- Background layer with location information about the streets, pavements, parking, as well as an orthophoto (image) with the buildings and land parcels. Data was also included from the Large Scale Database of Flanders (GRB) or from Open Street Map (OSM);
- Address data (street name, number) used in the form for the permit request and used to find the right location for which the permit should be initiated (geocoding);
- Administrative information related to the permit request such as: time-span of the request; type of event/activity (16 options available from a controlled vocabulary), e.g. container, lift, construction materials; drawing of the affected zones, through pre-defined symbols, free drawing, adding measurements …; whether there will be a hindrance or not; request for dedicated signage; contact details.

(Location) technology:

- Internet-based application (with several modules) for citizens and businesses to handle the requests;
- Mobile app for administrative personnel that performs controls to enforce implementation, as defined in the permit;
- Both applications use different interoperability components such as eID (for user authentication), CRAB API (addresses), GIPOD API (for linking to GIPOD), GRB API (for accessing the large-scale data) and several Web Mapping Services for visualising.

Figure 15. Screenshot of the Spotbooking user interface for citizens (graphical part)



3.2.7.2.2 Transformation

In the Conceptual Framework, transformation is described as the approach of (re)designing and (re)developing public services in order to create public value, whereby there is a radical innovation instead of an incremental innovation (Osborne and Brown 2011). The Conceptual Framework focuses on two aspects (or attributes) of transformation, i.e. Governance and Stakeholder Involvement, which relate respectively to internal and external processes (Crompvoets et al., 2021).

Governance:

The Spotbooking service is quite unique from the perspective of the way it is governed and the business model applied. Although the original solution was developed as part of a request (call for tender) by another city (Kortrijk), the company decided to invest in the solution so that it could be replicated and reused for other cities and municipalities. Kortrijk, on the other hand, allowed this reuse and the company to build a business model around it. In addition, experiences from different cities and municipalities were shared in dedicated meetings and through various initiatives. So, an ecosystem was created around the service.

Moreover, the implementation approach is also different from many other technical solutions, i.e. the system is not managed by the City of Leuven itself, but by a private company. The solution is implemented as a 'Software as a Service' in the cloud, so the city/municipality pays a fee, has a contract, and the solution is 'configured' based on local needs. This also means that the city does not need a copy of the datasets used and has no duties to 'manage' the solution. Of course, the requirements are defined by the city, and the permits (dossiers) are also managed by the city. In short, the private sector is responsible for the technical management, while the city focuses on the process handling itself (core business).

Stakeholder involvement:

For Spotbooking, stakeholder involvement was relatively complex but also innovative. Innovation came from a private sector partner providing a solution that was tailored to meet specific local needs. It was also innovative because the solution did not require huge technical and human investments for the City to implement and, because the service is conceived as a set of building blocks, it could be easily expanded with new modules and modernised when basic components and standards evolve.

Table 4. Internal and External stakeholders involved in the development, implementation and management of Spotbooking

Internal to the City of Leuven	External to the City of Leuven
City Council	Geosparc
ICT department	Public Transport Company 'De Lijn'
Police department	Hospitals and related emergency services
Fire Brigade	Information Flanders (former AGIV)
Financial department (payments)	City of Hasselt and HeLics[55]
Several other departments (advice)	Citizens and businesses

Although citizens and businesses are not involved in the decision-making process, they are taking part in the collection and transmission of information in a modern way with less 'red tape' than in the similar analogue process. From the perspective of the Government Models applied, the approach was also innovative in the sense that all stakeholders involved followed an Open Governance model: they defined and designed the solution together, while the original funder, i.e. the City of Kortrijk, allowed the private company the create a new market with the solution. Also, the fact that the SDI coordinator (Information Flanders) and other public sector players were actively involved and provided pieces of the solutions maybe made things more complex, but also open and innovative. End-users were involved in the design process in different ways: 1) public officers handling the permit request were involved intensively because of their knowledge of the process, and 2) end-users (citizens,

[55] https://www.helics.be

businesses) provided comments on different versions of the service developed. Both mechanisms provided input for improving the design and developing the technical solution in an agile way. However, the developer was not in direct contact with citizens or businesses, but they received feedback through the public officers involved. This is also the way in which feedback is collected once the solution becomes operational. The developer gets the comments from citizens the cities receive via e-mail.

3.2.7.2.3 Output

The Spotbooking service has an external and internal service, as defined in the conceptual framework.

The external service is directed towards the end-user, a citizen or business that requests a permit to use 'public space'. There is a dedicated interface. Users log in with their eID (they also can be 'guest') and get a form to collect the administrative information. At the end of the process, the user receives a permit (or not). Therefore, the output is the permit for carrying out the work, which includes a document with a map. It has a legal value and is followed by a physical implementation: the user occupies the requested part of the 'public space'. The technical department of the local administration provides appropriate signage (mandatory), and the Police department checks whether the occupation is in line with the permit and whether the signage is correctly positioned. In case of infringements (e.g. if more space is occupied), they will enforce that the specifications, as defined in the permit, are followed.

The service also has an internal part, where incoming requests arrive at involved departments that evaluate them against legal and administrative criteria. For example, depending on the request, it might be necessary to check with the fire brigade whether there is a security risk (fires, dangerous goods …). All the advice is collected and centralised with the Police department, which will provide the permit (or not). Therefore, the result of the internal phase is a decision, and an official document is issued.

3.2.7.2.4 Outcome and evaluation

In general terms, all interviewees agree that Spotbooking helps to achieve a more efficient process for delivering permits for the use of 'public space'. It decreases the workload for staff of the public administration. For citizens and businesses, it reduces waiting times. The process is not only simplified but also more transparent, as both citizens/businesses and local administration employees processing requests know exactly the status of any application/permit. Moreover, other stakeholders are also informed of upcoming (potential) hindrances so that they can take precautionary measures. For example, the public transport company ('De Lijn') can reroute a bus line in case a bigger work in a street would create a hindrance over a longer period (by using temporarily other streets).

In fact, the original idea for the digital service was to avoid the high workloads for staff of the local authority that had to fill the GIPOD database manually. By linking the two processes[56], citizens do much of the work themselves. Overall, less paperwork and fewer interventions are needed, making a "win-win for all" (Inventor of Spotbooking), with much of the focus being on operational aspects, including the organisation of the workflow and decision-making process, its efficiency and effectiveness.

Box 2. Key figures on Spotbooking in Leuven

- The process is 100% digital/online, including payment;
- More than 78.000 requests from 2018 onwards, for all types of use[57];
- Prior to the service, obtaining a permit for using 'public space' took several weeks, now it is often handled in less than a day (on average 4-5 days), and in case hindrance is expected it can take up to 10 days (because it is handled by the City Council in that case).

The revision of the process and the digital handling of the request involved the citizen more directly in the provision of the necessary information. The developers have paid particular attention to aspects of accessibility and inclusiveness in the way the solution is offered. For example, the application was tested on the use of colours (colour-blindness) in order to be as inclusive as possible. Therefore, codes were used as well as specific symbols

[56] Requesting/obtaining permits for using 'public space' and collecting and disseminating information on potential hindrance in public space.

[57] A citizen can have multiple requests.

(e.g. cars) as an addition to the traditional mapping. Notably, this followed Web Content Accessibility Guidelines (WCAG) from the W3C [58].

The use of the service is closely monitored for various reasons: to provide simple overviews on the use of the service for the City Council, but also to manage and follow-up complaints by users. To this end, a dashboard has been implemented, managed and used by the Police.

3.2.7.2.5 Replicability and scalability

The Spotbooking service was developed for the City of Kortrijk and then implemented in Leuven and other cities and municipalities (currently 13 cities and municipalities in Flanders use Spotbooking). Although the municipal process might differ to some extent, they are comparable, allowing it to be readily reused in different local authorities. This is also because the service does not rely on data from the local authorities but, rather, on data and technological components from the regional authority (Flemish SDI), where basic data include orthophotos, GRB (large-scale data covering Flanders), alongside open sources such as Open Street Map (OSM).

In Flanders, service implementation is relatively easy and can take only two months. Efforts have been made to 'export' the solution to Estonia, Spain, the UK, France and the Wallonia region, with some market interest observed. However, uptake and implementation in practice proved to be difficult because although there were similar processes, a legal basis may not be present. Indeed, it was suggested that "it would be great if there was a kind of EU legislation on the topic" (Inventor of the service). Technically speaking, the solution can work with other base data and other SDI components. Of course, a GIPOD-type of application is usually not available, but the service can also work without that particular link.

Currently, the company is trying to deploy the solution in The Netherlands (Amsterdam), the Czech Republic and Germany. The common starting point is the presence of a similar process in permit delivery for the use of 'public space'. Besides the lack of legal instruments to trigger the implementation of this type of service, a lot of inter-institutional networking and collaboration is required, which might be challenging when coordination efforts and mechanisms are not in place.

> *"Each city/local administration has its own system in Flanders. This kind of tool (from a private company) allows the administration to build a service that fits in the broader system of Flanders (as it makes use of general data) and that is designed for the local needs." - Police Leuven*

From the perspective of technical interoperability, the service can rely on European components such as eID, reusable components from INSPIRE and more generally speaking the Flemish SDI, such as different Web Mapping Services (WMS). The existence of reusable components is key for this type of service that also makes it potentially reusable through different APIs (GIPOD, CRAB, GRB). Moreover, V-ICT-OR[59], the organisation working on ICT solutions for Flanders, has developed OSLO – Open Standards for Linking Organisations – which is recognised by ISA² as a Best Practice, making it possible for other countries that also work with reusable components to implement the service based on the code developed in Flanders.

3.2.7.2.6 Lessons learnt

The following lessons learnt must be highlighted:

- The service is closely linked with an administrative process which was analysed and revised in the course of the set-up of the service and the implementation of the solution;
- The solution implemented contains two sides, one for end-users to submit a request for a permit and another for supporting the Back Office to process requests and make decisions (permit or not). Another (mobile) app supports the verification and enforcement part of the process in the field;
- Successful implementation and use of location-enabled services requires good collaboration between stakeholders, division of tasks and innovative/open governance models;
- Availability of high-quality location data and interoperable components based on international and/or national standards to access and use the data help to implement such services relatively

58 https://www.w3.org/Translations/WCAG21-nl
59 https://v-ict-or.be

quickly at a moderate cost. Especially web services and APIs are helpful building blocks to achieve this;

- Within a country, such services can be 'easily' replicated, especially when they are triggered by and are based on legislation. Technically speaking, reusing the solutions is not too difficult, even if the data and interoperability components are different in other countries. The central question is, rather, whether a similar process and obligation for implementation exist ;
- The public value created by Spotbooking is twofold. Firstly, the service results in gains in efficiency and effectiveness, allowing personnel from local authorities to do other work or to handle more requests in less time. Secondly, the service also affects, in a positive way, the hindrance in 'Public Space', such as more fluid traffic and less hindrance for social and economic activities in the city. It should be noted, however, that it is difficult to measure this impact and attribute it to the presence of the solutions and practices involved in this case.

3.2.8 Remote areas accessibility in Navarre

3.2.8.1 Introduction to the service and its context

The geographic area of the service is in the north part of the Navarre region, where there is a large number of scattered dwellings that are difficult to access and identify by the emergency services. The project is being expanded to the south of the Navarre region and has called attention across the border with France.

The objective of the project has been to identify any addresses with accessibility issues in order to respond to residential emergencies (Anbustegi 2019). The project has evolved and is currently divided into three tiers. The first is the identification of the addresses with a georeferenced and unique identifier (HelpBidea)[60]. This unique identification number is placed on a plaque (see Figure 16), which can be located at the entrance of the property. The second has aimed to improve access to complicated areas by creating maps like the metro (See Figure 17). This map is named Metro-Baserri, and it includes the unique identifier number for the houses. The third is a project that aimed to create a navigation system that would work offline and in remote areas (See Figure 19). The overall objective of these projects is to improve the response of emergency services.

The main stakeholders of this case are:

- Civil Protection: One of the leading promoters of the solution, providing funding for the implementation of the Metro-Baserri map signalisation (See Figure 18) and promoting the use of HelpBidea by participating in meetings with municipalities and end-users;
- SITNA – Territorial Information System of Navarre (Regional government) is another leading promoter by creating and making available HelpBidea and the routing application and licenses, as well as facilitating the creation of Metro-Baserri;
- Local Municipalities: Promoting the use of Metro-Baserri in the municipality and the unique identifier;
- Firefighters' department, end-users. They have also been working on the creation of the paths to reach the isolated houses and in the promotion of the solution by creating a video where they simulate the differences between having or not HelpBidea[61];
- Other end users are private owners that rent their houses as rural houses for tourism. They advise their guests to use the HelpBidea ID to locate the property or in case of any emergency in the house.

Background

The identification of the address issue started in 2007. The first actor to point this issue out was the firefighters' department. The project has been evolving by increasing the database of addresses and keeping it up to date. In 2016, Fire Brigades from the specific station of Oronoz, which serves the area of the North of Navarre, promoted the creation of a working group that involved all the relevant actors related to the maintenance of addresses, allowing requirements and needs for the use of addresses in the area to be determined, namely: Fire brigade of

[60] https://administracionelectronica.navarra.es/helpbidea/buscar.html
[61] https://www.youtube.com/watch?v=HQINh9H1-s0

Navarra[62], Navarre Health Service – Osasunbidea[63], Navarre Police[64], DG of Civil Protection, DG of Telecommunications and Digitalisation (SITNA)[65], Baztan Town Council and Tracasa Instrumental[66].

The responsibilities of the stakeholders are SITNA and the maintenance of the addresses system, while the municipalities provide the information. The information users are citizens, health authorities, firefighters and the regional police. Users such as the firefighters also contribute with feedback to improve the accuracy of the information. The plaques with the unique identifier number (See Figure 16) can be financed by the municipality or Civil Protection. For the routing application, the principal involved actors are Tracasa and the Public Works of Navarre.

Four online interviews with five actors were conducted in January 2022 and included one developer of the routing application, two promoters/end-users, one street-level service manager and one promoter/manager.

As mentioned above, the location solution is based on three main tiers:

- HelpBidea: Unique identifier that was created to identify isolated houses and has been extended to any house in the region. It has involved:
    - exhaustively compiling all the inhabited or habitable buildings in each municipality and updating the information in the address database of the region (Gestor de direcciones de Navarra);
    - Adaptation of the computer applications to make use of it.

Figure 16. Examples of the plaques with the unique identifier

- Metro-Baserri: represent the situation of isolated houses in a graphic way (See Figure 17) and involves:
    - Identification, employing physical plaques, of the remote and scattered areas. This is financed by the local councils and/or subsidised by Civil Protection. An example of the scattered and remote areas is provided in Figure 18;
    - Local councils explain the project to citizens of the scattered areas through letters, events, adverts in local media and giving them (or placing) the plaques.

Figure 17. Example of the metro maps in scattered areas

62 https://twitter.com/bomberos_na
63 http://www.navarra.es/home_es/Temas/Portal+de+la+Salud/Ciudadania/Actualidad/Carpeta+Personal+de+Salud
64 http://www.navarra.es/home_es/Temas/Seguridad/Contactar.htm
65 https://sitna.navarra.es/geoportal
66 https://itracasa.es

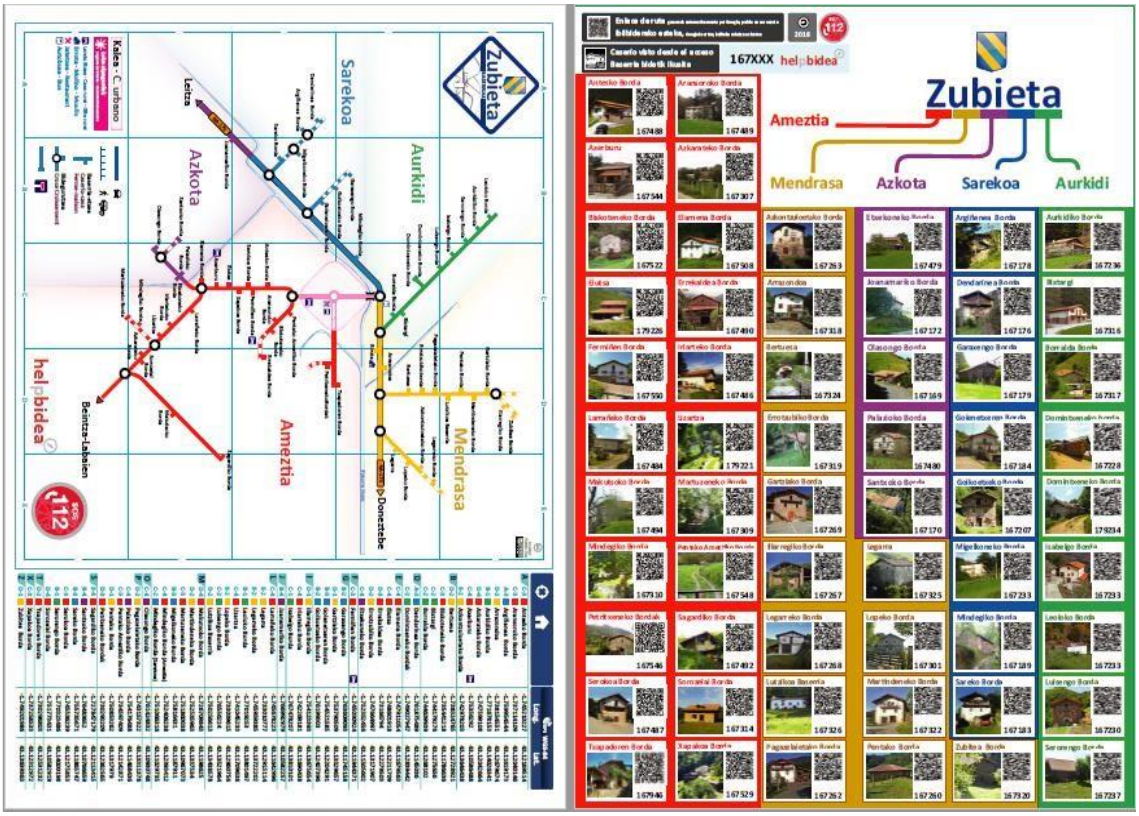


Figure 18. Visualisation of scattered houses in the Navarre region

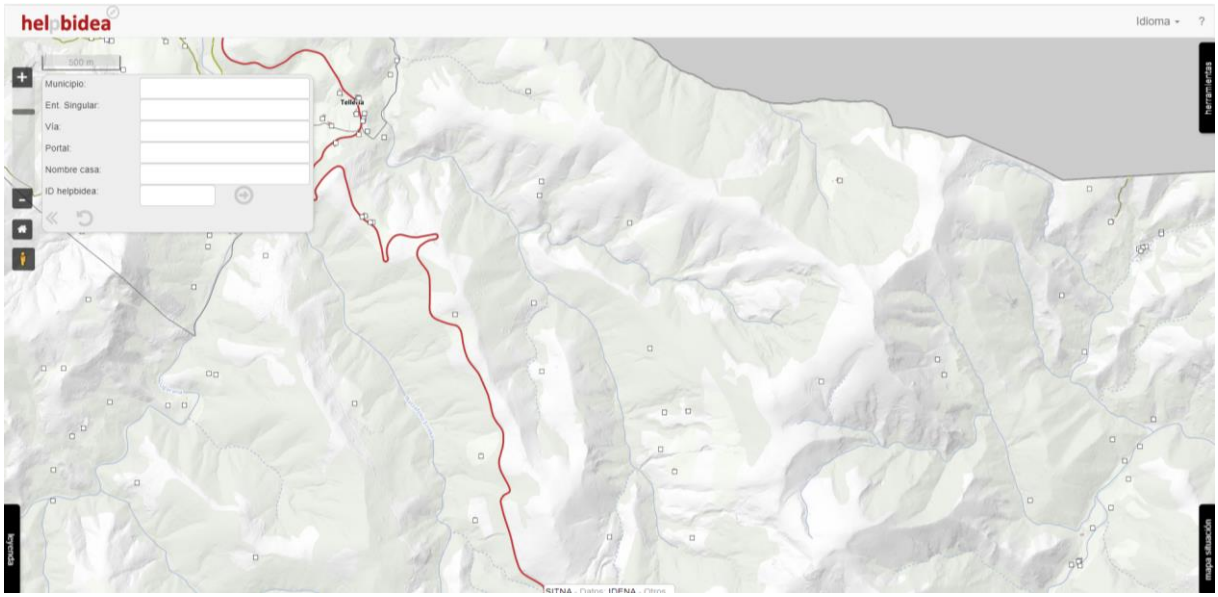
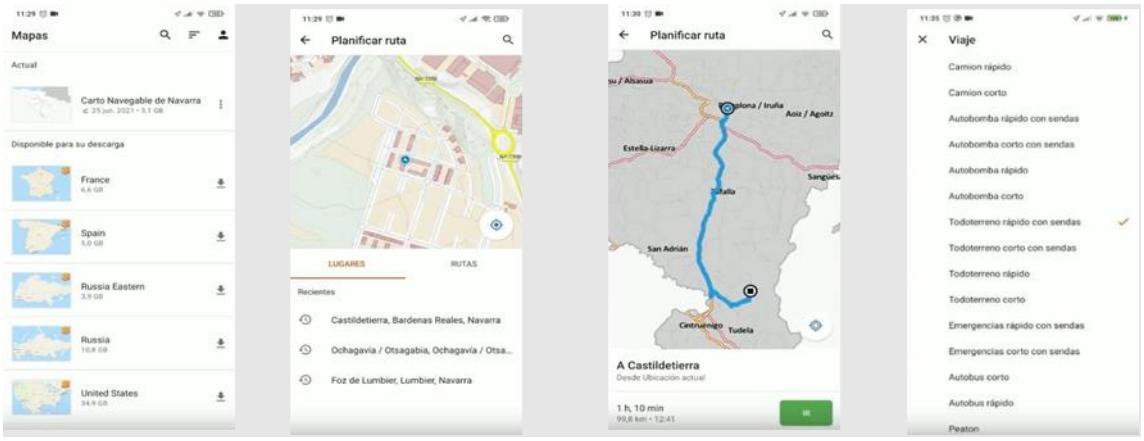


Figure 19. Example of the metro maps in scattered areas

- Routing application: App-based on a private solution that includes the paths to arrive at the isolated houses. Requirements:
    - Route APK on off-line mobile devices (voice navigation, use of the device's GPS);
    - To calculate routes on the navigable cartography developed by the Section of Cartography of the Government of Navarre;
    - To search addresses by coordinates, address (including HelpBidea), distance in kilometres, cadastral reference and place name;
    - To allow users to choose between the shortest and quickest route;
    - To allow filtering by roads, paths and tracks;
    - To allow filtering by type of vehicle;
    - To include access restrictions.

Figure 20 shows the interface of the routing app.

Figure 20. Interface of the routing app



The APK is in a pilot phase (both the application and the network), and it is being used by the Firefighters' Department, the Environmental Protection Service, the Regional Police and external collaborators.

In the conceptual framework developed within this study, "the Context refers to specific features and dimensions of the local and regional environment that must be considered for the transformation and value creation of local and regional public services" (Vandenbroucke, et al. forthcoming). The context was further defined around five attributes: beliefs and ideologies, drivers, challenges, local embeddedness, location data and technology management capability.

Drivers

The interviewees agreed that external contextual factors have not played a direct role in the project's development. The main factor has been the role played by the firefighter department. Their interest in improving the response to the services they provide has been vital. A collaborative governance approach has also been critical for the project's success.

"Governance is 100 per cent collaborative, there is no hierarchy". - SITNA

In the same vein, the interviewees agreed that political factors have not affected the project either. Yet, most stakeholders acknowledged that technological advancements have allowed the project's implementation. The benefits have been communicated to other actors, and this has supported the expansion of the project to the south of Navarre and raised interest from French firefighters across the border. Also, citizens have been supportive of the project as they have recognised the benefits, being the most important receiving access to emergency services in an efficient manner.

Challenges

The factors that have created some challenges for the project's implementation are:

- The complexity of unifying different information due to the different formats;
- The fragmentation of data in large municipalities;
- The existence of small municipalities with very few resources.

3.2.8.2 The service and the elements of the Conceptual Framework

3.2.8.2.1 Input

"Inputs refer to attributes that the transformation process taking place within a local or regional public administration and focused on a local or regional public service delivery, can use" (Crompvoets, et al. Forthcoming).

(Location) data and technologies

The input comes from the collaboration of different actors, and

"it is the result of collective intelligence". -Civil Protection

Users and developers are working together. For the addresses, the idea is to have all the geographic coordinates of all the doors, including houses, businesses, farms, etc. This also includes the identifier with the assigned number to the address. The information is being updated constantly with the support of users such as firefighters or citizens. The database of the addresses is updated daily. The initial database came from the cadastral office and it was used to develop the new one. It was also complemented with information from the municipalities. There is a database (MicroStation) for the addresses, and the information is published with GeoServer.

The navigation application uses a database developed by Tracasa, which is used over a navigation model. The model includes different types of roads, where each road has been classified and associated with the kind of vehicle that can access it. After selecting a vehicle type, options of fastest or shortest routes can be selected. The application aims to cover all the road axes of Navarre (currently 300,000 axes). The application is used in Navigator[67] and works with Android and iOS, allowing it to run on smartphones. ESRI standards are used, and

[67] https://www.esri.com/es-es/arcgis/products/arcgis-navigator/overview

they follow the INSPIRE directive[68]. In this regard, it is important to highlight that this is aligned with the Spanish policy. The Executive Council of the Spanish Geographical Information Infrastructure[69] approved the Action Plan for the Implementation of the INSPIRE Directive, creating Technical Working Groups for the elaboration of Transformation Guides[70]. Therefore, the SDI provides and uses INSPIRE data and services from Spanish data providers. Therefore, the SDI provides and uses INSPIRE data and services from Spanish data providers.

3.2.8.2.2 Transformation

"Transformation refers to the approach of (re)designing and (re)developing public services in order to create public value, whereby there is a radical innovation instead of an incremental innovation (Osborne and Brown 2011)." (Crompvoets, et al. Forthcoming). One can distinguish internal processes, that is, governance, and external processes, that is, stakeholder involvement.

Governance

The project started by addressing the need to improve the emergency service of firefighters, in particular, where the implementation process has been bottom-up, very lineal and 100% collaborative.

This project was not part of a larger governmental strategy or initiative. In this regard, this project is a clear example of a bottom-up approach, and it has been kept in this manner. In general, the interviewees see this approach as positive since it has allowed them to grow the project in a secure manner. Yet some actors consider that larger support could increase resources to scale up the implementation.

Stakeholder involvement

The project has advanced, and more actors are getting involved,

> *"the project could not be understood without the participation of all the different actors as it has many requirements". – Civil Protection*

While this project has not been integrated yet with larger projects, some of the interviewed actors consider that it is aligned with the Spanish government's interest in harmonizing public services.

The creation of formal and informal inter-institutional networks has been vital. Among the key collaborations are the ones between SITNA, the municipalities, the firefighters, Civil Protection and Public Works. Besides the collaboration, it has also been essential to creating awareness among citizens and municipalities.

The project, in some cases, has suffered some limitations due to economic resources. For example, in the case of the navigation app, there is a need for smartphones. However, there are cases where collaboration has already solved some economic resource issues. One example is the plaques that have the numerical identifier, as the Civil Protection authority financed them when some municipalities could not pay for them.

The interviewees did not identify any political conflicts. However, there has been resistance to change in very few cases, and implementation has taken longer than expected. Among the main challenges that the project has faced was the existence of illegal property developments. There are cases where someone has built a residential property (dwelling) in order to take ownership of the site. The local government is concerned that assigning them a unique identifier to the address can be understood or seen as an approval of the development. There are also some large municipalities where information is fragmented, and this makes it more difficult to identify an appropriate interlocutor for the implementation of the project.

The project's effects were expected in the short and long term. Among them is the inclusion of medical and security services beyond the current pilot projects or the scale-up of its application in other regions or across the border.

3.2.8.2.3 Output

"Outputs refer to the products of the transformation process of local or regional public services" (Vandenbroucke, et al. forthcoming), which can be divided into internal and external services. The output has been a better provision of emergency services,

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68 https://inspire.ec.europa.eu/SDICS/sitna

69 https://www.idee.es/en/codiige

70 https://plataforma.idee.es/en/5-transformar-los-datos

"we are now able to identify places with accessibility problems". - Firefighters Department

Furthermore, there is less uncertainty in identifying an address using numeric signs. This helps to provide better emergency services, and it can be used beyond them. The project has increased collaboration among the different actors taking part in the process. A clear example of this is the evolution of the project, which started with the identification of the address and the implementation of the unique identifier for the current project developing the navigation app. Collaboration is so important that, as mentioned,

"it is thanks to collaboration among administrations that the project exists". -SITNA

Collaboration has positively impacted the efficacy and efficiency of the emergency service provided by the firefighters and is being extended to other services; information is provided with more accuracy and faster. Importantly, citizens' are now using their assigned numbers when calling emergency services. In the same vein, one of the main aspects of this collaboration has been user feedback from firefighters and citizens.

Regarding the project's impact in terms of accountability and economic development, the interviewees agreed that it is too early. Yet, some of them mentioned that the address service could be attractive for delivery companies such as Amazon. Also, an interviewee considered that a quick reaction to an event would potentially decrease the economic damages associated with a property, although this has not been measured.

There has been openness from the different governmental actors and citizens in this case. In general, there has been good participation from the inhabitants, and the information is transparent and can be easily accessed. Where the project's impact is clear, it is in terms of increasing accessibility for users, as it improves the access for those inhabitants in remote locations.

"people who have received their plaque with identifier now have access to a better service".

It has increased society's inclusivity, as the service now can reach more people, benefiting the elderly and people in riskier situations. This includes medical emergencies and natural hazards. However, it is too early to know if the work has generally impacted the quality of life.

The project and its collaborative nature have also helped the stakeholders better understand other governmental actors, including municipalities. This has also enriched their vision around the project, allowing self-development.

In terms of environmental sustainability, it is also difficult to estimate the benefits. Yet, most of the interviewees agree that they have been able to identify appropriate routes to attend emergencies more efficiently in terms of time and distance. There are also faster reaction times to fires. Acknowledging the different benefits has also allowed trust to be built via the project with the citizens.

"In some cases, people were surprised that the project aimed to improve the service. People realised we were concerned about them". - Civil Protection

3.2.8.2.4 Outcome and evaluation

"Outcomes refer to results produced by transformation processes of public services at local or regional level. In contrast with outputs, the outcomes measure the value or impact of local or regional services" (Vandenbroucke, et al. forthcoming). The three outcomes from the project (HelpBidea, Metro-Bacerri and the navigation map) have helped to improve the provision of emergency services. However, there is no formal evaluation yet of the project by stakeholders as the project is still under development, where this work reports some perceived benefits by the actors involved based on their experience.

3.2.8.2.5 Replicability and scalability

The interviewed actors agreed that it is possible to replicate and scale the project, where doctors and the police have already started to participate, alongside its expansion to the south of Navarre and potential replication across the border in France.

From an interoperability perspective, the project has facilitated information sharing. However, the approach has been focused on the unification of one service. In this regard, it seems more like centralisation of information, that can be accessed by users online. Therefore, although interoperability is not specifically discussed, sharing information from different sources and developing a central database has been a complex project, but it has been a way to facilitate access to different users.

3.2.8.2.6 Lessons learnt

The case of HelpBidea provides important lessons on how innovation can be achieved via a collaborative process, where governmental actors also involve users of the delivered service to improve its quality.

- The bottom-up process of the project involving governmental actors shows how governments can become less hierarchical and embrace collaborative processes (Silvia 2011) and demonstrates that the public sector can be innovative.
- The bottom-up approach and collaboration have also decreased the possibilities of political conflicts. Up to now, the different stakeholders are satisfied with how this process has been conducted.
- A collaborative approach can facilitate the involvement of different actors, increasing the capacities and expanding the project's scope. This collaborative approach was extended to involve users in the improvement of public services. Hence, this case exemplifies how collaborative efforts can improve the quality of services by improving their delivery to meet users' needs (O'Brien, et al. 2016, Rodriguez Müller, et al. 2021).
- The case also provides an important lesson regarding leadership. It is worth noting that the organisation that starts the project has credibility and society's acceptance. This helps to build trust not only within the government agencies but also with citizens who are willing to support the project.

Among the factors that could hinder the replicability and scalability of this type of project are resistance to change from an organisational perspective, political conflicts, lack of awareness, lack of collaboration, or legal constraints. Therefore, it is important to consider such factors when implementing similar projects.

3.2.9 Traffic accident monitoring service in Pilsen

3.2.9.1 Introduction to the service and its context

This case study deals with a Traffic Accidents Service that was developed on the basis of the outcome of two EU funded research projects, PoliVisu[71] and Digital Urban European Twins for smarter decision making (DUET)[72] . The service was developed for the City of Pilsen (Czech Republic) and is currently being used by the local administration.

Policy Development based on Advanced Geospatial Data Analytics and Visualisation (PoliVisu) was Horizon 2020 Research and Innovation project designed to evolve the traditional public policy-making cycle using big data (2017 – 2020). The aim was to enhance an open set of digital tools to leverage data to help public sector decision-making become more democratic by (a) experimenting with different policy options through impact visualisation and (b) using the resulting visualisations to engage and harness the collective intelligence of policy stakeholders for collaborative solution development. While working with three cities to address societal problems linked to smart mobility and urban planning, the intention was to enable public administrations to respond to urban challenges by enriching the policymaking process with opportunities for policy experimentation at three different steps of the policy cycle (policy design, policy implementation and policy evaluation). Experimentation of policy options enabled the cities to tackle complex, systemic policy problems that required innovative thinking to develop transformative solutions.

DUET is also a H2020 Research and Innovation project that addressed city planners who were able to test their ideas using a 3D interface to create digital twins (2019 – 2022). These computer models can help city officials manage resources, enhance economic development, reduce ecological footprints and improve the quality of life for residents. DUET is leveraging the advanced capabilities of cloud and high-performance computing to evolve the traditional public policymaking cycle using large open-data sources. The use of digital twins allows city managers to react quickly to real-time events and ensure long-term policy decisions are more effective and

[71] https://policyvisuals.eu
[72] https://www.digitalurbantwins.com

trusted. Tested in several cities across Europe (Pilsen, Athens. Mechelen), the project creates a policy-ready data-as-a-service for all cities to use.

DUET provides a risk-free testing environment for simulating alternative policy options. Users can explore a range of what-if scenarios related to traffic, air quality and noise pollution before investing time and resources in potentially costly projects. Traffic analysts can simulate the impact of lane closures caused by construction work, analyse the effects of changes to a signalling plan or try to predict spikes in travel demand caused by local events. Urban planners can assess population exposure to noise-generating activities and measure the effects of different policies involving infrastructure, buildings and sound barriers.

This case focuses on the Traffic Accidents Service (TAS) for city planning in Pilsen. Located around 90 km west of Prague in Western Bohemia, Pilsen is the fourth most populated city of the Czech Republic, with about 175,000 inhabitants. The service allows the local administration, and in particular its local police, to obtain valuable input information for the city planning process.

As the TAS was developed on the basis of the outcome of two EU-funded research projects, the possibility of replicability and upscaling was always considered an important aspect. The TAS of the city of Mechelen (Belgium) is rather similar to the Pilsen service.

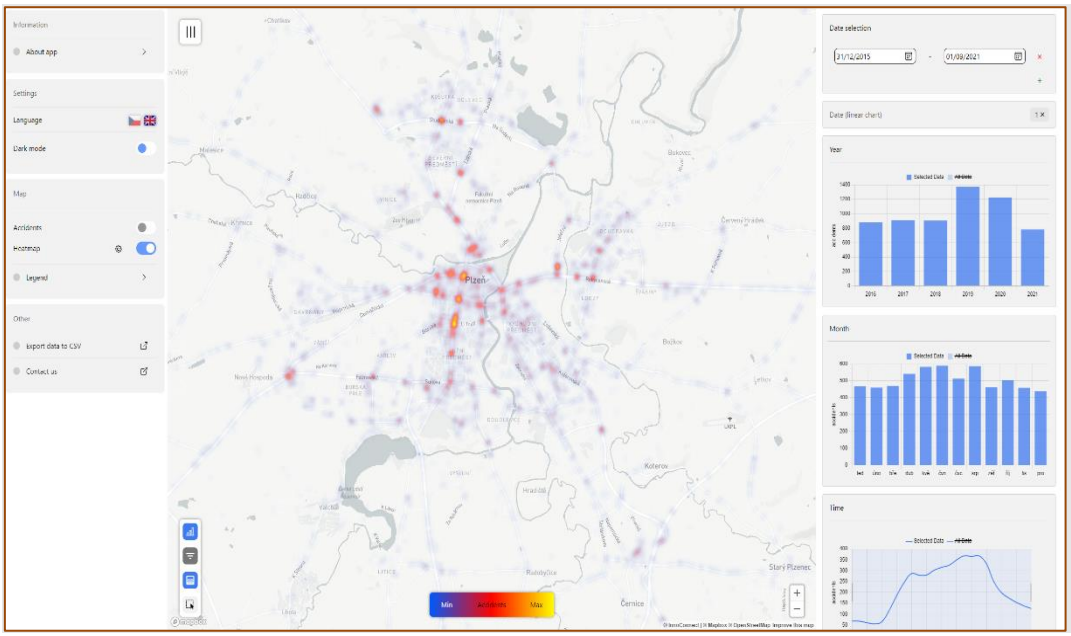
Case study research was executed via interviews with four actors and an analysis of the InnoConnect website[73] , as they provided the technology in the case. More documents could not be analysed due to language restrictions. Consequently, the research mainly relied on interviews with the following actors :

The TAS used by the City of Pilsen administration use map bases for ready interpretation and visualisation. The service allows the local police, in particular, to obtain input information for policy-making. These can potentially lead to the modelling of countermeasures which will reduce their existing values in topics such as accidents, offences and drug/alcohol abuse. Based on this information, pilot projects can be organised by the city administration in specific parts of the city, targetting interventions.

The TAS model is fed with data from the national and the local level. Indeed, accidents and offences are recorded by the responsible police units at local (Pilsen Municipal Police) or national level (Police of the Czech Republic) and then sent to the TAS. Public data are the starting point and outcome for the model. However, the data is not open to the public, except for traffic accident data. It was decided to keep the data closed for privacy reasons. The service can, as such, be considered an Internal Public Service, with an only partial publicly accessible online map. On this map, the traffic accidents were visualised in the form of a heat map (Figure 21), a technique that shows the magnitude of a phenomenon as colour in two dimensions, varying by intensity and offering visual cues about how a phenomenon varies over space (Wilkinson and Friendly 2009). Such techniques may also allow individual cases to be hidden and general patterns to be shared without encountering notable privacy issues.

[73] https://glayer.innoconnect.net/pilsen_accidents

Figure 21. Traffic Accidents Heat Map – Example from Innocents. Source: *InnoConnect*[74].



InnoConnect, which is the technical developer of the TAS in Pilsen, provides a demo to demonstrate how the map functions in practice (see Figure 21). As can be seen, there is a clear location element included in the service, and the map visualisation allows domain experts to gain better insights into accidents and offences and to develop concrete policy measures in response.

From the conceptual framework, the "Context refers to specific features and dimensions of the local and regional environment that must be considered for the transformation and value creation of local and regional public services. The Context includes various attributes that could affect the choices for planning and implementing public services at local and regional level, such as: Beliefs/Ideologies, Drivers, Challenges, Local embeddedness and Location management capacity" (Vancauwenberghe, et al. forthcoming). A number of those conceptual aspects could be identified as being relevant for the TAS, see drivers and challenges.

Drivers

Firstly, the following drivers could be identified among the different interviewees:

An existing Smart City agenda and GIS policy allowed for a link to be made between the TAS and the wider approach of the City of Pilsen;

- Political and domain expert support: both the political level and the domain experts side (administrative level) supported the use of new technologies for policymaking, especially in the city's Crisis Management Department;
- "Pilsen uses technology often, and we tried to do more with the data: the data was available, and we filled an existing gap." (Interview Respondent);
- Existing examples, as TAS was already demonstrated through PoliVisu and DUET. Its possibilities led to a close connection to the political support, along with visualisation;
- "We had something that we could show from the PoliVisu project, so that clearly helped. If other governments are already doing something similar, this always helps – not just in this project." (Interview Respondent);

74 https://glayer.innoconnect.net/pilsen_accidents

- Availability of financial resources: The City of Pilsen had sufficient financial resources that allowed the use of the TAS service;

Challenges

A number of challenges could be identified that were grouped as follows:

- Human capacity: in contrast to the availability of financial resources, there was a need to strengthen the knowledge and expertise of the staff of the city administration. Indeed, the TAS can be considered to be an expert tool, and the private company had to provide demos to the city staff. However, as one of the respondents underlined, the city staff were used to working with related data, so it was more an issue of the specificities of the service itself;
- Data volume and structure: both the volume and the structure of the data were (and are) complete and required data management questions to be addressed. Data was not only coming from the city itself but also from the national police, which had some initial challenges that were eased since part of the traffic data is now open data;
- Privacy and security: there was a reluctance in the city administration to open the data, whereas other actors (such as the private actor offering the service) pushed for the data to be open for reasons of transparency. It was agreed among the different involved actors to keep the data closed, except for the data related to traffic accidents.

3.2.9.2 The service and the elements of the Conceptual Framework

3.2.9.2.1 Input

Inputs refer to the attributes of the transformation process taking place within a local or regional public administration and are focused on what attributes a local or regional public service delivery can use (Vancauwenberghe, et al. forthcoming). The following attributes can thereby be considered: objectives, (location) data, (location) technologies and organisational resources.

The main input attributes to which the respondents referred were related to the location data and location technologies. The organisational resources were not considered to be a key input attribute but, rather, a contextual aspect.

(Location) data

Concerning the location data, one of the interviewees indicated the following: “the data is perfect to be pinned to a map. Tables do not work for this. The map helps in the imagination, it shows the data perfectly”, whereas another stakeholder highlighted that location improves data analysis and visualisation.

The local police data was directly available via the IT system of the city. The national police data was available in an open data format (CSV), but with a month delay, although this timing has limited impact on policy-making and analysis.

(Location) technology

Concerning the technology, the TAS made use of Open Street Map as it was free and faster than the internal GIS that was available for use. The TAS also makes use of the GLayer Analytical Maps Technology, a “GPU accelerated database engine focused on fast data aggregation, filtering and visualisation. GLayer can perform analytical queries on extremely large datasets in milliseconds with special emphasis on spatial data, spatial aggregation and interactivity”[75].

3.2.9.2.2 Transformation

Transformation is understood by Crompvoets et al. as follows: “[It] refers to the approach of (re)designing and (re)developing public services in order to create public value, whereby there is a radical innovation instead of an incremental innovation.” (Vancauwenberghe, et al. forthcoming). Two specific attributes related to transformation, as Internal Process (related to Governance) and External Process (related to Stakeholder Involvement), can be seen in relation to TAS.

[75] https://glayer.innoconnect.net/pilsen_accidents

Governance

Concerning the Internal Processes, the interviews demonstrated that the introduction of the TAS is a long-term innovation supported by the highest political actors within the City of Pilsen and the Crisis Management Department of the city. The respondents indicated a constant search for new and innovative technologies, where the implementation of TAS can be considered to be part of a wider innovation culture within the city administration. Consequently, the city administration was willing to develop the TAS.

Stakeholders involvement

Secondly, concerning the External Processes, it has to be underlined that there was only a highly limited role for external stakeholders. Citizens were not involved in the transformation process, and the only two external stakeholders that can be considered to play a role were : (1) the national police of the Czech Republic as a data provider and (2) the private sector actor behind the TAS technology.

3.2.9.2.3 Output

Crompvoets et al. define the output as follows, "[it] refers to the products of the transformation process of local or regional public services. [...] the output refers to public services enabled by location data or technology." (Vancauwenberghe forthcoming).

Internal and external services

In this case, an internal service was created, the TAS, without any predecessors. It was made possible via the combination of location data of various public administrations (at local and national levels) with specific GIS technology. A platform was also developed as an external (non-public administration) service so that users could consult traffic accident data. Interviewees, however, underlined that this external service has only a minor role to play compared to the internal service, given its policy-support role.

Finally, another output referred to by one of the respondents is related to other services: "The use of TAS, as an internal service, allows to improve other external services offered by the city – e.g. a safer cycling environment". Therefore, to some extent, the investment in the TAS for one policy purpose has offered data for reuse in another context, offering some potential savings.

3.2.9.2.4 Outcome and evaluation

As indicated by Crompvoets et al., "outcomes refer to results produced by transformation processes of public services at local or regional level". Evaluation "refers to an assessment of the approach taken via the input, transformation and output to create an outcome, in terms of the perceived intentions and results (i.e. the public value created), thereby taking into account the context (Vancauwenberghe, et al. forthcoming).

Concerning the outcome, the different respondents referred to a number of specific public values. For the operation values, the respondents indicate that especially efficiency and effectiveness are important. As one of the interviewees made clear, it was deemed necessary to increase the effectiveness of preventive measures and to have simplified access to data. For the second public value cluster, the respondents referred to transparency, openness and accountability. There was discussion among the respondents on the importance of the public value 'citizen participation'. Finally, concerning the social values, one respondent referred to the indirect effect of TAS: the service helps to improve the quality of life in the city of Pilsen by increasing the overall security in the city. Whereas, the other respondents did not see any connection to the social values.

Concerning the evaluation, it was indicated that because of the only recent introduction of the TAS, there are not yet measures in place to understand the outcome and the impact of the service. Indeed, there is currently no qualitative or quantitative measurement of the actual impact on the city and its ecosystem. Therefore, no examples of KPIs can be provided here.

3.2.9.2.5 Replicability and scalability

As the TAS was developed from two EU-funded research projects, replicability and upscaling were always considered important principles, where one interviewee indicated that "... there is nothing specific about the service, so it can be easily replicated". The data involved, however, may differ across EU Member States. Indeed, replication within the Czech Republic will be simple, but the Belgian example in Flanders (also in DUET) shows that data on traffic accidents might be incomplete, leading to incomplete and/or false conclusions if used in a similar service as TAS.

In addition, DUET's T-cell model supports interoperability between different domains and city systems. It is a central data and message broker onto which different data sources, models and interaction clients connect, making the solution extendable and reproducible. New components can easily be added or removed.

3.2.9.2.6 Lessons learnt

The following lessons learnt and recommendations can be derived from this case study:

- Ensure sufficient administrative and political support when developing and implementing a new service. Connect this to a clear visualisation that can help decision-makers see what can be gained from a service;
- The case shows a risk-free testing environment for simulating alternative policy options. Users can explore a range of what-if scenarios related to traffic before investing time and resources into costly projects. Traffic analysts can simulate the impact of lane closures caused by construction work, analyse the effects of changes to a signalling plan or try to predict spikes in travel demand caused by local events;
- Visualisations can build a shared picture of reality, fostering a common understanding among citizens about living conditions and any acute problems that they and their communities are facing;
- The capability of the case to make multi-actor collaboration meaningful and sustainable. By offering a holistic perspective on city dynamics, TAS can coalesce stakeholders around local challenges, encouraging them to seek consensus, define a shared vision and co-create solutions that will have a lasting impact;
- Participate in EU-funded projects. The TAS is the result of two EU-funded projects and allowed the City of Pilsen to co-develop and implement the service afterwards;
- Set up a clear innovation/technology culture (potentially supplemented with a written document – e.g. innovation strategy) within the local administration, as it provides a framework to stimulate innovation and to decide what innovations are relevant.

3.2.10 Citizen science against air pollution in Brussels Region

3.2.10.1 Introduction to the service and its context

CurieuzenAir[76] is a citizen science initiative in the Brussels Capital Region in which citizens collect data on air quality under the guidance of scientific experts. Through simultaneous measurements at 3,000 different locations, air quality in Brussels is mapped and analysed in unprecedented spatial detail. CurieuzenAir allows a better evaluation of the effects of NO_2 on health in order to better inform inhabitants of Brussels but also policy-makers about this topic. The initiative provides a more accurate mapping of air quality in Brussels and more insight into differences in air quality between different places, streets and neighbourhoods. Measurement of air quality at many different places allows to much better investigate air quality, since air quality and its impacts greatly differ from place to place due to the so-called 'street canyon' effect.

CurieuzenAir is an initiative of the University of Antwerp, the urban movement BRAL and the Université libre de Bruxelles, in close collaboration with Bloomberg Philanthropies, Brussels Environment, and several national and local media partners. The University of Antwerp supervises the air quality measurements and associated data analysis. The Université Libre de Bruxelles is responsible for the socio-economic analysis within the project. BRAL, the Brussels city movement, aims to engage people from all backgrounds in the project and supports it with knowledge from the city of Brussels. Media partners De Standaard, Le Soir, and BRUZZ publish and present the results of the measurements via their newspapers and online websites.

From a public service perspective, CurieuzenAir can be considered as a combination of an information service, providing air quality information to citizens, and a public participation activity, engaging citizens in air quality policies and services. It complements existing 'air quality' information services provided by Brussels Environment, the public service for the environment and energy of the Brussels-Capital Region. To measure and monitor air

[76] https://curieuzenair.brussels/en/home

quality in the Brussels-Capital Region, Brussels Environment operates a network of measurement points installed at various places in Brussels. Currently, information on air quality and its evolution can be found in various places, including the airquality.brussels website[77], the BrusselsAir app[78] and the website of IRCELINE, the Belgian Interregional Environment Agency.

Citizens are often surprised when they hear that our Region only has 11 fixed devices that can measure NO_2*. Now it becomes clearer why a project like CurieuzenAir is urgently needed – Brussels City Movement*

In the conceptual framework developed within this study, "the Context refers to specific features and dimensions of the local and regional environment that must be considered for the transformation and value creation of local and regional public services" (Vancauwenberghe, et al. forthcoming). The context was further defined around five attributes: beliefs and ideologies, drivers, challenges, local embeddedness, location data and technology management capability.

Drivers

Looking at the wider context in which the CurieuzenAir initiative is situated, several factors can be identified that had an impact on the implementation of the service. Although air quality in Brussels has improved over the past twenty years, citizens have become more aware and better informed about air pollution in Brussels, and more and more citizens and citizen movements started taking action to claim their right to clean air. In the 2019 regional elections air quality became an important electoral issue in Brussels. In the coalition agreement of the elected government, the government committed to "align and converge the thresholds currently set for all pollutants to the values recommended by the World Health Organisation". The CurieuzenAir project is fully in line with the policy of the Brussels Capital Region Government on air quality. The Brussels government has put in place a series of laws and plans to improve air quality in Brussels. At the same time, the Brussels Government has the ambition to more actively engage citizens in its policy processes.

The CurieuzenAir project should be seen in the context of a wider initiative on air quality in Brussels, the Brussels Clean Air Partnership, an initiative by Bloomberg Philanthropies, which brings together governments, universities, local research centres and NGOs to deliver a science-based, coordinated approach to curb air pollution throughout the Brussels-Capital Region. The Brussels Clean Air Partnership, which was launched in 2020, aims to harness the power of data by advancing the deployment of innovative technologies to monitor air pollution, filling in data gaps on ground-level local pollution data. This partnership constitutes an important financial factor for CurieuzenAir, as funding is provided by Bloomberg Philanthropies.

The partnership directly responds to the European Green Deal's mission to ensure clean air and engage communities in environmental action. In line with the European Climate Pact, this initiative is also a prime example of how partnerships and citizen action can create practical and data-driven solutions to two of the biggest issues facing our world today. This demonstrates the – indirect – impact of policy initiatives at the EC level. There also are the EU Air Quality Directives, which require Member States to establish a network of air quality monitoring stations in accordance with a set of criteria. An important judicial factor that should be recognised, too.

While some of the previous factors demonstrate the importance of "local embeddedness", another important driver was the proven success and impact of two previous CurieuzeNeuzen projects; CurieuzenAir is inspired by and builds further on two previous CurieuzeNeuzen projects organized in the City of Antwerp ("CurieuzeNeuzen Antwerp ") and the Flemish Region ("CurieuzeNeuzen Vlaanderen "). Both projects examined the air quality of citizens in their streets by collecting nitrogen dioxide concentrations on a large scale and making available these air quality measurements to the general public. Volunteering citizens and organisations attached a simple measuring device to the outside of a window on the street side, through which they measured the concentration of NO2 throughout an entire month. CurieuzeNeuzen Antwerp was launched in 2016, and in 2018 the project was followed by a larger measurement campaign covering the entire region of Flanders, CurieuzeNeuzen Vlaanderen. The CurieuzenAir project could build further on the methodology and experiences of these previous projects and on the expertise of some key partners who also participated in the CurieuzenAir project. Results of these previous projects were highly visible in the media (also media not participating in the project) and well

[77] https://qualitedelair.brussels

[78] https://qualitedelair.brussels/content/recevoir-les-alertes

received by politicians and other decision-makers. So, there already was strong evidence of the expected impact of the project.

Challenges

The main challenge of the CurieuzenAir initiative will be its long term impact and sustainability, which can be guaranteed by the uptake of the results into the government decision-making and service delivery processes. The CurieuzenAir case shows that transforming these existing decision-making and service delivery processes might be difficult for various reasons, including existing legal requirements on air quality information, existing procedures and processes, but also the impact of the air quality problem on other policy domains and policy issues, which requires action from many different actors and organizations.

3.2.10.2 The service and the elements of the Conceptual Framework

3.2.10.2.1 Input

Inputs refer to attributes that the transformation process taking place within a local or regional public administration and focused on a local or regional public service delivery can use (Vancauwenberghe, et al. forthcoming).

In the CurieuzenAir initiative, an important input was provided by the inhabitants of Brussels through their active contribution to measuring air quality. To collect data on air quality in their own neighbourhood, selected participants placed a board with two measuring tubes at the front window of their house or office. The figure below shows the CurieuzenAir panel, which contains the two measuring tubes.

After four weeks of measurements, participants removed the measuring panels from their windows and returned the tubes to the laboratory for analysis by scientific experts. Clear and easy-to-understand instructions were provided to the citizens on how to install the panels and tubes and how to return the tubes after one month. The measurement is done through a standardized measurement setup, which is simple but provides reliable data. To be sure of correct measurement results, each measurement setup contains two tubes. The board ensures that the measuring tubes hang at the same distance from the window in every location. Each tube contains a layer of gel that selectively absorbs NO_2 molecules from the air.

After four weeks, the tubes go to the laboratory for analysis. Here the total amount of NO_2 absorbed by the gel is determined, after which the average concentration of NO^2 in the outside air can be calculated. The measurement results then undergo a strict quality control and are calibrated at the measurement stations of Brussels Environment.

Figure 22. Example of CurieuzenAir panel installed at front window

Location technologies are used to support three main activities:

- The selection of measurement points: out of 5,578 candidate measuring points, a selection was made of the 3,000 best points via a computer algorithm. Aspects taken into consideration for this selection were the geographical spread of the measurement points over the whole area of Brussels, variations in street types and traffic intensity, and whether the street had closed or open buildings.
- The presentation and dissemination of the results of the measurements: the results of the measurements are presented via an interactive dotted map.

Additional analyses on air quality and its determinants: Results from previous CurieuzeNeuzen projects show large variations in NO_2 concentrations from street to street, neighbourhood to neighbourhood and city to city. Within the same city or village, there are very large differences in NO_2 concentrations between streets, and sometimes even within the same street. Analyses showed that the NO^2 concentration is mainly determined by local traffic emissions, the local street configuration (road network and street morphology) as well as the traffic flow in the street.

For these operations, other geospatial datasets (e.g. road network data, building data, urban infrastructure and green data) have been used. Most of these data could be found and accessed via regional geoportals. The consortium was still looking at how to obtain relevant traffic data that could be used for more detailed investigations of the impact of traffic flows.

3.2.10.2.2 Transformation

Transformation refers to the approach of (re)designing and (re)developing public services in order to create public value. CurieuzenAir can be considered as a transformation in the way air quality data are collected, presented and shared with the general public. Citizens and other non-government organisations are actively engaged in the measurement of air quality and awareness-raising on air quality among citizens and decision-makers. From a public service perspective, it complements existing approaches for monitoring and informing people about air quality at the local level, which to a large extent are determined by the European requirements for the measurement and monitoring of air quality. It is argued by the Brussels Government that the use of low-cost measuring instruments, such as the measurement systems used in CurieuzenAir, do not allow sufficiently accurate measurements to be performed that meet the legal quality requirements of the European guidelines.

These low-cost instruments are seen as an additional source of information, which cannot replace the official reference measurements, but can be extremely valuable for increasing awareness on air quality.

This means that the expected effects in the short term mainly involve increased awareness and active involvement of citizens in measuring air pollution. In the longer term, effects are expected on the decision-making processes and the 'official' monitoring procedures, e.g. through improving the air quality model.

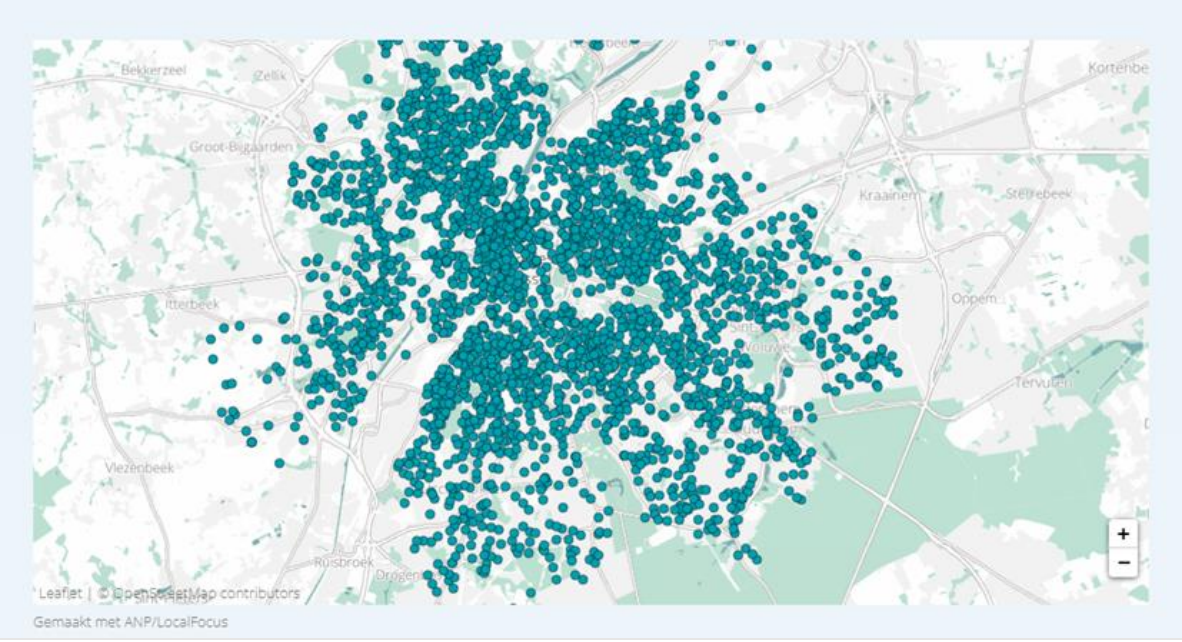
It is important to highlight that the CurieuzenAir initiative strongly relies on the support and contribution of various non-government stakeholders, including the University of Antwerp, the Université Libre de Bruxelles, BRAL and several media partners. Each of these partners brought their key expertise to the project and focused on those elements that are most closely related to their interests. Finally, and most importantly, there is the active contribution of citizens and other organisations to the 'service', being responsible for the actual measurements.

CurieuzenAir is implemented as a research - citizen science - project which will run for approximately one year. The project will result in a dataset of air quality measurements on 3,000 locations in Brussels, and a detailed investigation of the determinants and impact of air quality based on these data.

3.2.10.2.3 Output

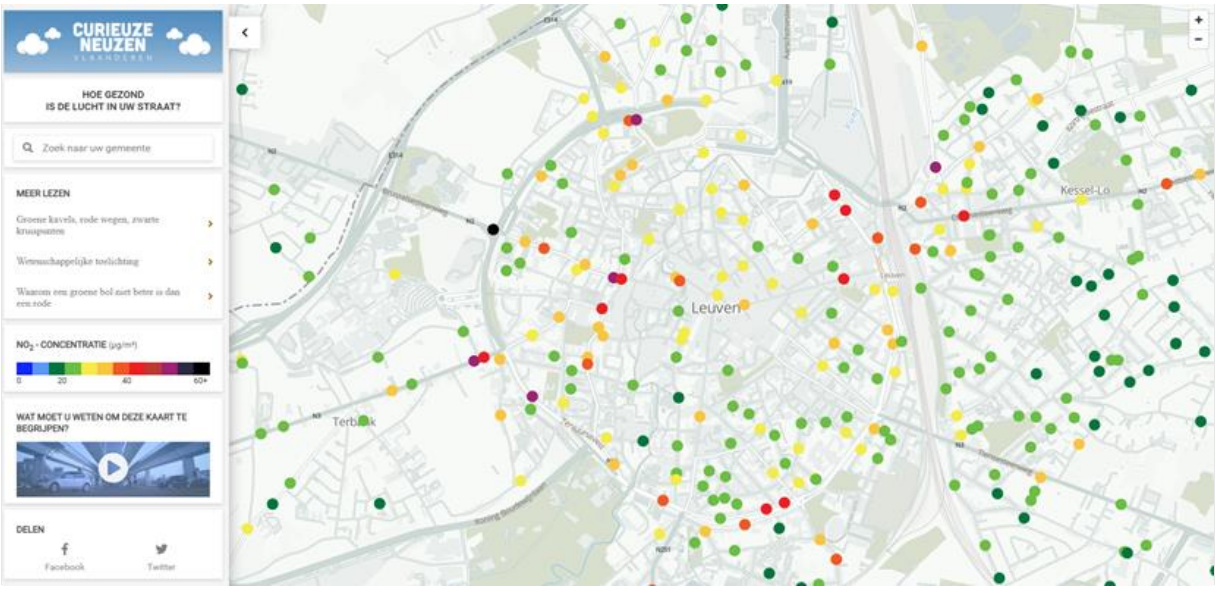
"Outputs refer to the products of the transformation process of local or regional public services" (Vancauwenberghe, et al. forthcoming), which can be divided into internal and external services. When looking at the product of the transformation process, the main output of CurieuzenAir is a more detailed mapping of air quality in the Brussels Capital Region. The map contains measurements of the air quality in 3,000 locations in Brussels, while the existing measurement network only covers 11 locations. The figure below shows the distribution of the measurements in the Brussels Capital Region. It should be noticed that the CurieuzenAir project only focuses on NO_2.

Figure 23. Distribution of the 3000 measurement points in the Brussels Capital Region



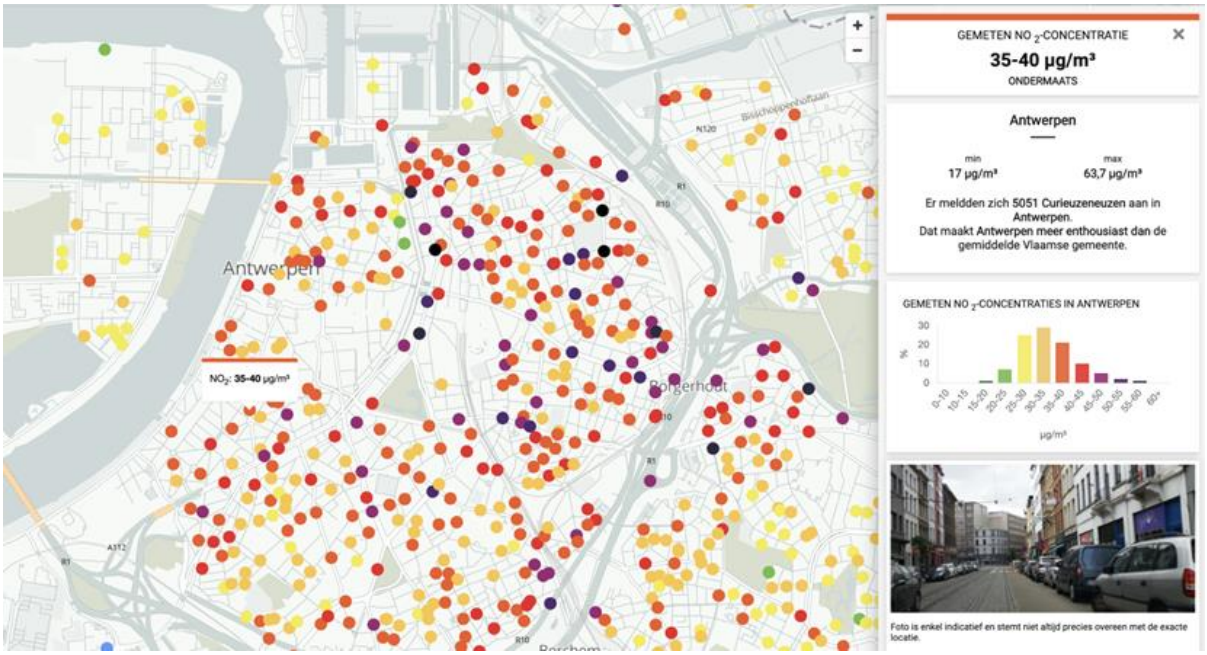
The results of the measurements will be announced in March 2022 via an interactive dotted map on the websites of the various media partners (De Standaard, Le Soir and BRUZZ). Two weeks later, the results will be made available via the project website and further disseminated by the other project partners. The results are presented in the form of a map of Brussels, covered with coloured dots. Each colour corresponds to a certain concentration of NO^2. To illustrate the likely output, Figure 24 shows the interactive map of the CurieuzeNeuzen Vlaanderen project, with results from various measurements in the city of Leuven.

Figure 24. Interactive map of the results of the CurieuzeNeuzen Vlaanderen project



For each 'point' on the map, the measured NO_2 concentration is provided and the classification (label) associated with this concentration (e.g. excellent, good, average, bad, and extremely bad). For each point, the total number of measurements in the same city or municipality is provided, as well as the lowest and highest measured concentration in the municipality; the distribution of all measurement concentrations is also presented. In addition, a picture is provided of the location of the measurement point. While everyone can view this map, individual participants also receive a personal measurement report with the results of their own measurement point and how it performs compared to other points in the region.

Figure 25. Map with information on one single measurement point of the CurieuzeNeuzen Vlaanderen project



The results of the measurements serve as input to a more detailed investigation of air quality and its effects on the health of citizens in Brussels. CurieuzenAir will generate an internationally unique dataset that provides insight into the exposure and health impacts of air pollution and will help to better inform clean air policies.

In terms of the internal public service innovation, it is important to mention that Brussels Environment will use the CurieuzenAir data to improve its air quality models. Within the framework of the "Brussels Clean Air Partnership", there is a dedicated project on air quality modelling, in which a tool will be developed for evaluating the impact of the emission scenarios on the air quality in the Brussels-Capital Region. This tool will be based on

urban scale modelling of nitrogen oxide and will allow the relevance of local or regional measures to be evaluated, such as those related to spreading the flow of vehicles. Also in previous CurieuzenAir projects, the collected data were used to improve the complex computer model for air quality. For example, in the region of Flanders, the data from the CurieuzeNeuzen project were used to examine whether the air quality maps used by the Flemish government were reliable. The data from the 20,000 measurement points of the CurieuzeNeuzen project were used to test the existing ATMO-Street air quality model and develop a new version of the model, which serves as the basis for underpinning air quality policies at the regional and local level.

3.2.10.2.4 Outcome and evaluation

"Outcomes refer to results produced by transformation processes of public services at local or regional level. In contrast with outputs, the outcomes measure the value or impact of local or regional services" (Vancauwenberghe, et al. forthcoming). The CurieuzenAir project has different types of outcomes, which refer to results produced by transformation processes of public services at local or regional level.

First of all, several operational impacts can be seen:

- Collaboration: improved collaboration between government, universities, non-profit organisations, media organisations and citizens in the collection and dissemination of air quality data and information in Brussels;
- Efficiency: involvement of citizens and local organisations and use of simple measurement devices for collecting air quality data;
- Effectiveness: better spatially detailed data on air quality in the Brussels Capital Region, through measurements on 3000 distinct locations;
- User-oriented: approaching a complex issue such as air quality and the impact of urban design and policies through a citizen perspective.

In addition to these operational impacts, the CurieuzenAir project also has important political impacts:

- Accountability: better insight into and understanding of current policies on air quality;
- Economic development: direct benefits to the media partners, in terms of sold newspapers and website visits;
- Equity in accessibility: particular effort to also involve socio-economically disadvantaged inhabitants of Brussels in the project, who are proportionally more affected by air pollution;
- Citizen Participation: citizens are actively engaged in the measurement of air quality in Brussels, since more than 5,500 inhabitants expressed their interest in participating in the CurieuezenAir project;
- Transparency: better understanding of existing approaches for measuring air quality in Brussels;

"It's here :-) Measuring the #AirQuality in #Uccle #Brussels starts on Saturday. I'm excited to know more about my local air...but I'm also quite worried too. #curieuzenair #CitizenScience #HowBadCanItBe" – Citizen participating in CurieuzenAir on Twitter

Finally, also some important social impacts could be seen. There is the inclusion of socio-economically disadvantaged citizens in the project, but also the impact of the project in terms of environmental sustainability.

Key performance indicators currently highlighted in the project are the number of people that have expressed interest in participating in the project (more than 5,500) and the total number of actual measurement points (3,000). Among the 5,578 candidate measuring points were 102 schools, 327 companies and associations and 5,149 individuals and families. An important indicator from the previous CurieuzeNeuzen project in Flanders was the total number of visits to the online map with the results, which was visited 670,000 times. There were more than 550,000 page views on the articles related to the project, while the videos had more than 50,000 views.

3.2.10.2.5 Replicability and scalability

Looking at the replicability and scalability of CurieuzenAir, it is important to note that CurieuzenAir builds on projects in Antwerp ("CurieuzeNeuzen Antwerp") and the Flemish Region ("CurieuzeNeuzen Vlaanderen"). These projects have demonstrated already the replicability and scalability of the approach and solution. Many municipalities, cities and regions in Europe are looking for effective and innovative methods and approaches for both citizen engagement and air quality policies. The CurieuzeNeuzen approach could serve as an interesting best practice for them. There are, however, some particular aspects of CurieuzenAir that might affect its replicability: the financial support provided by Bloomberg Philanthropies, the political commitment to improve air quality, and the openness of the administration to citizen science initiatives all are factors that strongly determine the success of the initiative. These factors will determine the extent to which the CurieuzenAir approach can serve as an alternative to more traditional approaches for monitoring and informing about air quality at the local or regional level.

Brussels is the first capital in the world that maps air quality with the help of citizens. As a pioneering study, it can serve as an example for other European cities.

Brussels is the first international capital where the air quality is mapped with the help of citizens, becoming an example for others, where it already participates in an international project on measuring air quality in different European cities. The pilot project "Operation Healthy Air" uses a new type of sensor to search for harmful substances in the air in Madrid, Paris, London and Brussels for 14 days. CurieuzenAir is involved in this project as the Brussels partner of Earthwatch, an American climate organisation. At 30 locations across the Brussels-Capital Region, a small sensor was installed to measure the concentration of a whole range of chemical substances in the air.

A new CurieuzeNeuzen project will be launched in Flanders, which aims to map the heat and drought throughout the region in great detail. "Curieuzeneuzen in the Garden[79]" investigates how we can better deal with the effects of increasingly warmer and drier summers. With a network of 5,000 measuring points, CurieuzeNeuzen in the Garden is the largest citizen research ever into heat and drought in Flanders and follows the air quality approaches and partnership working.

3.2.10.2.6 Lessons learnt

In the previous section, we already emphasized several of the key success factors of the CurieuzenAir project. In this section, we briefly summarise some lessons learnt and recommendations for other organisations that want to engage in a similar service.

It should be noted that CurieuzenAir goes beyond the transformation of an existing public service. Although the initiative is strongly related to a public service, i.e. the monitoring and dissemination of air quality data, it shows that this service also can be delivered by other stakeholders, including citizens. CurieuzenAir well integrates the needs, interests and strengths of different parties into one overarching initiative. Research institutions, media organisations, citizen movements and citizens themselves all can play a key role in such environmental and societal challenge. The large-scale communication and awareness-raising campaign, the close cooperation with medical centres, community centres and anti-poverty associations, the scientific approach and relevance and the active engagement of citizens all contribute to the success of the initiative.

Looking at the level of location-enablement, it can be seen that the initiative is relatively simple, both in terms of the (geospatial) data collected and the technologies used. The initiative uses the location of 3,000 measurement points, which are selected via spatial analyses. Results are presented via an interactive online map, and additional spatial analyses are undertaken to understand the impact of various factors (locations, traffic, building heights, and trees) on air quality. This demonstrates that even a moderate level of location-enablement can result in a successful service, or that innovation in local service delivery can take place without highly advanced technologies or large amounts of complex data.

The focus of the initiative was not on 'air quality as a problem', but rather on being curious ('curieus' in Dutch) about the state of air quality in a particular city, neighbourhood or street. The initiative did not only engage people and stakeholders with already a strong interest in (and knowledge about) air quality, but also successfully involved other citizen groups. Community building is an important pillar of the project. Citizens participating in

[79] https://curieuzeneuzen.be

the project expressed their interest in the topic of air quality and their involvement in the project by putting a large sign at the front window of their house. As a result, the CurieuzenAir signs dominated the streetscape in Brussels for an entire month.

It can, therefore, be argued that the digital transformation of government is not only about technology but also about (geospatial) data and the active contribution of different stakeholders outside of a public administration, including non-traditional sources such as citizen science.

4. Results of the comparative analysis and discussion

This section on comparative analysis and discussion investigates the approaches to using location data and technologies in local or regional public services. In this section, we also discuss the main findings arising from the case study analyses focusing on all components of the framework: the context, the input, the transformation, the output, the outcome and the evaluation. In addition, the section also aims to validate the conceptual framework developed in our previous work (Vancauwenberghe, et al. forthcoming). Thirdly, it assesses the replicability and scalability of the cases across local and regional governments in Europe.

4.1 Application components of the conceptual framework across the case studies

One of the objectives of this work was to validate the conceptual framework developed during the earlier phase of this research on location-enabled public services (Vancauwenberghe, et al. Forthcoming). In the following sub-sections we reviewed the core elements of the conceptual framework to show what public administrations have to govern to introduce successfully location-enabled technology in public service delivery.

4.1.1 Context

The first component of the conceptual framework is the **context**, that "refers to specific features and enablers of the local and regional environment that should be considered for the transformation and value creation of local and regional public services" (Vancauwenberghe, et al. forthcoming), including both outer and inner features and enablers, being the ones that find their genesis in external actors versus those that are born within the implementing organisation, respectively. It is possible to identify some issues that repeat across different cases.

Looking at the outer context, namely **beliefs, ideologies** and **challenges**, compliance, legal and ethical issues are the main topics. Compliance refers to one actor adapting their actions to the applicable rules and norms (e.g., national laws, sectoral code of conduct) and might connect external standards and rules to organizational culture. Compliance is, therefore, connected to the management of activities, while legal issues encompass all relevant rules and norms that might impact the activities of an organisation. Ethical issues might be tied, even closely, to legal norms, yet they include any consideration of what is right and what is not.

In most cases, these three components are inextricably linked. Data sharing among authorities, as in the case of Cascais, is challenging since crossing organisational boundaries requires additional efforts and legal advice because of the need to guarantee privacy to users whose data are being treated. Furthermore, public authorities that are more proactive are also the ones whose activity raises more privacy and, more generally, regulatory questions that need to be solved. For instance, in the case of Ravenna, the software provider Comuni-Chiamo is delaying updates to the platform since it is currently investigating if it falls within Italian digital public services regulations requiring unique digital access through the Italian National System of Digital Identity (SPID). In Amsterdam, the solution adopted a privacy-by-design approach, even going beyond regulatory limits, avoiding the recognisability of individuals and any individual data collection. Amsterdam is also the only case where ethical considerations were clearly outlined in a document, namely the Municipality's ethical data principles.

With regard to **local embeddedness,** one can highlight the presence of mimicking dynamics (Bekkers, Edelenbos and Steijn 2011). Organisations can see and repeat actions and initiatives carried out by other organisations that are close to them. This knowledge transfer seems, in the case studies, to be mostly geographically related, and can be understood as the product of regional relationships. In the case of Leuven, for instance, the service was replicated from another municipality and extended to several others during the years. One should not, however, limit mimicking dynamics to a mere "distance-minimising" cooperation. Ravenna's choice to investigate the solution in practice was driven by previous knowledge of the other municipality and by the very network built by the service provider around their solution. Something similar can also be found in Limerick's experience, even if at an earlier point of its evolutionary trajectory. On the other side of the mimicking dynamics, Amsterdam seems to be trying to be an example to other municipalities, maybe looking to other European innovative cities, since the algorithm was intentionally created and published as open-source so that it can be replicated in other locations and they have been presenting the solution to other cities and publishing information in the press, even if until now with limited results. In comparison, regarding external factors, local characteristics refer to every attribute of an area to which the organisation needs to adapt its approach. To a great extent, these local characteristics could shape the decisions on the tool to be adopted and the roll-out of the implementation process. For instance, South Tyrol is an agriculture-oriented area for which a crop recognition algorithm was well-

suited. With similar dynamics, demographic characteristics of the areas in which the service needs to be delivered (e.g., densely or sparsely populated) are powerful driving forces, as the context, needs and expectations that may shape the choices of resource allocation of the public authority, the way in which the service is design, and its accessibility criteria. Nonetheless, city greening and urban farming approaches of recent years could make use of tools similar to the South Tyrol case, if they are properly trained. The specific local characteristics do not necessarily limit the replicability of the solution, but they are able to explain to some extent why a specific service was conceived in the first place. This explains, to some extent, why a specific service was conceived in the first place.

Regarding the inner context and **local embeddedness**, path dependence dynamics are crucial to understanding the evolution of location-enabled public services in the analysed cases. These phenomena affect all organisations, yet public sector authorities are particularly prone to them. Path dependence is usually used to refer to past decisions' influence on current actions, even when the rationale for the past decision is no longer standing. For instance, Ravenna already had a similar forerunner service provided by the region and looked for a similar tool. In Cascais, the early work with data and digital public services, in general, allowed the Covid War Room to be ready-to-go and functioning with much less effort than a start-from-scratch solution.

Moreover, the co-presence of urgency and relevance is a powerful **driver** in adopting a specific service. The former refers to the need to act to solve or mitigate a problem quickly; the latter is related to the potential impact the service would have on the community. The case of over-tourism in Amsterdam is emblematic, since it was perceived as a politically sensitive issue. Similarly, the alpine nature of the territory in South Tyrol required the tailored approach of AgriML, Navarre's rural territory made it necessary to have a system of identification of buildings and Brussels' problems with pollution required action. In all the cases – except for South Tyrol – Covid-19 acted as a propellent for increasing the perceived urgency and adding new purposes to existing tools.

4.1.2 Input

The second component of the conceptual framework is the **input**, that is "attributes that the transformation process taking place within a local or regional public administration, and focused on a local or regional public service delivery, can use" (Vancauwenberghe, et al. forthcoming), namely Objectives, Location data, Location Technologies, and Organisational resources. . They include existing location-based datasets and technologies, clearly assigned innovation responsibilities, and a clear innovation strategy, even if invested resources are usually limited. In addition, some critical inputs refer to the technical enablers of adoption, including interoperability as an opportunity to use technology to overcome organisational and functional silos. These attributes can be both local or general, such as interoperability.

With regard to **organizational resources**, as highlighted, in several instances, an organisation responsible for innovation was involved in the adoption decision in the context of a clearly outlined organisational innovation strategy. Notable exceptions are the Navarre and Ahrweiler cases, both related to emergency services, where potential and actual crises brought stakeholders to implement a new system for addresses' definition and attribution.

However, additional internal resources invested in these innovations are usually limited since innovation does not seems to be a priority for internal actors but, rather, the Chief Innovation Officer (CIO) or Chief Development Officer (CDO). Therefore, CIOs' and CDOs' leadership capability and political support are crucial in sustaining innovation efforts. The exceptions are Pilsen, where the innovation strategy fostered innovative solutions that were able to receive funding from the EU and Brussels, where a foundation financed the project. At the same time, in South Tyrol, the autonomous government of the province allowed for more resources to be allocated to the project. In another two cases, a crisis-led innovation partially departed from this model: in Cascais the municipality was already committed to innovation from a budgetary point of view and reorganised resources, while the flood crisis in Ahrweiler made the adoption of a new localisation service urgent, even outside a structured innovation strategy.

Location-enabled public services were mostly adopted within local public authorities whose technical instruments and know-how (**location technologies and organizational** resources) were already in place to sustain these efforts, also granting interoperability, or within administrations that had outlined a clear innovation strategy to build upon. The infrastructure, data-related, physical or spatial, was already present in Cascais, Navarre and Amsterdam, partially in Ravenna, Pilsen, and Ahrweiler (e.g., the CCTV network of Amsterdam). The exception is South Tyrol, where a more consistent investment was needed to implement the PoC, and in Leuven, where the Spotbooking system substitutes old technologies and systems. In both these cases, the

implementation was aimed at completely restructuring the service delivery process of permits. This might explain the need to start from the essential elements of the new service because of the extensive required change and the resulting larger investment in resources. Interestingly, in several cases, solutions are not at the frontier from a technological standpoint, such as Ahrweiler, Ravenna, and Brussels. The exception is again South Tyrol, an early adopter of Machine Learning among public administrations using satellite image recognition in agriculture and Amsterdam, where the AI system was more accurate than other services available on the market. Existing data and infrastructure usually need some work to be adapted to the new needs.

The aspect of interoperability of **location data** will undoubtedly require further investigation. Already it can be seen that, in most cases, there was a need to integrate several data streams, where the connection was not particularly complex in most of them (e.g., South Tyrol, Ravenna, Pilsen and Leuven). High-quality location data were already available, and the other components were already interoperable by design, making it easier to connect the blocks of the process.

4.1.3 Transformation

The third component of the Conceptual Framework is **transformation**, that is "the approach of (re)designing and (re)developing public services in order to create public value, whereby there is a radical innovation instead of an incremental innovation" (Vancauwenberghe, et al. forthcoming) and includes the elements of governance and involved stakeholders. Existing literature underlines that the public service context is complex also because of the presence of multiple stakeholders that have multiple interests and expectations around the same issue and, in turn, have different preferences for, and judgements about, priority setting and public organisations' performance in solving those issues (Boyne 2002, Cucciniello and Nasi 2014, Venkatraman 1986). One should, however, also consider that public administrations usually decide what services to provide and how, often failing to include the preferences of citizens in their decision process (Rose, Flak e Sæbø 2018). Therefore, the focus is, on the one hand, on the governance of the involved stakeholders, that is, the management of the web of relations in which public authorities navigate; and on the other hand, literature investigates implementation approaches that allow organisations to put in place and make available services to end-users.

With regard to **external** processes, it is interesting to note that most cases experienced some form of multi-level and multi-stakeholder governance within their implementation. In some cases, such as Navarre and Pilsen, this collaboration seems to be inherently linked to the very existence of the service. Cases involved both public (e.g., health authorities in Cascais) and private actors. Within the implementing authority, it is possible to recognise the office responsible for innovation and the involved departments; outside, contractors and providers and other public authorities can be found. It is relevant to highlight that governance models were implemented in most cases, avoiding strict hierarchical mechanisms.

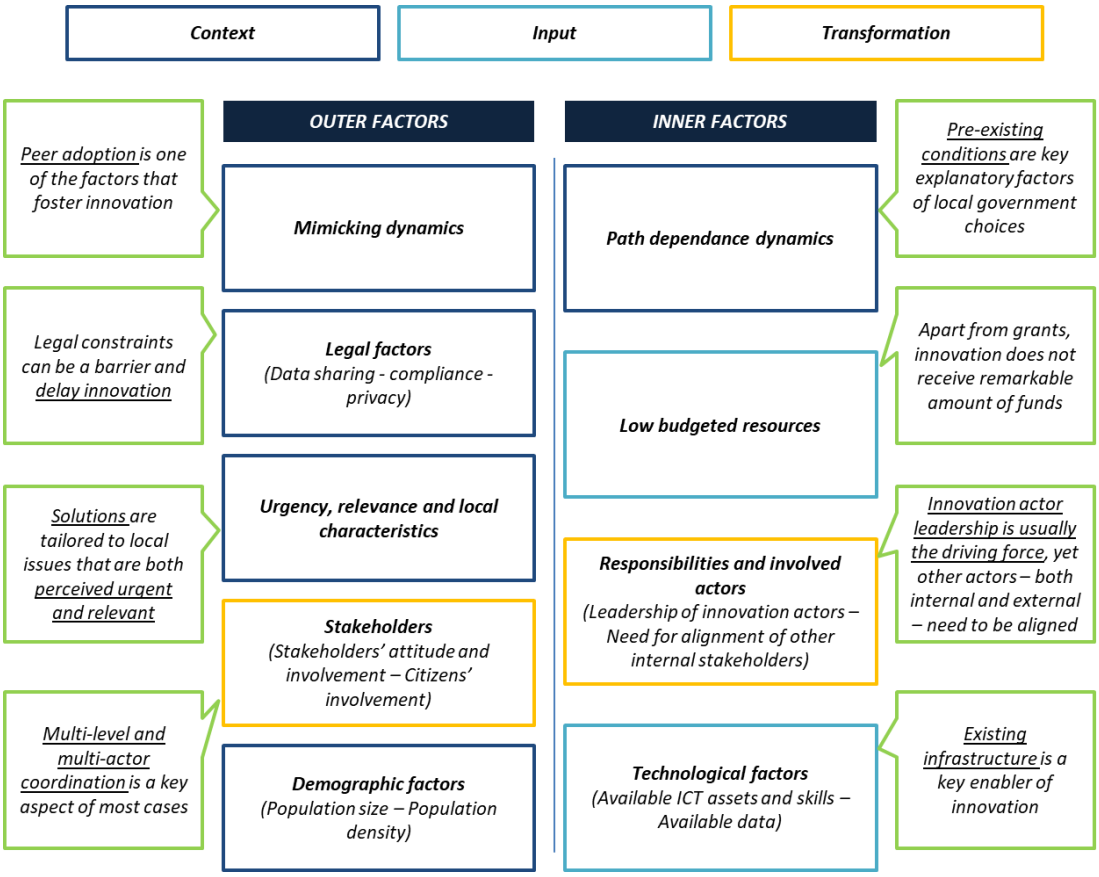
Literature underlines that effective digital transformation in public administrations delivering services derives from the pervasive exogenous force of digitalization and their institutional capacity, the values of citizens in their context and the critically important interaction between the two. In the analysed cases, citizens-users are not just part of the outer context, but an integrated stakeholder in the public service ecosystem, since they are actors in the delivery process or its beneficiaries. Their influence also extends to context since users contribute with their beliefs, values and ideologies to frame the value in context. The latter informs their service experience during service delivery, having a direct impact on their satisfaction and, in turn, the value the service may generate (Osborne, Nasi and Powell 2021). Citizens' involvement exists in some cases but is not a general requirement for service redesign. Few experiences sought to involve citizens, even with different degrees of success. Citizens' involvement can be found in at least three cases. Nevertheless, one should consider that Ravenna's involvement results from more than a decade of carrying out such a solution. In Brussels, the CurieuzenAir project's existence is based on citizens' involvement. In the case of Leuven, where the service has become the main form to require a specific permit – both for citizens and firms - adoption and involvement have been remarkable. Public authorities still need to define a clear path to ensure that the public would find the service valuable before investing too many resources in digital public service. Yet, they should also find ways to pilot new services without being limited by fear of failure.

With regard to **internal** processes, innovation officials were leaders of the adoption in Ravenna, Amsterdam and South Tyrol. The latter's termination of the project before the full adoption demonstrates the need for a close alignment between technology innovators and business users, which was lacking in that context. The same was experienced in Amsterdam, albeit to a lesser degree, as transferring the service from the developer (the innovation unit) to the service user (mobility department) was a challenge. Even if innovation actors can lead

coordination, other stakeholders, from internal stakeholders to end-users and interested citizens, should be part of the whole process, and continuous strategic alignment is pivotal to a successful implementation. This web of interaction across actors can be understood as the service ecosystem. For instance, the municipality of Ravenna conducts weekly training from the Innovation office to other departments' new employees that need to use the software. In Ravenna and South Tyrol, the solution needed some degree of personalisation, strengthening the organisation and internal capabilities thanks to the provider's contribution. In Amsterdam, the solution was developed in-house, with a contractor's contribution, for the very same purpose.

In order to summarise the context, input and transformation components of the Conceptual framework, we highlighted and synthesised the most compelling ones in Figure 26. Such a scheme allows these factors to be looked at across the conceptual framework. The figure allows looking at the attributes related to the first three components of the conceptual framework, further specifying their nature as external or internal attributes. Each factor is better exemplified through the side boxes.

Figure 26. A synthesis of influential factors (Context, Input, Transformation)



The transformation component is interesting because it represents the nexus connecting objectives to needs and results (outputs and outcomes).

4.1.4 Output

The next component of the Conceptual Framework is **output**, which is identified as "the products of the transformation process of local or regional public services […] enabled by location data or technology" (Vancauwenberghe, et al. forthcoming) and can be inward-looking (internal service) or outward-looking (external service) depending on the focus of the solution. The outlined outputs are mostly related to efficiency and more rapid and streamlined processes. The products of transformation that can achieve these improvements are of two different kinds. On the one hand, some cases resulted in the design and use of data analysis and visualisation tools, such as heatmaps or KPI dashboards, that could be both for internal and external use depending on the case. On the other hand, some SaaS resulted in workflows with different degrees of sophistication that re-design and streamline internal public authorities' processes. Improved efficiency seems to be the main result in most cases: in Amsterdam, it allowed real-time monitoring, in South Tyrol, all requests were monitored (versus only 6% earlier), in Ravenna through a streamlined and quicker process, in Leuven by reengineering the administrative

process while digitalising it. Although most services are inward-looking, it should be noted that they are usually **external services** rather than internal, since they are provided as a platform that meets different stakeholders' needs. In Pilsen, indeed, the interviewees recognised that the external service has only a minor role.

4.1.5 Outcome and evaluation

The last two components of the Conceptual Framework are closely related: **outcome** and **evaluation**. While the former is the "results produced by transformation processes of public services at the local or regional level", the latter refers to "an assessment of the approach taken to create an outcome, in terms of the perceived intentions and results" (Vancauwenberghe, et al. forthcoming). The Framework defined the outcomes as the generated value or impact, distinguishing them as operational, social, and political outcomes. While output goals are readily assessable, outcomes are challenging to measure, especially in the public sector. In the public sector, assessing the value created by innovation is a challenge due to the absence of a single unified indicator shared across the public sector. Overall we noticed a high degree of heterogeneity in defining output and outcome measures. As a consequence, it is hard to compare initiatives and generalise results. Several examples of frameworks that could be adopted can be found in Singh et al. (2020). While operational improvements are clear to the directly involved stakeholders in a case, who can outline the efficiency gains, time savings, and increased effectiveness (e.g., in Leuven, permit handling has become faster), social and political outcomes are more broadly defined and less measured. Most cases start outlining objectives related to broad social and political public values, yet they usually refer to operations and processes when asked. This potential mismatch should be further investigated and could potentially, and at least to some extent, be related to difficulties in putting in place practices/approaches rather than final outcomes for beneficiaries. It points to the possible issue of limited engagement with end-users, not knowing how they feel about results or the activity/resource they have engaged with.

Furthermore, in most cases, outcome evaluation was not conducted at all via KPIs and data analysis, but just as a qualitative judgement, as in the case of Amsterdam Public Eye. It is perhaps not surprising to consider the theoretical and practical difficulties of measuring outcomes, primarily social and political ones. Nonetheless, measuring outcomes has proven difficult also for cases such as Pilsen, where the outcome is more operational and tangible, being related to mobility. Furthermore, in most cases, declared outcomes were often related to transparency and citizens' engagement, dimensions that are difficult to evaluate thoroughly. Surprisingly, one of the only two cases in which results were carefully assessed with clear KPIs is South Tyrol – which was also quite successful - the only case of ceased implementation.

4.2 Pathways for replicability

Most of the examined cases have shown a positive attitude towards replicating in one or more locations in European countries. Usually, services and technologies that are more stably implemented in the public sector and mature in the Technology Adoption Lifecycle (Rogers 2003) are more prone to be replicated. In Figure 27, we organised the analysed cases according to the interviewees' responses, triangulating them under the abovementioned scheme.

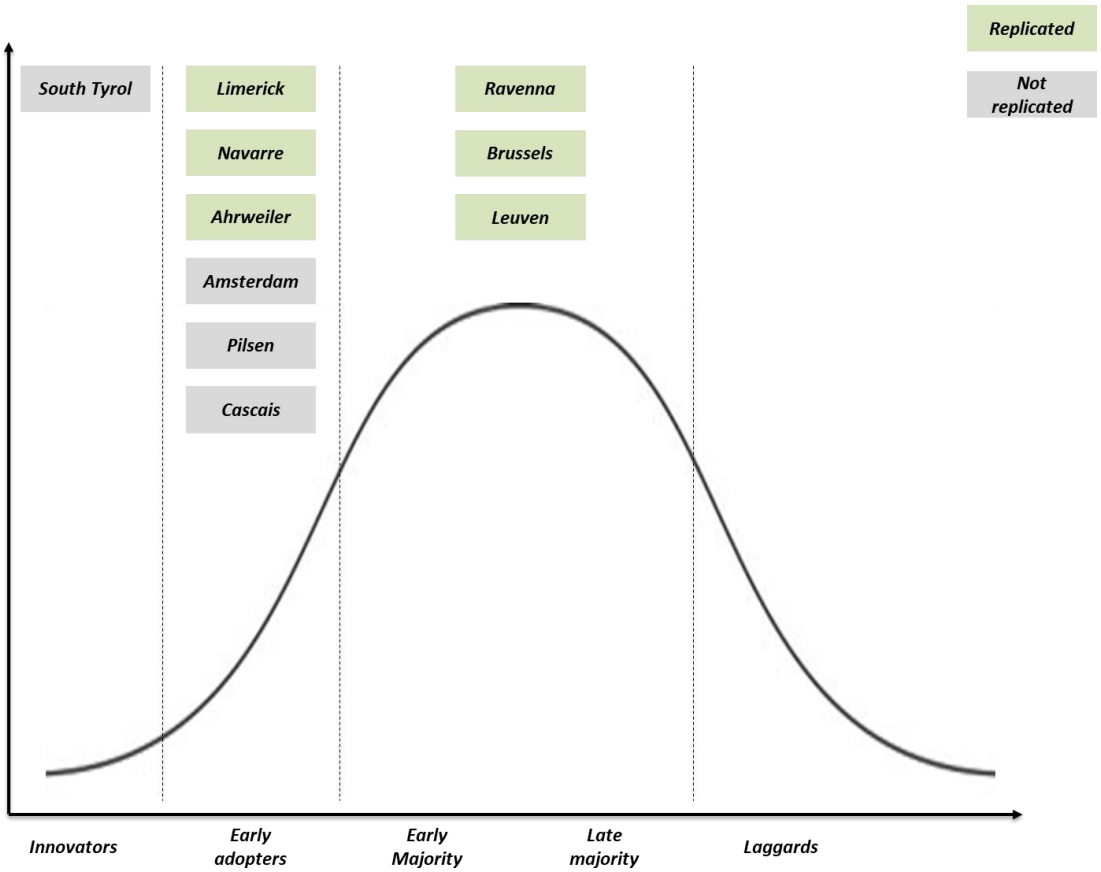
As a general indication, services are usually replicable in other locations from a technological standpoint. Language does not constitute a barrier since translation services are widely available and easy to access. During the policy lab, participants underlined that most cities and regions face similar problems. They should assess their individual needs and shape the solution to adapt to the specific contexts (prioritize and contextualize). Some of the analysed experiences are already scaling at the national level, like the Ravenna and Leuven cases. Scaling, that is, the expansion of the same service, does not depend on technology but on factors such as organisational maturity and competencies, which have been thoroughly underlined in Figure 27.

However, most cases underlined challenges that could prevent scaling into other EU countries. First, some experiences are very sectorial products, requiring adaptation if moved to another context. For example, in South Tyrol, Machine Learning was adapted to the local crops and was embedded in the particular bureaucratic processes of the province. In such cases, the scalability may not occur for several reasons, including: the awareness that a solution was adopted due to the lack of exchanges of practices and reuse catalogues (as the OPSI from the OECD[80]); the competitive advantage of firms that may not find it profitable to address smaller projects that require significant tailoring; the actual culture of innovation. It is interesting to highlight that there is limited evidence of feeding specific tools into communities or *toolboxes* to then be adapted to new local

[80] https://oecd-opsi.org

contexts. In other instances, such as the Cascais Covid War Room, the issue is not the replication of the solution *per se* but the replication of the conditions that made it possible: in Cascais and Navarre, the multi-stakeholder ecosystem that contributed to a shared platform; in Leuven, the service was mandated by national regulations; in Pilsen, the availability of high-quality data related to mobility, that might not be present in other cities. A second barrier to scalability is represented by the more significant financial needs required. In some instances, these would be generated by the need to increase capacity by purchasing more computational capacity; in other instances, open-source solutions would require an economic commitment from other authorities willing to use it that might prefer a more straightforward off-the-shelf solution, such as in the Amsterdam Public Eye case. Finally, a third barrier is represented by "normative scalability", since the absence of a comprehensive and homogeneous set of EU-wide rules in the domain of digital public services requires approaching each country as a new market. For example, in Leuven or South Tyrol, where the service is based on administrative processes, local regulations might be so different that similar needs are not found in other communities.

Figure 27. Replicated and not replicated cases by Technology Adoption Lifecycle



This perspective, coming from case study stakeholders, can be complemented by the results of a policy lab with experts carried out by the authors as a follow-up to this research. The policy lab underlined that there are at least four matters of concern. First, political commitment must be present to adopt the solution. Thus, aligned political priorities are a prerequisite for implementing the existing solution. In turn, political priorities are related – even if not closely nor univocally – to territorial specificities that concerned also case studies' stakeholders. Second, some contextual factors might slow downscaling activities, such as different habits and cultures, the willingness to have a "proprietary tool" instead of someone else's, or the preference for autonomous work instead of voluntary data collection and sharing. Third, the legal framework was highlighted as a potential difficulty, as seen in some case study analysis results. Lastly, regarding data, the policy lab participants highlighted that local and regional public authorities have a wide range of data availability, particularly in the case of geospatial data and that usually (geospatial) data are not comprehensively used to demonstrate value generated by public policies.

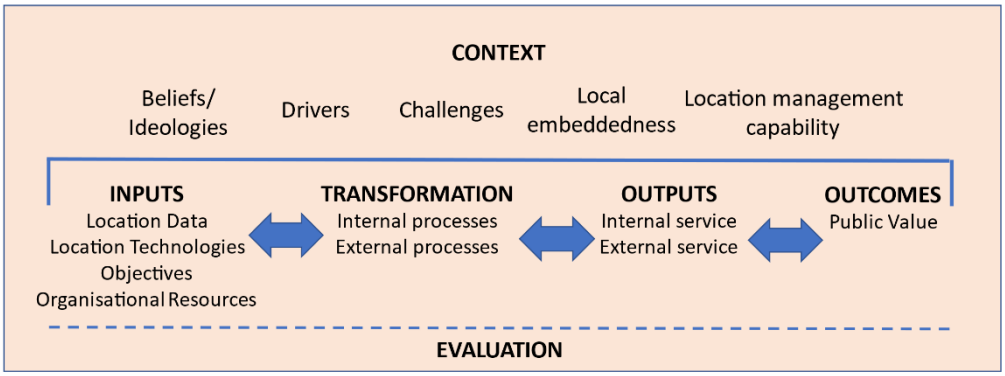
Nonetheless, according to the policy lab participants, enablers are potentially able to foster location-enabled public service adoption. Firstly, a common and centralised approach to open geospatial data could act as a backbone for services to be implemented and replicated, creating the conditions for semantically interoperable

data-driven solutions, minimising the need for changes and adaptation moving from one context to another; secondly, a selective approach that only scales the capabilities that are scalable ("do not try to re-use everything"); thirdly, since many digital services are already well-functioning, providing resources and incentives to add the location-enabled element might increase value for providers and users, without building from scratch new infrastructure and processes.

4.3 Assessing the validity of the conceptual framework

One of the objectives of this work was to validate the conceptual framework developed during the earlier phase of this research on location-enabled public services (Vancauwenberghe, et al. forthcoming) depicted in Figure 28. Case studies are valuable at all stages of the theory-building process but most valuable at the stage at which candidate theories and conceptual frameworks are tested (Eckstein 2000). The work aims "to develop a framework that considers what public administrations have to govern to introduce location-enabled technology in public service delivery successfully", and the comparative case study analyses discussed in this report show that the framework holds up well to this test.

Figure 28. Conceptual Framework: Relations between Context, Inputs, Transformation, Outputs, Outcomes and Evaluation. Source: (Vancauwenberghe, et al. forthcoming)



Overall, all conceptual framework components hold with the empirical analysis, providing relevant implications for scientific research, policy and practice. However, based on the case study analyses, some attributes of each of the framework elements may be expanded.

Firstly, the context may be assessed from a broad perspective to shape the relationship between the environment in which the service is designed and the value it aims at creating. The case study analyses point out that public service delivery occurs within *service ecosystems*, defined as "relatively self-contained self-adjusting systems of resource-integrating actors connected by shared institutional logics and mutual value creation through service exchange" (Vargo e Lusch 2014). Several actors are involved in the delivery process: the public administrations, the technology providers, the users that co-produce it, citizens with their public interests and private and non-profit organizations involved, as in the case of Ahrweiler and Brussels.

All these actors are also embedded within their social systems, which will fashion their own beliefs and values. Their *values* shape the context (*value-in-context*) and may influence the experience of the service users. For example, the technical culture of the technology provider may shape the design of the solution, and, in turn, its usability may influence the users' experience and satisfaction (value-in-use). Therefore, the context component may approach location-enabled public services from a multiple-standpoint perspective that recognises three spheres: the "providers' sphere", the "user sphere", and the "joint sphere". As a follow-up, the role of (actual and potential) users as service co-producers might be further emphasised. Co-producers are users that actively provide their time, efforts, knowledge and experience to the simultaneous production and consumption process of service delivery. In the case study analysis, the role of other public and private sector organisations co-producing the service has been highlighted in Brussels, Navarra, and partially in Ravenna. The role of users as co-producers has been limited to a few cases, such as Brussels and Ravenna. This requires further assessment in future initiatives.

Secondly, it is important to clearly state what is included in the input component and what is included in the context to avoid misunderstanding. Examples from the cases may contribute to clarifying it. According to the case study analysis, the input can be distinguished as existing resources, services and products (e.g. the role of

public maintenance providers in Ravenna), the human capital (e.g., the role of the municipality's innovation officers) and the financial resources (both internal and externally acquired) required to deliver the public service. In Pilsen, for instance, the interviewees stated that they valued organisational resources as contextual factors rather than inputs. Also, the role of the transformation component and its acting as nexus between needs and results (outputs and outcomes) can be further detailed and assessed.

Finally, the service ecosystem was rarely fully understood because we were able to observe, through the interviews, mostly bilateral partnerships (e.g., between the public authority and its provider). Given the diffusion of data ecosystems and data spaces and an increased emphasis on interconnectivity and relationships in general, the role of these factors as input components might be further analysed. Only a full understanding of the service ecosystem can furthermore provide the elements to clearly distinguish the output and outcome elements. Although the performance literature clearly distinguishes outputs as the components resulting from the transformation process and outcomes as indirect consequences, where impacts do not necessarily depend only on the outputs (De Bruin 2002), in reality, public service organisations and their actors do not necessarily differentiate these two components. However, we recognise outputs as operational achievements and outcomes as impacts which depend not only on the location-enabled public service itself but also on the converging actions and behaviours of all stakeholders with a public interest around the problem. Looking beyond this work, such differentiation would be key in the analysis and actual implementation of (location-enabled) public services (see 5 - Conclusion). A greater measurement culture of impacts generated by public services seems necessary for fully understanding public services' generated value within communities.

4.4 The case study method in practice: challenges and improvements for future use

From a theoretical perspective, Bartlett and Vavrus (2017) argue that "cases generate rich theoretical insights that transfer to other times and places". If the observer may generate bias in their research by their actions or simple presence, This work has mitigated the challenge through the definition of a semi-structured interview questionnaire and different teams carrying out the case studies, as well as correlating the case studies' results with the findings from our previous work (Barker, et al. 2021, Vancauwenberghe, et al. forthcoming) . A qualitative and small sample method poses some challenges related to the generalization of the results (Zainal 2007). Flyvbjerg (2009) suggests that while in a quantitative analysis, it is the researchers themselves that transpose insights from the matter at hand to other settings; in a qualitative design, the reader is attributed with this responsibility. Partial mitigation of this problem is represented by carrying out ten case studies that might increase the range of observed experiences and behaviour to give readers a more comprehensive account.

From a practical perspective, at least three case studies experienced difficulties reaching the foreseen number of interviewees. Having a fixed number of stakeholders to interview is sometimes a challenge since a project may be carried out with the close involvement of a minimal number of stakeholders. Another factor is the linguistic and cultural one, since connecting and interviewing are easier tasks when they can be conducted in a common language but can be problematic if, for example, interviewees are not confident with English. Should such work be repeated, a balancing between geographical outreach and linguistic compatibility should be carefully evaluated to grant extensive and solid analysis. On the contrary, the least problematic cases were related to experts who knew about the authors' work and were already in contact with them. In these cases, the interview identification was quick and establishing a connection was easier, as well as understanding the perimeter of the implementation experience. Future work should consider the challenges related to connecting with case stakeholders and foresee a more extensive scoping of cases to avoid such problems. Additionally, the alignment between the interview protocol and the conceptual framework was purposely kept loose. The aim was to guarantee that the interviewees' responses could not be biased towards the conceptual framework. However, this misalignment was sometimes challenging in distinguishing between transformation and context attributes. Future works should carefully assess these elements to guarantee both the validation aspect and the clarity of the connection between interviews and the theoretical component. It could also include specific examples to link the questions to the conceptual framework and to potential examples in reality. Another aspect that could have been more extensively delved into was the specific skill sets employed within the experiences analysed in the case studies, such as professional profiles involved in the design of the solution, in citizens' engagement, in communication and in the technical aspects.

5. Conclusions and future work

From the comparative case study analysis, it is possible to understand that location-enabled public services are usually developed within the interplay of inter-institutional settings, capacity and consensus.

Our research suggests that location-enabled public service adoption and implementation are positively influenced by both internal and external factors. These are, first of all, the local agenda that might refer to the urgency and relevancy of an issue, as well as particular local characteristics. Secondly, path dependence dynamics are a strong positive factor whenever they encompass past decisions of service digitalisation and the strengthening of technological capabilities. Thirdly, the assignment of clear responsibilities for innovation, as well as a well-defined innovation strategy, play a role. Therefore, location-enabled public service adoption seems to prosper when competencies and innovation attitudes are present.

Location-based data and technology are fundamental for the functioning of services, yet the adoption and implementation do not seem to be a technical matter. From a technological perspective, technologies are usually far from the frontier, since the public sector seems to be significantly behind in the implementation of state-of-the-art technologies. From an organisational perspective, the more mature services are, the more easily replicated they may be outside their city of origin, although a rather loose link exists with technological maturity per se. Future work should also properly address the issue of scalability, perhaps extending the scope of analysis to a large scale to have a more nuanced understanding of scaling, its drivers and challenges.

Location-enabled public service adoption and implementation are indeed not a technological matter but, rather, managerial (Damanpour and Aravind 2015) since they are the result of the organisation's capacity to act within the context and being able to identify needs, craft appropriate objectives to address those needs and generate value for stakeholders. Yet the nexus objective-needs-results is still mostly inward-looking, and it is producing short-term related outputs that are usually efficiency-driven. In other words, the analysed experiences are still not starting with user needs and often are influenced by technical possibilities or technical perspectives (e.g., cybersecurity) rather than being fit-for-purpose. The thorough analysis of the context, input and transformation component of the conceptual framework can pave the way to research that identifies and deploys tools for capacity building, built on the actual strengths and weaknesses of implementing organisations. Such analysis could adopt a service ecosystem approach to understand and involve the interested actors, including citizens, and strengthen service co-production methods.

Outcomes, instead, are less measured and difficult to operationalise in external measures. The generated values are mainly related to operations. In the case studies, the main highlighted values are, in fact, increases in efficiency and collaboration across multiple stakeholders. It is particularly interesting to underline that the expected (and declared) value to be generated is usually social or political (e.g., increase in transparency or citizens' engagement), yet organisations fail to assess and measure it. Future research should investigate the difficulties in measuring impacts and the lack of a structured measurement culture to understand their roots and find potential paths to overcome them.

While these elements are of a larger scope than just location-enabled public services, digital (location-enabled) public services could benefit from such research because of their nature in terms of challenges and opportunities related to interoperability that often involve data-sharing between stakeholders, as well as notable innovation related to digital transformation. Future research should therefore focus also on the limited citizens' involvement in these services showing that co-production is still poorly addressed. Future work should delve into the role of users and, more broadly, of citizens adopting a threefold perspective:

- The users' satisfaction, their experience and the usability of the service;
- The factors that are responsible for paving the way for co-production efforts;
- The characteristics of solutions that are fit-for-purpose in terms of public value creation.

The first point will also be incorporated in future work of the authors, as the foreseen next steps include the exploration of different methodologies, including potential focus groups, additional interviews and reviews of the feedback on certain apps. In parallel, a literature review will delve into some preliminary aspects of the second point, regarding current approaches to citizens' perspective from the digital government standpoint.

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List of abbreviations and definitions

Abbreviations

AGIV	Agency for Geographic Information Flanders
AI	Artificial Intelligence
AML	Advanced Mobile Location
AMS	Amsterdam Institute for Advanced Metropolitan Solutions
API	Application Programming Interface
APK	Application Package Kit
AR	Augmented Reality
ASC	Amsterdam Smart City
ATMO	Street Air quality Model
AWS	Amazon Web Services
BR	Better Regulation
CCTV	Close-Circuit Television
CDO	Chief Development Officer
CIO	Chief Innovation Officer
CMSA	Crowd Monitoring System Amsterdam
CRAB	Central Reference Address Database
CSV	Comma-Separated Values
CTO	Chief Technology Officer
DG	Directorate-General
DGS	Directorate-General of Health of Portugal (Direção-Geral da Saúde)
DIN	German Institute for Standardization (Deutsches Institut für Normung)
DSM	Digital Single Market
DUET	Digital Urban European Twins for smarter decision making
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
EEA	European Economic Area
eID	Electronic Identification
EIF	European Interoperability Framework
ELISE	European Location Interoperability Solutions for e-Government
ESA	European Space Agency
ESRI	Environmental Systems Research Institute
EU	European Union
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GIPOD	Generic Information Platform Public Domain
GIS	Geographic Information System

GPS	Global Positioning System
GPU	Graphics Power Units
GRB	Large-scale Reference Database
ICT	Information Communication Technology
IMACS	Inter-Ministerial Appraisal Committees
INSPIRE	
IP	Internet Protocol
IT	Information Technology
JRC	Joint Research Centre
LSTM	Long Short-Term Memory networks
MALL	Marineterrein Amsterdam Living Lab
ML	Machine Learning
MPSD	
MR	Mixed Reality
NGOs	Non-Governmental Organisations
NHS	National Health Service
OECD	Organisation for Economic Co-operation and development
OGC	Open Geospatial Consortium
OSLO	Open Standards for Linking Organisations
OSM	Open Street Map
PCR	Polymerase Chain Reaction
POC	Proof of Concept
PPE	Personal Protective Equipment
PSM	Public Sector Modernisation
REST	Representational State Transfer
SaaS	Software as a Service
SDI	Spacial Data Infrastructure
SIAG	South Tyrol Informatic Agency (Südtiroler Informatik AG)
SITNA	Territorial Information System of Navarre (Sistema de Información Territorial de Navarra)
SMEs	Small Medium Enterprises
SPID	Italian Public System for Digital Identity (Sistema Pubblico di Identità Digitale)
TAS	Traffic Accidents Services
THW	German Federal Agency for Technical Relief (Technisches Hilfswerk)
UEFA	Union of European Football Associations
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
V-ICT-OR	Flemish ICT Organisation
VITO	Flemish Institute for Technological Research

VR	Virtual Reality
W3C	World Wide Web Consortium
WCAG	Web Content Accessibility Guidelines
WHO	World Health Organisation
WMS	Web Mapping Services

Definitions

- **Case study**: according to Yin (2008), case studies can be used to explain, describe or explore events or phenomena in the everyday contexts in which they occur. These can help to understand and explain causal links and pathways resulting from the adoption of location information and technologies to improve local public services.
- **Context:** refers to specific features of the local environment that must be considered for the transformation and value creation of local public services. Various attributes affect the choices for planning and implementing public services at the local level, such as:
    - Values: Economic, Social, Environment, Governance
    - Drivers: History of the city/municipality, development focus of the solutions (such as levering on the deployment of ICT for local development, leveraging on human capital, attracting investments, etc.), and local dimensions to be improved (such as economic, social, environment, mobility, health, living and governance
    - Challenges: economic, social, environmental, technological, service delivery, financial, governance, legal, ethical, and institutional
    - Risks: economic, social, environmental, technological, financial and strategic
    - Region: comprising more cities/municipalities sharing similar problems and opportunities.
- **Co-production:** regular, long-term relationships between professionalized service providers… and service users… where all parties make substantial resource contributions" (Bovaird, 2007 p. 847).
- **Digital Government transformation:** "a notable change, modernisation effort or innovation, introducing digital technologies in government's business processes, service delivery models and culture, restructuring how the government performs basic functions and governs. [… It is] the abandonment of analogue operating models (e.g., manual, paper) in favour of the new digital systems", not in a gradual manner. Other key aspects of Digital Government Transformation are (Barcevičius et al 2020):
    - Transformation as a process with different degrees of maturity (traditional government, e-government, digital government).
    - "The new, 'transformed', technology-based systems should not only be consumer-friendly, strategy-driven, and capable of providing a better experience for those interacting with the government, but, more importantly, should also improve the way the government systems operate".
- **Dynamic Location Data:** for the purposes of the report, dynamic data refers to data that is updated at more frequent intervals, may relate to a dynamic entity (e.g., a moving individual or vehicle), is often spatio-temporal (i.e., relating to both a specific location and point in time), and can be generated from a dynamic ecosystem of data producers, whether citizens, public or private entities.
- **Geography**: the selected case studies will span various global geographies, however applicability to EU Member States will be noted.
- **Geospatial Application**: broadly classified as a data-sharing platform; wayfinding; real-time decision making, planning and simulation; data collection; indoor location; alternative geospatial mapping.
- **Innovative aspect of the solution:** including the focus on the outputs/attributes of the solution, interoperability, openness, scalability and re-usability; application of leading-edge technologies, such as IoT, edge computing, AI/ML, quantum, digital twin.

- **Innovative use of data**: Data used in a novel manner in reference to an organization, a sector or a policy.
- **Inputs:** refer to elements that the transformation process of a local public service delivery can use. Two main input attributes can be identified: location technologies and data.
- **Interoperability:** A key factor in making a digital transformation possible. It allows administrative entities to electronically exchange meaningful information in ways that are understood by all parties. (ELISE Glossary)
- **Local and regional governments:** Territorial public authorities within a sovereign state. In the context of the European Union, local and regional governments correspond to NUTS-2, NUTS-3 and LAU (Local Administrative Units) in the EU common nomenclature of territorial units for statistics.
- **Location data**: geospatial information embedded into the solution to deliver services to the stakeholders. Data with a direct or indirect reference to a specific location or geographical area (cf. the legal definition in the INSPIRE directive, Directive 2007/2/EC). This term can be interchanged with location data, geospatial data or geodata.
- **Location-enabled (public) services:** Services provided by public authorities which depend on effective management or use of location information. Their location component is essential to creating value. It refers to services that regularly use location-enabled technologies and to the ones that make innovative use of them. (source: EULF Blueprint)
- **Location-enabled technologies**: geospatial technologies embedded into the solution to deliver services to the stakeholders. The focus is both on data and technology.
- **Location information:** Any piece of information that has a direct or indirect reference to a specific location or geographical area, such as an address, a postcode, a building or a census area. Most information from diverse sources can be linked to a location. This term can be interchanged with spatial, geospatial, place or geographic information.
- **Location intelligence:** The process of deriving meaningful insight from geospatial data relationships — people, places or things — to solve particular challenges such as demographic or environmental analysis, asset tracking, and traffic planning. (source: Gartner Research)
- **Maturity:** digital maturity refers to the extent to which digital technologies have transformed an organization's processes, talent engagement, and citizen service models. (source: Deloitte, 2015)
- **Outcomes:** refer to results produced by transformation processes of public services at local level. The outcome of these processes is the creation of public value.
- **Policy/Service area:** including energy, transport, health, housing, education, etc.
- **Public sector:** any type of organisation delivering public services, acting within a local or regional territory. Examples include public organizations such as municipalities, non-profit organizations, public companies, private sector firms, port authorities, transportation and utility companies. (source: Brown and Osborne 2012)
- **Public service:** a service intended to serve all members of a community. It is commissioned by the public sector or delegated/taken up/delivered by others and is a solution that serves a purpose for its stakeholders. The taxonomy "European taxonomy for public services" developed by ISA2 will inform the project's activities. According to this taxonomy, public services can be defined as a combination of themes (e.g., Education, Health Care) and patterns (e.g., Information, Financing, Production).
- **Public value (creation) / generated value**: results of the activities the public sector has achieved. It is a multi-dimensional concept that embraces several dimensions of value, including efficiency, effectiveness, output, quality, responsiveness, and democracy, that are relevant to the different stakeholders of public services. The team acknowledges that value may also be destroyed for some stakeholders. The focus will be on cases where the overall public value is positive. Osborne, Nasi and Powell (2020) identify three *loci* of value creation:
    - Individuals/Citizens, as end-users, stakeholders, communities;

- Society, because the public service is an expression of societal values or addresses systemic societal problems;
- Public Sector Organizations because of learning and consequent change implemented in public services.

While Osborne (2018) distinguishes between

- Value-in-use: the customer utilization of the offer generates value for the customers themselves;
- Value-in-context: customers create value because the utilization of the offer interacts with their experiences of life and social environment.

- **Public values:** beliefs and ideologies in the context. Public values represent a contextual variable that informs the project. Public values should be addressed among the determinants of the external environment in providing recommendations for upscaling and diffusion of location-enabled services. (source: Osborne 2018).
- **Public-value of e-governance:** According to Pin-Yu and Chu (2017), it can be operational (efficiency, user-oriented service), political (transparency/accountability, citizen participation, equity in accessibility), social (trust, self-development, quality of life, environmental sustainability).
- **Readiness:** methods for determining the maturity of technology during the acquisition phase.
- **Solutions:** means to create value. They include the technology but also the data/digital components.
- **Stakeholders:** all actors with an interest/expectation in the need for which the service represents a solution. The team will use the power and interest stakeholder matrix, and it will mainly focus on stakeholders with high power and high interest.
- **Static Location Data:** in the context of the report, we use the term static data to refer to data which relates to a static element of the environment, e.g., a property or parcel of land. These data sets tend to be more persistent and are updated less frequently. These datasets tend to be provided and managed by a single public sector entity with a limited role played by the broader ecosystem.
- **Transformation:** refers to the processes of redesigning and improving public services and of delivering new, innovative services. This study focuses on transformation driven by or enabled by location data and technologies. Transformation could refer to new, innovative approaches for the design and delivery of public services and/or for the governance of services. Looking at the existing literature on digital transformation and innovative public services, various specific attributes relevant to the transformation process could be identified: approaches, stakeholders, governance and maturity models. Each of these attributes could be classified into relevant sub-attributes:
  - Approaches: top-down and bottom-up
  - Stakeholders' attributes: Types, Roles, and Partnerships
  - Governance: requirements, principles, vision, resource management, models and government roles
  - Maturity models for measuring and monitoring the level of progress: eGEP2.0 model (Salvoldelli and others, 2013), scorecards (Meynhardt and Gomez, 2013)

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Annex 1. Interview protocol

General

Goal: scientific study on location-enabled public service;

Audio recording;

Full anonymity.

Sections

Scope of the case, aimed at understanding the scope of the project and the role of the interviewee;

Transformation approach, aimed at getting an understanding of the way project's implementation was carried out;

Determinants and barriers (including context and input), aimed at investigating which factors enabled or favoured the implementation versus those that blocked or delayed it;

Output, outcome and evaluation, aimed at investigating the type and attempting to get a deeper understanding of the value the project is creating (whether it is creating it).

Introduction to the interview

Introduction to the project;

Informed consent;

Explanation of the scope of the case study analysis;

Ask interviewees to introduce themselves and their role within the case study;

Scope of the case

1. Please, describe which are the objectives behind the implementation of your location-enabled public service.
2. Please, describe the stage of adoption that characterizes the service: when was it implemented? What has been its evolution trajectory?
3. Eventually, ask some contextual information about the case still missing/not fully understood after the desk research.

Guidelines questions [the following checklist should be checked to eventually ask clarifications or integrations to the interviewee – see appendix 0 case factsheet]

Which are the characteristics of the service?

Which technologies is the service exploiting?

On which types of location data or other data is the service based?

Which organisational resources (funds, personnel …) are available for the service?

Is the organisation the first adopter at the regional/national/EU level?

Is it among the first ones?

Transformation

4. This research focuses on location-enabled public services. To you, how influential were/are the following factors in shaping the implementation of the location-enabled public service under analysis? *(guideline for interviewers: first ask the interviewee the general question, eventually guide them if they are not specific to make sure you mark whether each factor listed below has been influential [YES/NO]; for each item they list make sure to ask for an explanation to clarify their choices – open end response)*

a) Adaptation processes: change in organisational processes, and to what extent (e.g., radical versus incremental change)

b) Political conflicts: conflict between different groups over values, power, resources;

c) Incentives at various levels: set of monetary on non-monetary benefits provided in case an actor performs a certain action;

d) Inter-institutional networks: formal or informal connections between different institutions;

e) Change management: particular approach to change that is meant to govern and direct an organisation towards a different situation;

f) Organisational inertia and/or resistance: active or non-active behaviours that impede changes;

g) Legal constraints: the set of legal norms – any level from the constitutions to organisational rules;

h) Lack of interoperability: lacking capacity of existing ICT systems to integrate and share information with other services;

i) Scarce awareness of benefits: lacking of the basic knowledge about the potential effects of the innovation on the organisational outputs and outcomes;

j) Change in leadership: emergence of a new leadership or of a new way of leading that helps the process unfolding;

5. With regard to the adoption of location enabled technology to support public services:

    a) Was this "innovation" a priority? Was there an organisational/economic engagement and to implement?

    b) Is this innovation part of the organisational strategy? Has there been communication between info strategy and processing?

    c) What is the role of the leadership towards innovation? Are they aware of its strategic significance?

6. Was this innovation aimed at producing effects in the short term or long term? If so which ones? Was it embedded into a larger scale digital transformation (i.e. smart city strategy) if relevant?

7. With regard to the overall governance what are the processes and decision-making rules in place? Which responsibilities can be identified?

8. With regard to external stakeholders (that is, external to the perimeter of the organisation(s) delivering the public service), which ones were involved and which roles did they take (e.g. Project owner, project performer, strategic partner, civil society, and customers? Please consider stakeholders such as citizens, local governments, city officials, private enterprises, Internet Service Providers, etc.

9. If so, how were partners selected? Which was their expertise, in terms of vision and implementation capacity? What is the formal and informal relationship between the service provider and the institutional actor(s) involved?

Determinants and barriers of the context

10. Various factors that are inside or outside the organisation can have facilitated or hindered the implementation of the location-enabled public service.

    - To you, which contextual factors (internal or external) promoted or hindered the implementation? Or were they irrelevant?
    - Which ones were more influential?
    - Can you explain why?
    - Can you bring examples from this experience?

(Guideline for interviewers: first ask the interviewee the general question. Eventually make sure to address in details the relevant items. Should they give general answers, make sure to ask whether each

factor of the following list was influential [YES/NO]; secondly ask for a comment and an explanation for their choices)

a) Demographic factors

b) Economic factors

c) Environmental factors

d) Ethical factors

e) Financial factors

f) Governance factors

g) History of the city/municipality/region

h) Individual factors

i) Institutional factors

j) Inter-institutional dynamics

k) Legal and legislative factors

l) Local dimensions to be improved

m) Organisational factors

n) Political and administrative factors

o) Social factors

p) Strategic objectives

q) Technological factors

11. With regard to the location-enabled components of the project, which challenges and/or drivers to the implementation you can identify?

12. What was the rationale for the location-enabled element of the service, what capabilities does it bring and why are these important?

Determinants and barriers of scalability and replicability

13. This research has an additional focus, that is, the replicability and scalability of location-enabled innovative public services. Specific influencing factors characterized the scalability and replicability of innovation.

14. Is your solution currently [or in the foreseeable future] being replicated elsewhere? Is the service currently [or in the foreseeable future] being scaled to a broader area? Do you think the solution could be replicated to cover a broader area within the EU or the whole EU?

15. To you, how influential were/are the following factors in scalability and/or replicability of your location-enabled public service? Or – if the replication/upscaling process still has to be launched – how influential would they be in the future process according to your perception? *(guideline for interviewers: first ask the interviewee the general question, eventually guide them if they are not specific to make sure you mark whether each factor listed below has been influential [YES/NO]; for each item they list make sure to ask for an explanation to clarify their choices – open end response)*

    a) Adaptation processes;

    b) Political conflicts: conflict between different groups over values, power, resources;

    c) Incentives at various levels: set of monetary on non-monetary benefits provided in case an actor performs a certain action;

    d) Inter-institutional networks: formal or informal connections between different institutions;

    e) Change management: particular approach to change that is meant to govern and direct an organisation towards a different situation;

f) Organisational inertia and/or resistance: active or non-active behaviours that impede changes;

g) Legal constraints: the set of legal norms – any level from the constitutions to organisational rules;

h) Lack of interoperability: lacking capacity of existing ICT systems to integrate and share information with other services;

i) Scarce awareness of benefits: lacking of the basic knowledge about the potential effects of the innovation on the organisational outputs and outcomes;

j) Change in leadership: emergence of a new leadership or of a new way of leading that helps the process unfolding;

k) Proper owner: clear attributions of responsibilities – and corresponding powers – in the process.

16. What is/would be the role of interoperability in replicating/upscaling your location-enabled public service?

Output, outcome, evaluation

17. What is the main output of your location-enabled public service? Is it more focused on the ability of the organisation to fulfil its objectives or is it a platform to facilitate stakeholders' activities?

18. What is the impact of the service on the respective policy area? Consider in particular the following categories of generated public values

    1. Operational: Collaboration, Effectiveness, Efficiency, User-oriented

    2. Political: Accountability, Economic development, Equity in accessibility, Openness, Citizen Participation, Transparency

    3. Social: Inclusiveness, Quality of life, Self-development, Environmental Sustainability, Trust

19. Did your organisation/partners measure outcomes and impact? Was it a qualitative or quantitative measurement? How is the measurement and evaluation process carried out?

20. Please provide us with some examples of KPIs you are using to evaluate the service. [Here the interviewer can ask for other relevant documentation related to the evaluation if it has not been collected through the desk research]

Conclusion

- Ask if respondent wants to add something which was not yet covered.
- Check whether he/she want to see the interview report and validate it.
- Check whether he/she wants to be kept updated about the progress of the study.
- Thank the respondent for the interview

Annex 2. Full list of potential cases considered for this study

Table 2. Full list of potential cases

Name	**Policy / Service AREA**
A Citizen Observatory and Innovation Marketplace for Land Use and Land Cover Monitoring (LandSense)	Biodiversity and landscape
Address Data System	Other
AgriML	Agriculture, forestry, fishing, and hunting
AirBezen	Pollution abatement
ALKIS	Housing and communities' amenities
Amsterdam beacon mile	Other
AppyWay	Transportation (including mobility)
Basic Data Program	Transportation (including mobility)
Border landmarks	General public services
Busup: Multi-platform On-demand Crowdsourced Bus Transportation (including mobility) for Smart City Mobility	Transportation (including mobility)
Capacity Management Solution for the Beaches of the Costa del Sol	Tourism
Cities as Mobility Hubs: Tackling Social Exclusion Through 'Smart' Citizen Engagement (SMARTDEST)	Tourism
City Pulse: Stratumseind Living Lab	Police Services
CityFlows - Decision-support System for Pro-active Crowd management of Crowded Urban Spaces	Public health services
Crowd Insights Monitor	Tourism

Name	Policy / Service AREA
Crowdsourcing at school	Education
Curious Noses	Biodiversity and landscape
Deakin University - Deacon Scout	Other
Digital Twins of Helsinki	Other
DUET - Digital Urban European Twins for smarter decision making	Transportation (including mobility)
ELISE Energy Pilot	Other
Emergency Asset Management	Resource planning, emergency services
Territorial Information System of Navarre: SITNA	Other
Feel Florence	Public health services
Fix My Street	General public services
Flanders Digital Underground Utility Location System	Other
Granada Human Smart City	Tourism
Heidelberg smart waste	Waste management
HushCity app	Housing and communities' amenities
Improve the Map	Transportation (including mobility)
Ireland SDG Hub	Other
IssueDoc	Housing and communities' amenities

Name	Policy / Service AREA
LandSense	Agriculture, forestry, fishing, and hunting
Lisbon Mobility Catalogue	Transportation (including mobility)
Local tourism insights from MPD – Setomaa in South Estonia	Tourism
Microsoft Soundscape	Transportation (including mobility)
MijnTuinLab	Biodiversity and landscape
Open VetMap	Biodiversity and landscape
OpenStreetMap	Transportation (including mobility)
Oriient	Public health services
Osoitehaavi – Address net	Other
Paikkatietoalusta	Transportation (including mobility)
ParkTrack	Transportation (including mobility)
PDOK - Public Services On the Map	Other
Pointr	Transportation (including mobility)
POLIVISU	Transportation (including mobility)
Real-time Crowding Heatmap	Public health services
Rennes Urban Data Interface (RUDI)	Other
Sensor detection walk	Other

Name	Policy / Service AREA
SMART-FI in Malaga: CityGo and CityDash	Transportation (including mobility)
Territorial Information System for the Network of Open Areas in the Province of Barcelona (SITXell)	Biodiversity and landscape
TfL wi-fi data collection	Transportation (including mobility)
Toponyms from historical associations	Other
Tourist information	Tourism
Urban Development: Solar Roof Cadastre	Pollution abatement
Urban platform	Other
Urban platform	Other
URBANITE	Transportation (including mobility)
We Service Heerlen (WESH)	Other
What's in Your Backyard for farmers	Other
what3words	Other

Annex 3. Selection criteria evaluation form

Eligibility criteria for case studies	Description	Evaluation	
		Priority (from 0 to 5, *5 max)	Relevance (from - 2 to + 2)
Policy/service area	Under-explored policy areas (as defined in T2 - State of the art report)		
Geography	NUTS 2-3 / LAU 2 level of operation, if applicable, with a particular focus on target entities that are able to represent the broader perspective for the entire city or regional community. The selected case studies will span various global geographies, however applicability to EU member states will be noted.		
Stage of adoption/technological readiness	aligned with EC classification: Research and innovation (~ TRL1 - TRL2), Proof of concept (~ TRL3 - TRL4), Prototype (~ TRL5 - TRL7), Production System (~ TRL8 - TRL9)		
Degree of disruption of location-enabled technologies	Level of embeddness of the service delivery process run through location-enabled technologies (i.e. no use of Location enabled tech, minimal use, support to processed, end-to-end)		
Maturity	Maturity of the adopter classified as: Pioneer, Follower, Late adopter, Laggard. (classification on the universe of location-enabled public services, not just referred to case studies)		

Innovative technologies	Technologies or data that are innovative - aligned with OGC geospatial tech trends and emerging trends (Artificial Intelligence, Machine learning, Cloud Native Computing, Edge Computing, Blockchain, Immersive Viz: VR, MR, AR, Connected Autonomous Vehicles, UxS/Drones, 5G Cellular, Urban Digital Twin) (i.e. scaled by level of employment of cutting edge technologies)		
Innovative use of data	Data used in a novelty manner in reference to an organisation, a sector or a policy (i.e. both with regard to existing data used for new purposes and/or with regard to dynamic datasets where multiple, often real-time, non-government owned sources are increasingly meshed together)		
Interoperability	The ability of organisations to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organisations, through the business processes they support, by means of the exchange of data between their ICT systems. ISA2 EIF (European Interoperability Framework) IMACS levels: Ad hoc (level 1): Poor interoperability – the digital public service cannot be considered interoperable Opportunistic (level 2): Fair interoperability – the digital public service implements some elements of interoperability best practices Essential (level 3): Essential interoperability – the digital public service implements the essential best practices for interoperability Sustainable (level 4): Good interoperability – all relevant interoperability best practices are implemented by the digital public service Seamless (level 5): Interoperability leading practice – the digital public service is a leading interoperability practice example for others		
Value generated/destroyed	Presence of tools/methods to assess outputs/outcomes and value (i.e. definition of KPI, use of methods, actual assessment and reporting)		
Replicability	Non context-specific case that presents characteristics fro dissemination at EU level of a location enabled public service to be repeated to obtain a consistent result; to ensure that the solution may be adjusted to other contexts (i.e.		

	geographical, level of jurisdiction; service sector/policy area) and under the proper feasibility conditions it could be replicated		
Citizens' engagement	Engagement or not of citizens in the design, production and delivery phases		
Use	Effective participation of the target population in the public service delivery, as foresighted by the public service design? (e.g., adoption rate, number of active accounts, popularity …)		

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