OpenGovIntelligence

Fostering Innovation and Creativity in Europe through Public Administration Modernization towards Supplying and Exploiting Linked Open Statistical Data

Deliverable 2.2

OpenGovIntelligence Framework

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Abstract:	This document contains an update and improved version of the framework that was initially produced under D2.1 The new framework takes a systems based approach and aims to help clarify the process of open government data-driven public service co-creation.

Effort of Participating Partners

	Name	*Short Name*	*Role*	*Person Months*
1.	Centre for Research & Technology - Hellas	CERTH	Participant	3.0
2.	Delft University of Technology	TUDelft	Participant	0.0
3.	National University of Ireland, Galway	NUIG	Participant	1.5
4.	Tallinn University of Technology	TUT	Leader	15.0
5.	ProXML bvba	ProXML	Participant	0.22
6.	Swirrl IT Limited	SWIRRL	Participant	0.4
7.	Trafford council	TRAF	Participant	0.1
8.	Flemish Government	VLO	Participant	0.0
9.	Ministry of Administrative Reconstruction	MAREG	Participant	0.1
10.	Ministry of Economic Affairs and Communication	MKM	None	0.0
11.	Marine Institute	MI	Participant	0.5
12.	Public Institution Enterprise Lithuania	EL	Participant	0.1

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Version	*Date*	*Revised by*	*Reason*
0.1	29/09/2017	TUT	Submission to partners for feedback
0.2	16/10/2017	TUT, all partners	Submission for internal quality review
0.3	24/10/2017	CERTH	Feedback from internal quality review
1.0	31/10/2017	TUT	Submission to EC

Statement of originality:

This deliverable contains original unpublished work except where clearly indicated otherwise.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

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List of Abbreviations

The following table presents the acronyms used in the deliverable in alphabetical order.

Abbreviation	*Description*
API	Application Programming Interface
CSV	Comma Separated Values
D	Deliverable
EC	European Commission
HTTP	Hypertext Transfer Protocol
ICT	Information and Communication Technology
ISO	International Organization for Standardization
JSON	JavaScript Object Notation
LOSD	Linked Open Statistical Data
NGO	Non-Governmental Organization
OGD	Open Government Data
OPM	Object Process Methodology
RDF	Resource Description Framework
SE	Systems Engineering
ST	Systems Thinking
URI	Uniform Resource Identifier
UK	United Kingdom
WP	Work Package
XLS	Microsoft Excel spreadsheet file extension

Executive Summary

The aim of the OpenGovIntelligence Framework's final release (D2.2) is to present a structured framework for looking at and understanding the co-creation of LOSD-driven public services. This framework represents an update and improvement to the initial release (D2.1); the framework incorporates suggestions and addresses feedback that was received from the European Commission as well as the open review process. The framework has four main contributions:

1. Description of LOSD and OGD-driven co-created public services;
2. Model of the OpenGovIntelligence co-creation system;
3. Generic architecture for the services developed by the OpenGovIntelligence project;
4. Recommendations and strategies for policy makers.

In the first part of the framework an overview of the traditional understanding of public service delivery is presented, which is then followed by a description of the new paradigm we are entering; one of LOSD-driven co-created public services. There are many changes from the traditional model, but the largest shift takes place in the relationships between stakeholders. The view taken here is that all stakeholders, whether public or private, may take the lead in developing a new service to create public value. Thus, there is a move from a top-down approach in public service creation to a more horizontal and networked relationship where multiple stakeholders play a role in the public service creation process.

The OpenGovIntelligence Framework takes a hard systems based approach and uses object process methodology (OPM) to develop a model of the OpenGovIntelligence co-creation system. The OpenGovIntelligence co-creation system model consists of two main diagrams or levels. The first level consists of one main process, co-creating. When performed, co-creation takes open government data and generates public value and leads to the creation of a co-created OGD-driven public service. The second model provides an 'in-zooming' on the co-creation process and demonstrates how there are four main sub processes within co-creating: co-initiation, co-development, co-implementation, and co-evaluation. Furthermore the model presents environmental factors that influence co-creation and the entities that are required for co-creation to take place.

The systems model provides an overview of the necessary parts and processes that are needed for the co-creation of OGD-driven public services, and from this model an architectural model based around ArchiMate has been constructed and presented. It demonstrates where and how co-creation occurs. As the development of co-created OGD-driven public services often occurs in an agile manner, iteration is important. Thus, two different architectural diagrams are presented to demonstrate how the service development occurs through iteration and how multiple iterations change the structure of the service.

The final contribution of the framework is the development of recommendations for government agencies and for non-governmental stakeholders which, if adopted, would allow for better access to OGD and increased levels of co-creation. These recommendations are based on feedback that was received from participants in a stakeholder survey that was conducted in WP1 and, additionally, feedback that has been received in informal interviews with policy makers and other stakeholders.

1 Introduction

1.1 Scope

The OpenGovIntelligence Framework's final release (D2.2) presents the second and final version of the OpenGovIntelligence framework for the co-creation of data-driven services. The objective of the framework is to propose and describe an ecosystem that enables the co-creation of data-driven user-centric public services by public authorities, citizens and other societal stakeholders. The framework defines the entities, their interrelations and processes that constitute the co-creation system. It also proposes policies and strategies that can support the functioning of this ecosystem.

The first release of the framework has been published in D2.1[1] in October 2016. As an extension and improvement of the first version, the current version explicitly takes a systems approach to the framework, combining constructs and tools from systems thinking in social sciences and information technology. It gives a detailed presentation of the entities and interactions involved in the innovation ecosystem and proposes a general architecture for a co-created data-driven public service web application.

In addition to extending and elaborating the first version of the framework, D2.2 also builds on input received from other OpenGovIntelligence deliverables, the results of the first project review, and feedback to the framework from the academic e-government community. The following input has been received from these additional sources:

- OpenGovIntelligence D4.2 (Evaluation results – First round). This deliverable presents the first description of the pilots, which has been used as the basis for mapping the elements of the service co-creation system.
- OpenGovIntelligence D4.3 (Pilots and Evaluation Plan – Version 2) and D3.3 (ICT tools – second release). The drafts of these deliverables (both released in parallel with D2.2) have provided information on the evaluation framework of the OpenGovIntelligence pilots and the ICT toolkit that can support the creation of LOSD-driven services.
- Results from the first OpenGovIntelligence review. The reviewers' comments on the first version of the framework (D2.1) have been used as a basis for developing the second version of the framework. In particular, the comments related to the aspiration of the framework, its role and function in the project, and the schematic representation of the framework have been addressed in the new version.
- Two academic papers on the framework, presented at top e-government and e-democracy conferences in 2017. The first article, „Open Data as Enabler of Public Service Co-creation: Exploring the Drivers and Barriers", focused on the context factors that affect open data-driven public service co-creation and was presented at the CeDEM 2017 conference in Krems in May 2017. The second article, „A Framework for Data-Driven Public Service Co-Production", was presented at the IFIP EGOV/EPART conference in St Petersburg in September 2017. Both papers were well received by the academic community and the latter one was also nominated among outstanding papers in the category of „the most promising practical concept".

[1] Available at: http://www.opengovintelligence.eu/downloads/deliverables/OGI_D2.1%20OpenGovIntelligence%20framework%201st%20release_v0.1.pdf

1.2 Audience

This deliverable is public and open to anyone interested. The primary audience of this deliverable includes the OpenGovIntelligence consortium, in particular the pilot partners, and the European Commission (EC). However, the framework may also be interesting to public, private and community organisations outside the project consortium, the research community, and individual members of the general public, in particular those that work with Linked Open Statistical Data (LOSD) or are interested in learning how government data may be turned into services that generate public value.

1.3 Structure

The deliverable is structured as follows. This first introductory chapter is followed by Chapter 2, which explains the objective of the framework. Chapter 3 then defines the concept of LOSD-driven public services. Chapter 4 describes the background and rationale for adopting a systems approach as the guiding approach to the framework development. Chapter 5 presents the framework and its components, outlining the entities, interrelations and processes involved in the co-creation system of LOSD-driven public services. Chapter 6 proposes a general architecture for data-driven public service web application. This is followed by Chapter 7, which gives recommendations for policies and strategies that can support the public service co-creation system. Lastly, conclusions are provided and some suggestions given for possible practical applications of the framework in Chapter 8.

2 Objective of the Framework

The objective of the framework is to present the OpenGovIntelligence co-creation system and demonstrate how a systems approach towards LOSD-driven co-creation and innovation allows new and innovative services to be engineered in a way that allows for higher levels of public value to be created by encouraging co-creation. The framework addresses the systemic and environmental factors that influence LOSD-driven co-creation of public services, and proposes an architecture LOSD-driven co-created public services with the aim of aiding society and public service providers in the development and implementation of data-driven public services. This aim is achieved by proposing general guidelines for public administrations, citizens and businesses for opening up and exploiting LOSD in a way that addresses the relevant challenges and facilitates the co-creation of innovative data-driven services through the direct participation of citizens and businesses. More specifically, the framework aims to:

- specify improved business processes for feeding society's input (needs, data, feedback) and data reuse into service delivery (i.e. facilitating the co-production of services);
- define strategies and policies to support the involvement of society in the design and delivery of data-driven public services and opening public sector data;
- propose an architecture for LOSD-driven co-created public services that helps to ensure successful co-creation and public value creation

In order to comprehensively describe the OpenGovIntelligence co-creation system, the framework outlines a number of components, including processes for opening up data; strategies and policies for innovation; architectures for LOSD-driven co-created public services; and contextual drivers and barriers.

2.1 Approach

The aim of the OpenGovIntelligence framework is to demonstrate that the concepts of LOSD and co-creation have the potential to change the way that public services are created and delivered. As the world becomes more networked and intertwined, co-creation is becoming more common and a framework for understanding this process is needed. Therefore, the framework aims to progress past towards the traditional public service delivery processes and aims to redefine these processes to allow for a genuinely service user-led and data-driven innovation. The framework utilizes systems engineering and systems thinking to develop a new understanding of co-creation and data-driven public services. The framework views public service creation as an innovation process and, in this regard, builds on innovation theories, looking at innovation strategies and the various drivers (e.g. technology, users) that can act as the source of this innovation. As a core innovation strategy, the framework proposes to learn from lean and agile service development models that have become the norm in the private sector but not yet so in the public sector. At the same time, to account for the complexity of the system, the framework also considers a variety of factors, actors and processes that affect the shift to data-driven public service co-creation, including stakeholders, enablers and barriers at different levels, and supporting strategies and policies.

3 LOSD-Driven Public Services

A public service can be understood as a service that is offered to the general public with the express purpose of developing public value; public value can be understood as the total societal value that is shared by all actors in society which is the result of all resource allocation decisions (European Commission, 2013). Public value is broader from the concept of commercial value in that it is not only limited to economic or monetary gains for certain actors but can mean any outcome considered valuable by the public.

Traditionally, services that create public value (in other words, public services) have been initiated, designed, and provided by public administrators. In this traditional system public administrators act as a "broker" between society and the political system, they attempt to feed society's needs to the relevant political bodies who, in turn, produce and provide their understanding (correct or incorrect) of the corresponding public service to meet those societal needs (Peristeras and Tarabanis, 2008). Traditionally during this lifecycle society is only involved as the receiver of the service whereas the public administrators are the ones leading and steering this cycle in a top-down way.

Today we are starting to see some examples of services that – just as traditional public services – are targeted towards producing public value but are beginning to drift away from the traditional top-down approach. In these recent developments, services that generate public value are being created and delivered due to private initiatives. Another recent development is the movement towards the exploitation of data. Public services that are built upon the exploitation of data in this manner, at any point in the public service lifecycle, are termed **data-driven public services**. In the public sector, efforts are being made to exploit the large quantity of data which currently exist in governmental databases to help increase the efficiency of public service production. However, at the same time, we also see private initiatives emerging where citizens or other non-governmental stakeholders have taken the lead to utilize open data from public databases (often complemented by data crowdsourced from citizens) in order to create public value-adding services.

For example, in the UK, a service called "Check That Bike!"[2] was initiated by entrepreneur John Moss. The service – offered free of charge – uses open data and data from citizens to allows citizens to find their stolen bike or check the history of the second-hand bike they are planning to buy by checking the bike frame number against datasets of stolen bikes provided by the police or insurance companies. As another example, in Estonia, the platform "Ajapaik"[3] (Timepatch) collects and displays historic images about different locations in Estonia by connecting data from public databases and private collections and engaging citizens in the digital documentation of cultural heritage by geotagging historical images and uploading their own images. The service was initiated by a group of private citizens who are now working in close collaboration with interested citizens and public agencies responsible for the preservation of cultural heritage.

These examples demonstrate that data-driven and public value-adding services can also be created bottom-up, not only top-down. However, in order for these bottom-up initiatives to be successful, two conditions need to be met: a) open data needs to be available; b) a co-creation process needs to take place.

[2] Available at: https://stolen-bikes.co.uk/
[3] Available at: https://ajapaik.ee/

3.1 OpenGovIntelligence approach to public services

In the previous section the current state of public service creation was discussed, in this section the OpenGovIntelligence approach will be defined. In the OpenGovIntelligence approach, a combination of recent trends is utilized and the idea of a "**co-created data-driven public service**" is proposed. It is important to note that this new approach is not merely a combination of these new recent trends, but it does represent a large shift from traditional public service delivery methods.

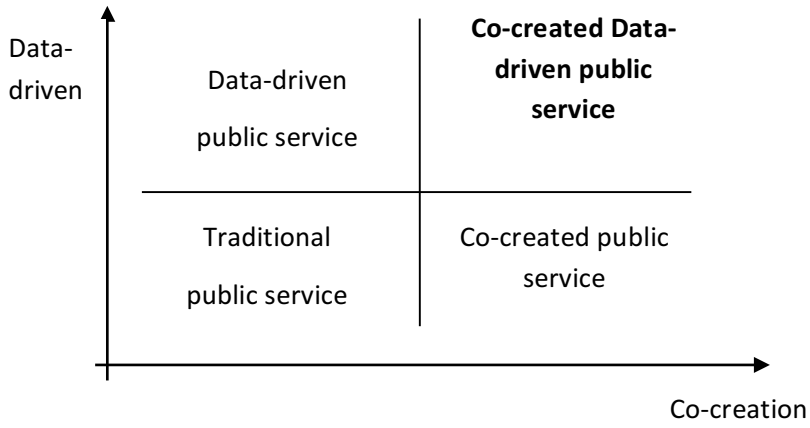


Figure 1. OpenGovIntelligence: Data-driven public service co-creation. Source: authors.

3.1.1 Public service co-creation

A collaborative approach to public service production has emerged as an important way to innovate public services, which have traditionally been provided by public administrations in a top-down manner. The engagement of users in the service production process is seen as a way of increasing efficiency and effectiveness by aligning services to users' needs and interests. At the same time, engaging stakeholders such as citizens, businesses and researchers in the design and delivery of public services is seen to foster the openness and transparency of public administration (EU eGovernment Action Plan 2016-2020).

This direct participation of citizens, businesses, voluntary organisations, researchers and other stakeholders in various stages of public service production has become termed 'co-production'. This concept has its roots in both public management and service management theory and is closely related to the idea of 'co-creation' (Osborne et al., 2016). While these two concepts are often used interchangeably in literature, the concept of co-creation is more often associated with creating value for service users and the public (see, for example, Bovaird and Loeffler, 2012; Osborne et al., 2016; Voorberg et al., 2014). As public value is central to the definition of public services proposed by OpenGovIntelligence, the term co-creation rather than co-production will hereinafter be used to refer to collaborative public service creation.

Co-creation and co-production cover a range of more specific concepts that reflect the different stages and types of stakeholder involvement, including co-design, co-decision, co-implementation, co-evaluation, etc. (Pollitt et al., 2006; OECD, 2011). The core idea is that stakeholders can make valuable contributions throughout the whole cycle of service creation, for example as explorers who discover problems and needs, as ideators and co-initiators of solutions, as co-designers of services, or as co-implementers and diffusers of service innovations (Nambisan and Nambisan, 2013).

However, the spread of digital technologies and concepts such as open data and open government seem to be driving an ongoing paradigm shift towards thinking of citizens and other non-state actors not only as contributors to public services initiated by the public sector, but as actors that can take the lead in providing services for the public good. According to this new thinking, ICTs and open access to data can facilitate a collaborative production of electronic public services by anyone, including government, citizens, NGOs, private companies and individual civil servants, regardless of the role that the government plays in this process (EC, 2013, p. 6).

One of the challenges and preconditions of this new collaborative model of service creation is the need to redefine fundamentally the traditional roles of public and private actors in the process. As suggested by Hartley et al. (2013, p. 827), this requires politicians to redefine their role from "political sovereigns who have all the power and responsibility" to one of setting the agenda through dialogue with a number of relevant actors; it requires public managers to redefine their role from being experts-technocrats to "meta-governors" who orchestrate collaborative arenas that involve a range of innovators. At the same time, private companies and voluntary organizations need to become "responsible partners in the production of innovative solutions for public value" rather than promoters of their own interests; and citizens need to be seen as "co-creators and co-producers rather than solely as clients, customers, or regulatees" (*ibid*).

However, this could also be seen as just the first step in the full transformation towards a new kind of public services. According to a more radical vision, the changing roles may well lead to a complete blurring of boundaries between politicians, civil servants, experts, consumers, citizens, etc. in the public service production process (EC, 2013). Therefore, public service co-creation would mean that any actor, whether public or private, could take the lead in developing a new service to create public value, and any actor can take part in the co-creation of this service.

3.1.2 User Generated Content

Data alone does not translate to data-driven government. An individual data element has little value beyond its applicability to its citizen, business or other subject. The higher value comes, not from the individual data elements themselves, but from using all the data to obtain insightful or actionable information and have it available when and where it is needed (IBM, 2015). By opening up government data to citizens, public institutions become more transparent and accountable to the people they serve and, in effect, create higher levels of public value from their data. By encouraging available and shareable data, governments can help promote innovative, citizen-centric public services (OECD, 2016). Opening up governmental data also provides the opportunity to involve innovators from inside and outside governments to create innovative ways to tackle new and existing problems. This has the potential to increase public sector efficiency and effectiveness.

Linked Data has been introduced as a promising paradigm for opening up data because it facilitates the integration of datasets across the Web. The term Linked Data refers to data published on the Web in such a way that (i) it is machine readable, (ii) its meaning is explicitly defined, (iii) it is linked to other external datasets, and (iv) can in turn be linked to from external datasets (Bizer et al., 2009). In contrast to the full-fledged Semantic Web vision, Linked Data is mainly about publishing structured data in RDF using URIs rather than focusing on the ontological level or inferencing (Hausenblas, 2009). Linked Data requires the identification of entities with URI references that can be dereferenced over the HTTP protocol into RDF data that describes the identified entity. In addition Linked Data include the creation of typed links between URI references, so that one can discover more data (Berners-Lee, 2006).

3.1.3 Data-driven public service co-creation

In the context of data-driven services, service co-creation largely revolves around different stakeholders providing or using data to add value to different phases of service creation. For instance, in the problem discovery and needs identification phase, citizens can contribute their data to notify the government about problems in their neighbourhood such as potholes or graffiti (see Text Box 1 for current examples of citizen data contributions).

Current Examples

FixMyStreet: FixMyStreet (www.fixmystreet.com) is an application allowing citizens to report street problems (like graffiti, fly tipping, broken paving slabs, or street lighting) to the local councils who are responsible for fixing them. Through the FixMyStreet application citizens pinpoint the spatial location of the problem on the map, can add a description and photo, and updates can also be posted e.g. by the responsible council until the problem is finally resolved. FixMyStreet is a classic example of how citizens can contribute to enhance the services offered by local government.

StreetBump: Street Bump (www.streetbump.org/) is a crowd-sourcing mobile application that helps improve the condition of local streets. Utilizing the mobile phone's accelerometer and GPS, the Street Bump application automatically detects and records "bumps" on the City map while the user is driving. If three or more bumps occur at the same location, the city will then inspect the obstacle and assign it to a queue for short-term repair or record its location to assist with long-term repair planning. Thus, Street Bump provides governments with real-time information to fix problems and plan long term investments, and citizens are effortlessly being co-creators of an added-value public service.

Text Box 1: Current examples of services using user provided data

Citizens with more advanced data skills can also mine and analyze open data to explore patterns or discover problems (Nambisan amd Nambisan, 2013). As a simple example, residents of an area could scan data provided in waste collection plans and report problems to improve the collection schedule or locations (Scherer et al., 2015). In the ideation and initiation phase, data can inform the development of ideas for solutions. In the service design phase, citizens with proper ICT skills can be connected to data providers to develop data mashups or apps to address problems and needs (Nambisan and Nambisan, 2013). Services can be co-implemented with citizens by having citizens contribute user data to enhance data-based services or by actively contributing code through an online collaboration platform, such as GitHub. Finally, citizens can also be involved in monitoring services through providing feedback and reporting data to point to problems in service provision (Scherer et al., 2015).

The proposed approach proposes a shift in how a data-driven public service may be created, puts a large emphasis on citizen involvement in the process, and, ultimately, provides a needed upgrade to the current understanding of public service creation. If this new citizen-centric and data-driven service strategy is followed, it should result in more user-friendly and effective public services, improve the quality of decision-making, promote greater trust in public institutions and thus enhance public value (Coats and Passmore, 2008). This approach, driven by opening up and sharing assets – making data,

services and decisions open – enables collaboration and increases bottom-up, participative forms of service design, production and delivery (open governance framework) (EC, 2013).

Data-driven public service co-creation leads to the following changes:

- Any actor, even individual citizens, can be actively involved in the co-creation of public services;
- Public services can utilize not only governmental data, but also citizen data, business data and social data;
- The public service creation lifecycle will be transformed
- Public services can be created independently from the governmental policy making process;
- The public service production process can be owned by any actor not just public administrations.

Consequently, the traditional top-down public service delivery model is revised with all actors (public administration, businesses, NGOs, individual citizens, etc.) undertaking any of the data provider, service provider or service consumer roles.

4 Systems Engineering and Systems Thinking: Overview and Reasoning

The OpenGovIntelligence project is multi-disciplinary in nature, proposes the new concept of "co-created data-driven public services", and notes that this new concept comes hand in hand with a reimagining of the public service delivery system and traditional stakeholder roles. In order to understand this shift fully, the OpenGovIntelligence project has decided to take a systems-based approach with the aim of fostering a greater understanding of co-created data-driven public services. The initial framework did not fully take into account the importance of the operating environment, and therefore an improved approach was needed. Thus, this updated version of the framework has been built and conceptualized around the themes of Systems Engineering (SE) and Systems Thinking (ST). This chapter will provide an overview of the aforementioned concepts, and will then justify why a systems approach seems to provide a suitable foundation for the OpenGovIntelligence framework. As there are many domain-specific terms involved in the discussion of SE and ST, a list of definitions has been provided in Annex 1.

Systems Thinking (ST) is the approach that is used to evaluate and understand systems (Checkland 1994). However, within ST there are two main approaches, hard and soft systems thinking. The soft side, known as Soft Systems Methodology (SSM), views the world as complex, dynamic, and confusing and attempts to explore and understand this complexity by utilizing a systemic process of inquiry (Checkland 2000). The hard version of ST is Systems Engineering (SE); SE views the world as systemic where systems can be engineered and understood (Checkland 2000). Both SSM and SE provide a way for looking at, and understanding, a world of systems, but for the purpose of the OpenGovIntelligence project a hard systems thinking/SE approach will be utilized.

SE may be understood as a "multidisciplinary approach [that] enables the successful delivery of systems in complex environments through a comprehensive set of approaches, techniques, and tools"(Locatelli et al. 2014). The toolkit that is provided by SE includes methods for everything from stakeholder and requirements analysis through systems modelling and onto system implementation. For the purpose of this deliverable, the main elements of SE that are to be exploited deal with the modelling of the OpenGovIntelligence co-creation system and the architecture for the implementation of a co-created LOSD-driven pilot projects.

For modelling the OpenGovIntelligence system, the approach put forth by (Crawley et al. 2015) will be used:

1. Identify the system
2. Identify entities of the system
3. Identify the relationships among the system's entities
4. Identify the emergent properties of the system

This process allowed for a clearer understanding of the OpenGovIntelligence co-creation system to be gained, and once this was obtained, the system could be modelled. However, due to the complexity of systems, a concise and standardized modelling language was needed. To this end, the project will utilize Object Process Methodology (OPM), ISO standard (ISO/PAS 19450:2015), to model the system. OPM "supports the conceptual modelling of systems with formal syntax and semantics… and the domain-independent nature of OPOM opens system modelling to the entire scientific, commercial, and industrial community (Dori 2015). OPM consists of three parts: objects, processes, and the

relations between them (Dori 2002); this clear and standardized methodology provides a way for practitioners across disciplines to view, model, and understand systems.

The OpenGovIntelligence project is inherently multidisciplinary, on the technical side, there is the opening up of data, linking data, and developing applications that create public value from said data. In addition to this, on the social sciences side, is the notion of co-creation and understanding how OGD and LOSD may lead to a change in how public service providers interact with public service consumers (movement from users as customers to users as collaborators) (Denhardt & Denhardt 2000). The OpenGovIntelligence project is also affected by many environmental factors such as regulations, funding, organizational beliefs, etc. In order to understand the effect that these factors have on the process of co-created data-driven public services and, additionally, to understand the process of co-created data-driven public services itself, a systems based approach was needed. Since the OpenGovIntelligence project is multidisciplinary and is systemic in nature, SE seemed to be the perfect fit for the foundation of the OpenGovIntelligence Framework. Furthermore, a standardized model of the system allows an architecture to be developed that pilots may follow to ensure that the emergence of the operating system is anticipated and desirable (Crawley et al. 2015).

With this brief background and overview of SE presented, the future chapters will be able to demonstrate how SE has been applied to the OpenGovIntelligence project. In Chapter 5, the four-step process for understanding systems will be used in combination with OPM to develop a model for the OpenGovIntelligence co-creation system. Furthermore, in chapter 6, the systems model will be transformed and an architecture for OGD-driven co-created public services will be put forth that emerges from the systems model. This architecture will be quite generic in nature, but it provides a general architecture that all pilot partners may use to ensure that co-creation takes place and that public value is created.

5 OpenGovIntelligence Framework for Co-Created Open Government Data Driven Public Services

5.1 System Model Development Process

In SE, the first step is to identify the system, its form, and its function (Crawley et al. 2015). In the case of OpenGovIntelligence, the system is the "co-creation system", the form is the "the OpenGovIntelligence co-creation system", and the function of this system is to create public value. Though the form and system are easier to identify due to their existence, understanding the primary function is a bit more complicated; systems may have more than one function, but there will always be one primary externally delivered value-related function that defines whether or not a system is working (Crawley et al. 2015). Understanding the primary externally delivered value-related function allows for the rest of the system to be understood and modelled. In order to understand this, one must identify the value-related operand, the value-related attribute and state, and the value-related process (Crawley et al. 2015). As stated in the OpenGovIntelligence proposal, the aim of the project is to demonstrate how OGD may be used to create public value[4]; thus, Figure 2 demonstrates the OpenGovIntelligence understanding of the primary externally delivered value-related function of the OpenGovIntelligence co-creation system. Though there is only one primary externally delivered value-related function, there can be multiple values that are delivered as a system operates, in the case of OpenGovIntelligence, public value is the primary value delivered, but it is also expected that there would be an increase in time savings, transparency, participation, and a decrease in administrative burden. In Figure 3, OGD is the value-related operand, it has the attribute public value with an initial value of low, and public value changes from low to high during the public value creating process.

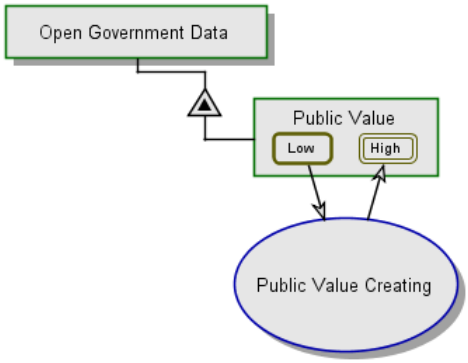


Figure 2. Primary Externally Delivered Value-Related Function of OpenGovIntelligence System. Source: authors.

Once an initial understanding of the system's primary externally delivered value-related function is obtained, the next step is to understand the concept that allows this public value creating to take place. Figure 3, demonstrates how different processes like statistical reporting of OGD, analysing OGD, or exploiting OGD, may lead to higher levels of public value.

[4] Though the project largely deals with linked open statistical data, the term open government data is used in the models and diagrams in an attempt to be as broad and inclusive as possible. The reason for this is that all linked open statistical data will be open government data, but it is also possible for open government to not be linked. Since the system can operate with data that is linked or unlinked, it was decided to use a term that encompassed both possibilities.

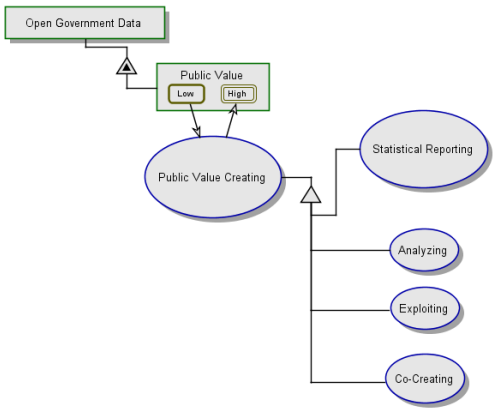


Figure 3. Concept Generation Example. Source: authors.

However, as the OpenGovIntelligence project aims to demonstrate how co-creation allows OGD to create public value, this is the process that was chosen to be associated with the creation of public value. Figure 4, shows that co-creating takes OGD and creates public value.

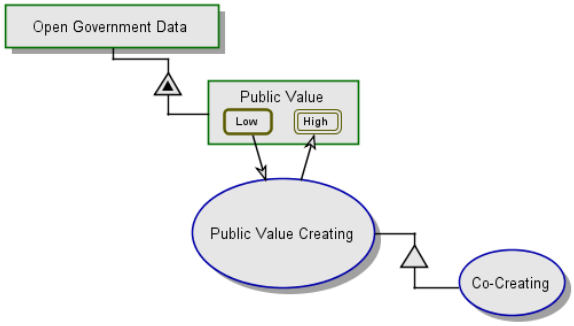


Figure 4. OpenGovIntelligence System Concept. Source: authors.

Once the system had been identified, in addition to its form and function, it was possible to identify the entities that are directly involved in the OpenGovIntelligence co-creation system. To identify the entities that are involved in the co-creation system, all possible entities that could be related to the OpenGovIntelligence co-creation system were listed out. The next step was to understand the entities that were core components of the OpenGovIntelligence co-creation system and separate them from those that are relevant, but not core to the function of the system; from the initial list, three entities were deemed core components of the system: ICT Tools, Co-Creators, and Open Government Data. Systems, of course, do not operate in vacuums and it was also necessary to understand what systemic factors influence the OpenGovIntelligence co-creation system, based on previous work it has been discovered that organizational beliefs, regulations, funding sources, and previous experience all effected co-creation (Toots et al. n.d.). When putting these entities together, the general model of the OpenGovIntelligence co-creation system emerges and is shown in Figure 5. This system may be understood as follows:

- Open Government Data exhibits public value. Public value is initially low, but by performing co-creation on OGD public value becomes higher.
- Performing the act of co-creation on OGD leads to the creation of a co-created OGD-driven public service.
- The co-creation system consists of the following entities
    - Systemic – Many ICT Tools
    - Systemic – Group of Co-Creators

    - Environmental – Many Organizational Beliefs
    - Environmental – Many Regulations
    - Environmental – Many Funding Sources
    - Environmental – Many Experiences
- Co-creating requires many ICT Tools.
- A Group of co-creators is responsible for operating the co-creating process.
- Many organizational beliefs, many regulations, many funding sources, and many experiences effect co-creating.

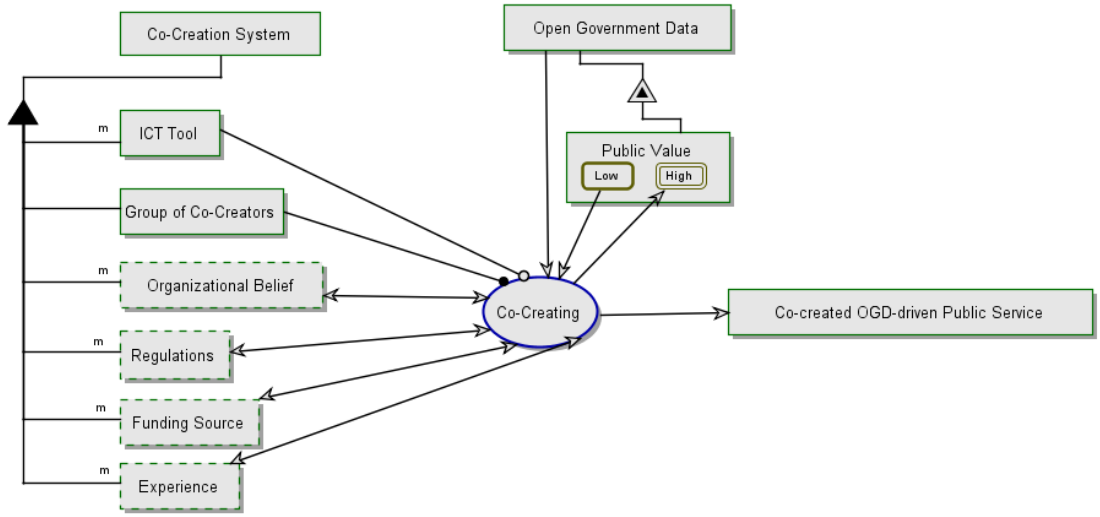


Figure 5. OpenGovIntelligence System Overview. Source: authors.

With the initial system model in place, the next step was to “in-zoom”, or dive deeper, into the co-creating process to understand how co-creating takes place; this is shown in Figure 6. When looking at Figure 6, it is possible to see that the co-creating process is made up of four sub processes that happen in the following order: co-initiation, co-design, co-implementation, and co-evaluation. It also shows that the co-created OGD-driven public service has four states that correspond to a given “co-“ process, that is to say, as co-creating occurs, the service progresses through each “co“ stage and at the end of the process a co-created OGD-driven public service emerges. It is also important to note that entities have also been broken down, namely ICT Tools and group of co-creators. Different ICT Tools are used in the co-creating process, not all are necessary, but the aim was to demonstrate that many different tools are available to aid in co-creating an OGD-driven public service. In addition, the group of co-creators has been broken down to demonstrate the different stakeholder groups that may be involved in the co-creation of an OGD-driven public service. Any stakeholder group many be involved, but for co-creating to take place, at least two different stakeholders need to be involved.

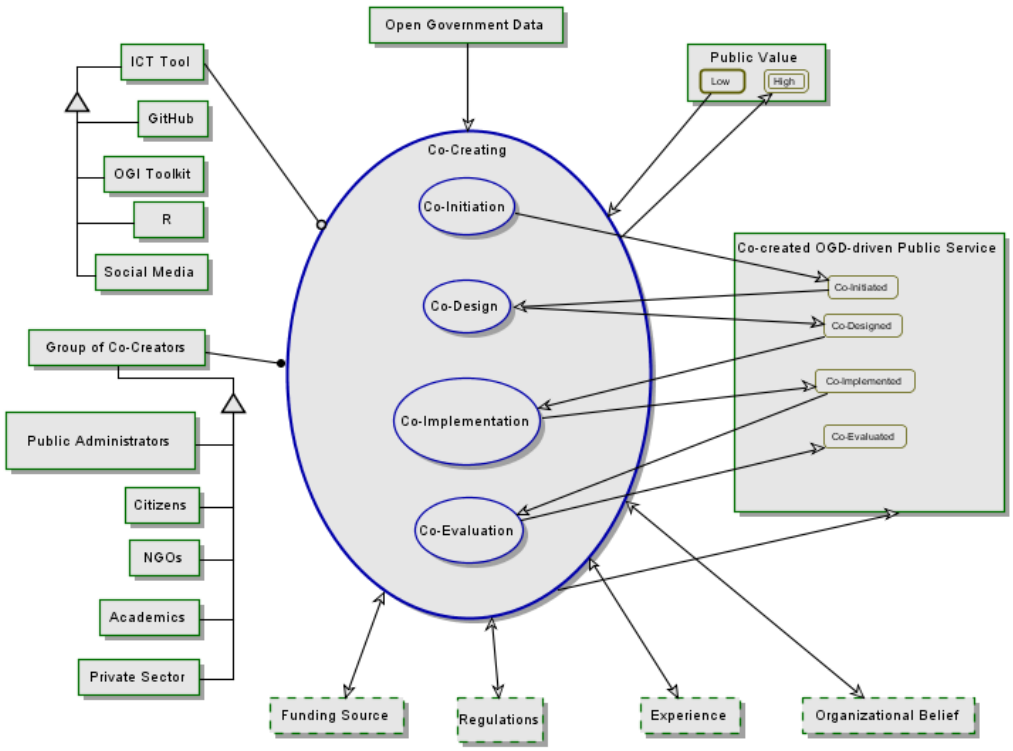


Figure 6. OpenGovIntelligence System Co-Creating In-Zooming. Source: authors

Figures 5 and 6 make up the general model for the OpenGovIntelligence co-creation system. The initial figure provides a general/broader overview, while the next figure demonstrates a more in-depth look at how co-creating happens. These models allow for a better understanding of the system that is co-creation and, from these models, an architecture for the OpenGovIntelligence pilots has been developed and will be presented in Chapter 6.

The aim of this section was to provide the process that was undergone in order to develop the model for the OpenGovIntelligence project and, as such, the specific influences of the environmental factors was not touched on. Thus, in Section 5 of this chapter a more in-depth presentation of all the entities within the system their effect on it will be presented. It must also be kept in mind that this system is focusing specifically on the co-creation of OGD-driven public services and takes into account the availability of OGD. However, this is not always the case, and in Section 2 of this chapter the OpenGovIntelligence process for opening up data will be presented.

5.2 Process for Opening Up Data

This section describes the process for opening up statistical data (Figure 7) which is a refined version of the publishing part of the Linked Open Data Lifecycle reported in “D1.1 OpenGovIntelligence challenges and needs”. Precisely, the process for opening up statistical data is the final version of the updated and refined Linked Open Data Lifecycle according to the feedback taken from the pilots as well as the technical experts of the project.

The process for opening up statistical data consists of four steps, namely

1. Process initial statistical data;
2. Create and validate Linked Open Statistical Data;
3. Publicize Linked Open Statistical Data;
4. Maintain Linked Open Statistical Data.

Each step consists of a number of sub-steps. For each sub-step, we present its detailed description as well as additional information like the input, output and implementation details. The implementation details are related to specific requirements that will be addressed by OpenGovIntelligence deliverables in various WPs of the project.

1. **Process initial statistical data**

This first step regards the initial processing of statistical data in order to facilitate the creation of qualitative Linked Open Statistical Data. The step includes five sub-steps, namely *1.1 Discover datasets, 1.2 Access Datasets, 1.3 Select data and create conceptual cube, 1.4 Wrangle data,* and *1.5 Combine data.*

Title:	1.1. **Discover datasets**
Input:	Requirements for discovering datasets
Output:	Sources that provide relevant datasets
Description:	Citizens can access government statistical data supplied by governments and governmental organizations (e.g. National Statistics Offices) usually through governmental data portals. In some cases, however, accessing government statistical data may require additional effort. This sub-step includes searching in data sources for datasets that satisfy specific requirements (e.g. datasets that measure unemployment in parliamentary constituencies of the UK and during years 2015-2016). In the case that a data source provides its datasets through a data portal, the search is performed by searching in the data portal using, for example, suitable keywords. In the rest of the cases, however, the search requires more effort and is succeeded in various ways such as by manually searching the website of the data source or even by contacting the data source using the phone. The result of this step is a list of data sources that include relevant datasets and can be used to answer questions like: • Which data sources provide datasets that satisfy the specific requirements? • How many relevant datasets are provided in total by different data sources? • Do discovered datasets fully satisfy the specified requirements?
Implementation:	Guidelines for data search (to be delivered in D4.7)

Title:	1.2. **Access datasets**
Input:	Requirements, Data sources that provide relevant datasets
Output:	Datasets from various sources and in various technical formats (e.g. CSV, JSON, XLS)
Description:	In many countries government data are open by default and are free to be used and re-used by anyone. However, sometimes, technical, organizational or legal issues do not allow users to gain access to government statistical data.

	In these cases, governments specify the conditions under which the datasets can be accessed and also define the process that should be followed to access and re-use the datasets. In the same cases, data portals are updated accordingly to avoid legal issues. This sub-step regards the process that followed to get access (electronically or manually) to datasets discovered in the *1.1 Discover datasets* subset. The result of this sub-step is a list of datasets from various data sources and in various formats including csv, tsv and xls.
Implementation:	Request permission

Title:	1.3. **Select data & create conceptual cube**
Input:	Requirements, Datasets
Output:	Selected data in accordance with the conceptual cube
Description:	Datasets accessed during the previous sub-step should be examined to understand what kind of records are included and decide on if they truly satisfy the specified requirements. Requirements may be fully satisfied by only one dataset, may require the combination of more than one datasets or maybe not fully satisfied by the available datasets. A conceptual cube specifies the structure of the data that will be selected from one or more datasets (i.e. specifies the dimensions and measures of the cube). The structure of the conceptual cube depends on the specific requirements that need to be satisfied and also on the available data. Once the conceptual cube is defined, data can be processed in the following ways to align with the conceptual cube: • Keep only the part of the initial data that correspond to the conceptual cube. This is common at large CSV files with many columns. • Combine data from different CSV files.
Implementation:	Software tools: Excel, Google refine, Grafter (WP3) Guidelines on how to create a conceptual cube (to be delivered in D4.7)

Title:	1.4. **Wrangle data**
Input:	Selected data in accordance with the conceptual cube
Output:	Cleaned & aggregated data
Description:	Data wrangling regards (i) cleaning and (ii) aggregating data selected from the previous step. • Data cleaning is necessary to improve data quality. Very often, for example, different words are used to describe the same concept. For instance, the words “Mercedes” and “Mercedes-Benz” can be both used to describe the specific car brand. In this case, all words with the same meaning should be identified and replaced by a single word. Another challenge that requires data cleaning is the different formats used to

	represent data. Examples of different representation formats include: (i) decimal number representation e.g. 10,4 and 10.4, (ii) date representation formats e.g. 20/4/2017, 4/20/2017 and 20 April 2017 and (iii) time representation formats e.g. 13:00 and 1:00 am. This challenge can be addressed by homogenizing the different representation formats. Finally, in some cases, selected data need to be properly aggregated (to ensure, for example, the protection of their privacy) and, at the same time, be compliant with the conceptual cube specified in the previous step.
	• Data aggregation comprises two steps:
	  • Transform continuous dimension values to discrete. Data values are usually continuous. For example, 13:05 and 13:20 are continuous time values and 13/6/2017 and 24/6/2017 are continuous date values. Data aggregation requires transforming continuous values to discrete. In the above examples, 13:05 and 13:20 can be replaced by 13:00 while 13/6/2017 and 24/6/2017 can be replaced by 6/2017 (month level) or 2017 (year level).
	  • Aggregate selected data. The aggregation of data is based on the appropriate aggregation function (count, sum, mina, max, avg, mean) e.g. count all the records that have the same values.
	In both cases, previous information is lost and cannot be retrieved.
	
	The output of this sub-step are clean and (if required) aggregated data coming from different datasets.

Implementation:	Software tools: Excel, Google refine, Grafter Guidelines for discretization and aggregation (To be delivered in D4.7)

Title:	1.5. **Combine data**
Input:	Cleaned & aggregated data
Output:	Final initial dataset
Description:	This sub-step regards the combination of the cleaned and aggregated datasets of the previous sub-step in order to create the final initial dataset.
Implementation:	Software tools: Excel, Google refine, Grafter Guidelines on tabular structure of data cubes (To be delivered in D4.7)

2. Create and validate Linked Open Statistical Data

This step regards the creation and validation of Linked Open Statistical Data (LOSD) using the RDF Data Cube Vocabulary. It comprises five sub-steps, namely *2.1 Define URIs, 2.2 Define RDF data cube structure, 2.3 Define code-lists, 2.4 Create RDF data cube,* and *2.5 Validate RDF data cube.*

Title:	2.1. **Define URIs**
Input:	Final dataset
Output:	URI patterns
Description:	This sub-step includes the definition of URI patterns for all the cube elements including the cube, the cube dimensions, measures, attributes, Data Structure Definition and observations. It is highly recommended to use well-structured URIs that facilitate their comprehension.
Implementation:	Guidelines for URI definition (To be delivered in WP5)

Title:	2.2. **Define code lists**
Input:	Existing code lists, Final dataset
Output:	Code lists to use
Description:	It is a good practice to use code lists for the values of the cube's dimensions, thus this step includes the definition of the code lists to use. There are currently many code lists that can be re-used (e.g. reference.data.gov.uk for time values). New code lists should be created only if existing code lists do not adequately cover the requirements for the dimension values..
Implementation:	- Software tools to create code lists (WP3) - Guidelines to identify existing code lists or create new ones (To be delivered in D4.7)

Title:	2.3. **Define RDF data cube structure**
Input:	Final dataset
Output:	RDF data cube structure
Description:	This sub-step defines how initial statistical data will be mapped to RDF data cubes following the RDF data cube vocabulary. Best practices for RDF data cube mapping should be followed here to address mapping challenges. In addition, when the tool that will be used for the creation of the RDF data cube (see "Create RDF data cube" sub-step description) requires RDF data cubes to have a specific structure, this sub-step will ensure that the output structure of the RDF data cube is formatted properly.

Implementation:	- Best practices on the application of standards (To be delivered in D4.7 and D5.5)

Title:	2.4. **Create RDF data cube**
Input:	URI patterns, code lists, RDF data cube structure, Final dataset
Output:	Linked Open Statistical Data
Description:	This sub-step comprises the creation of the RDF cube including the data structure definition (i.e. dimensions, measures, attributes) and the observations. The RDF Data Cube Vocabulary enables the adoption of different publishing approaches thus resulting in non-interoperable data cubes. It is important to follow specific guidelines when creating RDF data cube to facilitate their interoperability and linking.
Implementation:	- Google refine, Grafter (WP3) - Guidelines to create the RDF data cubes (To be delivered in D4.7)

Title:	2.5. **Validate RDF data cube**
Input:	Requirements, Linked Open Statistical Data
Output:	Validated LOSD
Description:	This sub-step includes the validation process of the LOSD created in the precious sub-step through specific rules and recommendations. The quality of linked data, the RDF cube and the RDF graphs need to be validated by best practices and guidelines. A set of conditions must be satisfied in order to provide successful data integration.
Implementation:	Software tools: SHACL, ShEX

3. Publicize Linked Open Statistical Data

This step regards publishing the created Linked Open Statistical data in order to be accessed and re-used by the public. The step includes two sub-steps, namely *3.1 Create Metadata* and *3.2 Publicize Linked Open Statistical Data.*

Title:	3.1. **Create metadata**
Input:	Validated Linked Open Statistical Data
Output:	Metadata
Description:	This sub-step includes the creation of metadata and additional information derived from the data. Dimension and measures' names are usually added as basic information. During the creation of the RDF data cube additional metadata may be produced and may also need to be added to the cube. In addition, this sub-step includes (if required) the definition of access control rules that will specify who, how and when someone has access to the created LOSD.
Implementation:	- Guidelines for metadata creation (to be included in D4.7)

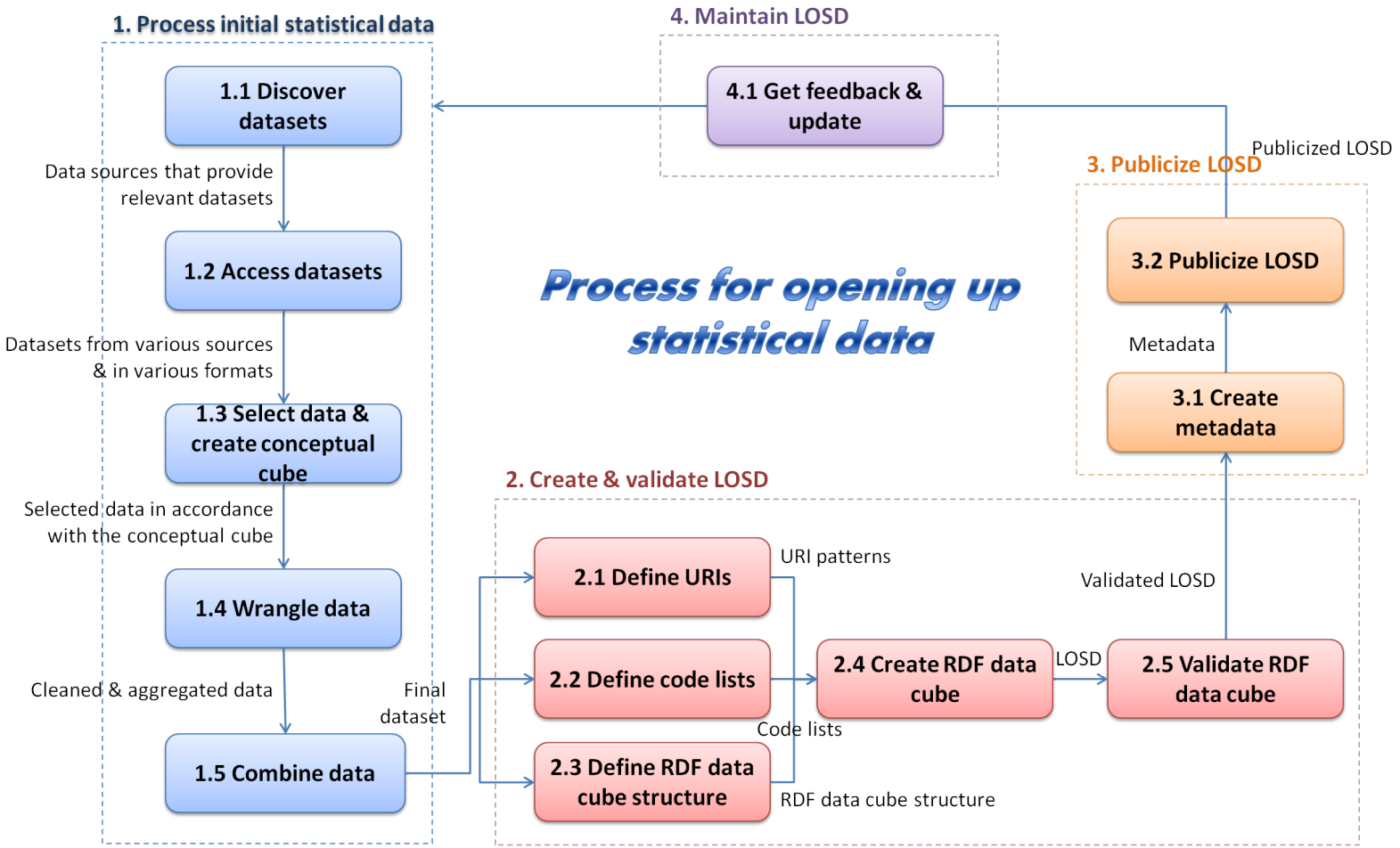
Title:	3.2. **Publicize Linked Open Statistical Data**
Input:	Linked Open Statistical Data and metadata
Output:	Publicized Linked Open Statistical Data
Description:	This sub-step regards the publicizing of Linked Open Statistical data, which is required to make them accessible by the public. RDF data cubes can publicized along with their metadata in various ways (e.g. in data portals, websites etc.). Data access should also follow the access control rules defined in the previous sub-step.
Implementation:	- Medium to publicize LOSD

4. Maintain Linked Open Statistical Data

This step regards maintaining Linked Open Statistical data and includes a single sub-step: *4.1* Get Feedback *& update.*

Title:	4.1. **Get feedback & update**
Input:	Publicized Linked Open Statistical Data
Output:	Updated Linked Open Statistical Data
Description:	This sub-step regards getting meaningful feedback about the publicized Linked Open Statistical Data. In addition, this sub-step also regards the update of the publicized Linked Open Statistical Data that can be performed any time throughout the process for opening up statistical data.
Implementation:	Software tools for user collaboration (WP3 and WP5) Guidelines for providing feedback (will be delivered in D4.7 based on D2.2) Guidelines for updating data (will be delivered in D4.7)

Figure 7. The process for opening up statistical data. Source: authors.



5.3 Description of System Parts

In Section 1 of this chapter, the process for developing the OpenGovIntelligence co-creation system model was presented. However, this model only allows for a visualization of the process and it is therefore necessary to discuss each individual entity that is present so that its purpose in the model is understandable. Thus, it is the aim of this section to provide an overview of all relevant entities and outcomes of the OpenGovIntelligence co-creation system. It will start by discussing the systemic factors and outcomes and will then move on to discussing the environmental factors that affect the co-creation process.

5.3.1 Systemic Entities

ICT Tools

One of the essential elements in the co-creation system is the ICT tools and platforms that enable co-creators to work with data, i.e. to open up, link and exploit data from various sources and to co-create data-driven web services. The ICT Toolkit that is used within the OpenGovIntelligence project is described in further detail in D3.3.

Group of Co-Creators

The very idea of co-creation suggests the involvement of more than one stakeholder group in the creation of public services. The three broad groups often mentioned in the context of public service co-creation are public administrations, citizens/citizen organisations, and businesses. In order for co-creation to happen, the group of co-creators needs to have at least two different stakeholders present in the process representing different stakeholder groups.

It is important to note that the characteristics of the stakeholders involved in the co-creation process play a role in the success of co-creation. Based on the analysis of challenges related to open data-driven co-creation (published in D1.1 and Toots et al. 2017), stakeholders' lack of awareness of open data can pose significant barriers to co-creation. Policy-makers and citizens often do not know what open data is and lack a clear concept of how it could be used. Due to the perceived lack of benefits, the idea of open data may lack political support and OGD may not be published by governments. A similar lack of understanding has also been noted for co-creation – if the benefits of co-creation are not understood, stakeholders are unwilling to dedicate their time to collaboration on data-driven services. Therefore, a major precondition for open data-driven co-creation to happen is that different kinds of stakeholders perceive open data as an important source of public value. According to D1.1, the recognition of the benefits of OGD can be fostered by enthusiastic individuals such as visionary policy-makers, administrators or citizens. In addition to beliefs and knowledge, data-driven service co-creation requires a technological skillset – the OGD-driven co-creation system thus requires the participation of at least some stakeholders with sufficient digital skills to work with data.

Open Government Data

Open Government Data refers to the idea that public sector data should be available in a convenient (ideally machine-readable) form; it should be freely accessible, reusable, and redistributable by everyone. The availability of OGD is a necessary requirement for the OpenGovIntelligence co-creation system to function as it is the value-related operand that is changed during the co-creating process.

The quality of OGD matters as well. Based on the challenges identified in D1.1, poor data quality and usability (fragmented datasets, missing values, outdated data, lack of metadata) often constitute barriers to the co-creation of data-driven services. This can lead to a situation where data is being released, but it can simply not be used to assist in driving the co-creation of new services. On the other hand, the availability of data in structured, easily shareable and reusable formats such as LOSD can facilitate the co-creation of data-driven services. In case LOSD is not readily available, co-creators can also turn statistical OGD into LOSD by following the OpenGovIntelligence process described in Section 5.2.

Public Value

It has been stated that public value cannot simply be defined by saying that public value is created when "public managers create results that are valued" (Stoker 2006; Moore 1995). Instead, a debate and conversation needs to happen between service-provider and service-user and only then is it possible to know whether public value has been delivered (Stoker 2006; Moore 1995). In the case of the OpenGovIntelligence co-creation system, this debate is ongoing between service users and service providers and therefore, if the system is working, public value will be created and, if it is not, a balancing loop will kick in until public value does emerge. The exact meaning and substance of "public value" is thus always defined through the interaction and conversation between the co-creators involved in the creation of a particular service. Valued outcomes that may be delivered by open data-driven services include, for example, decreased information asymmetry, increased government transparency, decreased administrative burden, cost savings, time savings, etc. A data-driven service may also be able to generate different valuable outcomes at once – what is important is for these outcomes to be defined as valuable by service users and providers.

Co-Created OGD-driven public Service

The co-created OGD-driven public service is the physical result of the OpenGovIntelligence co-creation system. This is the physical artefact that will be used by service-users and will likely be built following the architecture presented in Chapter 6.

5.3.2 Environmental Entities

The OpenGovIntelligence stakeholder survey conducted as part of WP1 (see D1.1 and Toots et al. 2017 for more details) highlighted the importance of the environmental factors in influencing the process and outcomes of the co-creation of open data-driven services. Indeed, even if the systemic entities such as open data, ICT tools and group of co-creators are present, the process of data-driven service co-creation may face impediments that are due to the broader environmental factors which have an effect on the core elements of the system. Based on D1.1, such environmental factors include – but are not limited to – the routines, culture and management of public sector organizations, prior experience, political priority, the availability of funding, and policies and regulations. Depending on their configuration and the particular context, these factors can act as barriers or drivers in the co-creation system. While the OpenGovIntelligence framework cannot prescribe ready-made solutions for overcoming any barriers that may emanate from these environmental factors, it does emphasize

the importance of being aware of these environmental entities and their effects on the co-creation system.

Public Sector Organizations' Beliefs, Routines and Culture

The willingness and ability of public sector organizations to publish open data or participate in the co-creation of data-driven services is affected by the existing routines, work processes and culture of these organizations. Based on D1.1, a number of barriers to OGD-driven co-creation exist at the level of public sector organizations. Such barriers include incompatible work processes, a lack of feedback loops between citizens to public administration, resistance from the public sector to change, lack of trust, lack of political priority, inadequate resources and poor change management. Public sector organizations may be resistant to publishing open data if their confidentiality procedures are incompatible with the idea of open data, or if they make part of their revenue by selling key datasets. As public sector organizations are often characterized by resistance to change and lack of innovation orientation, the transformation of existing processes and revenue models for the sake of publishing open data may be slow to happen. Substantial changes are also needed to integrate the concept of co-creation in the way public sector organizations offer public services. Co-creation requires governments to be open to receiving feedback from citizens and have the ability to respond to this feedback – such feedback loops are so far seldom part of the public service provision process.

Funding

Funding has the potential to either drive or inhibit OGD-driven co-creation. Public sector organizations often operate with a scarcity of resources and tend not to prioritize spending on publishing open government data. Therefore, as part of the survey carried out in WP1, it was found that sufficient funding for publishing open data had a large effect on the availability of data. Similarly, other studies of OGD-driven co-created services have found that "external funding appeared to be an active driver for the co-creation of OGD-driven public services" (Mcbride et al. 2018).

Experience

If an organization has experience with open data or co-creation they are more likely to become actively involved with the provision of open data or playing a role in co-creation (Mcbride et al. n.d.). If an experience does exist, and it is positive, then this represents a large positive influence for their participation in OGD-driven co-creation. However, a negative experience provides a large negative influence.

Regulations and policies

According to D1.1, existing regulations and policy measures exert an important influence on the availability of open data and the possibilities and incentives for using open data to co-create services. Interestingly, legislation-related barriers seem to involve two types of factors – those that arise from the actual legislative provisions, and those that have to do with the way the existing legislation is perceived and interpreted. Privacy and confidentiality regulations are often seen as barriers to the provision and reuse of open data. However, in the OpenGovIntelligence survey, respondents also referred to "concerns" and "misunderstandings" about privacy and identity-related regulations as a

source of barriers. This implies the need to both review the legislation in force and also raise public awareness of what the law actually means.

At the same time, enabling legislation and government policies are considered to have a positive effect on the availability and reuse of OGD. For example, legal obligations to publish open data, open standards policy, open data action plans and the existence of a broader open government policy agenda can be major drivers for the co-creation of OGD-driven services.

6 OpenGovIntelligence Co-Created Public Service Architecture

With an understanding of the system, its entities, relationships, their forms and functions, and the concept in place, the next step was to develop the architecture, or engineer the system, so that the anticipated emergence of increased public value could take place. The purpose of this chapter is to present the initial architecture for the OpenGovIntelligence pilots that should provide a guideline for how to ensure co-creating takes place and that public value is created. The architectural model presented also reflects the presence of iterative development cycles due to the inclusion of agile devleopment practices and methodology in the pilots.

The architecture is shown in Figures 8 and 9. The aim of this was to encapsulate the co-creation aspect of the OpenGovIntelligence pilots, the agile and interative nature of development, and the entities that are involved within the system. When looking at the architectural diagrams, it is important to note that the environmental entities that were highlighed are not shown as they do not form a part of the actual implementation of the pilots, but their existence is known and can influence the pilots. Similarily, the co-initiation aspect is not shown in the architecture and this is due to the fact that it happens externally to the implementation, co-initiation is what starts the process of building and designing a co-created OGD-driven public service.

The architecture has three main components, the invovled stakeholders, the application, and the foundation/infrastructural layer that the application is built on top of. These three components or layers have been derived from Archimate's three layers of business, application, technology (The Open Group, 2017).

Figure 8 represents the initial implementation of the co-created OGD-driven public service and, as such, the foundation of the service is OGD that has been provided by the government. Service Producers then use ICT Tools and some sort of collaboration platform, GitHub, for example, to exploit the OGD; this exploitation of OGD is where the co-implementation phase happens. The collaboration platform is used by the service producers to provide feedback and contributions to the code, this is where the co-design happens. Service users then access the application and this is where/when the public value from OGD emerges. It must be noted that the term 'application' is quite generic and can take many different forms. For example, the application could be a web service, mobile phone application, or a new way of delivering data. Co-evaluation is shown by the communication between service user, service producers, and government where feedback is provided either on the service itself or on the government data. The future iterations, shown by Figure 9, are able to include user feedback from the co-design stage in the in the foundation of the service. Though the co-creation stages are shown in the diagrams as occuring at certain places, it is also possible that a form of co-creation takes place elsewhere. For example, if a web application is built that facilitates easy ways to provide data to a government agency, when someone uses the application to upload or generate data they could also be co-implementing the service. Similarily, co-evaluation could take place on the collaboration platform by providing code review.

If followed, this architecture should allow for services to be developed in an agile manner, provide high levels of public value, and also lead to increased levels of co-creation. Furthermore, when services are developed in an open-source and collaborative manner they may become more sustainable.

Figure 8. OpenGovIntelligence Architecture First Iteration. Source: authors.

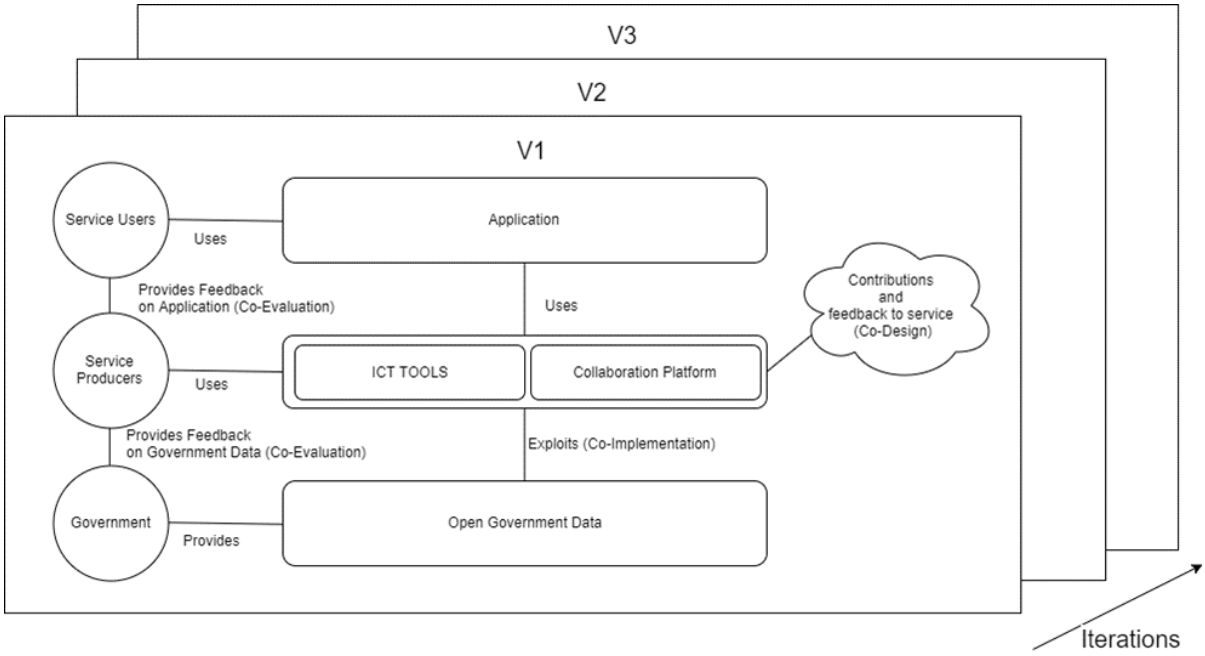
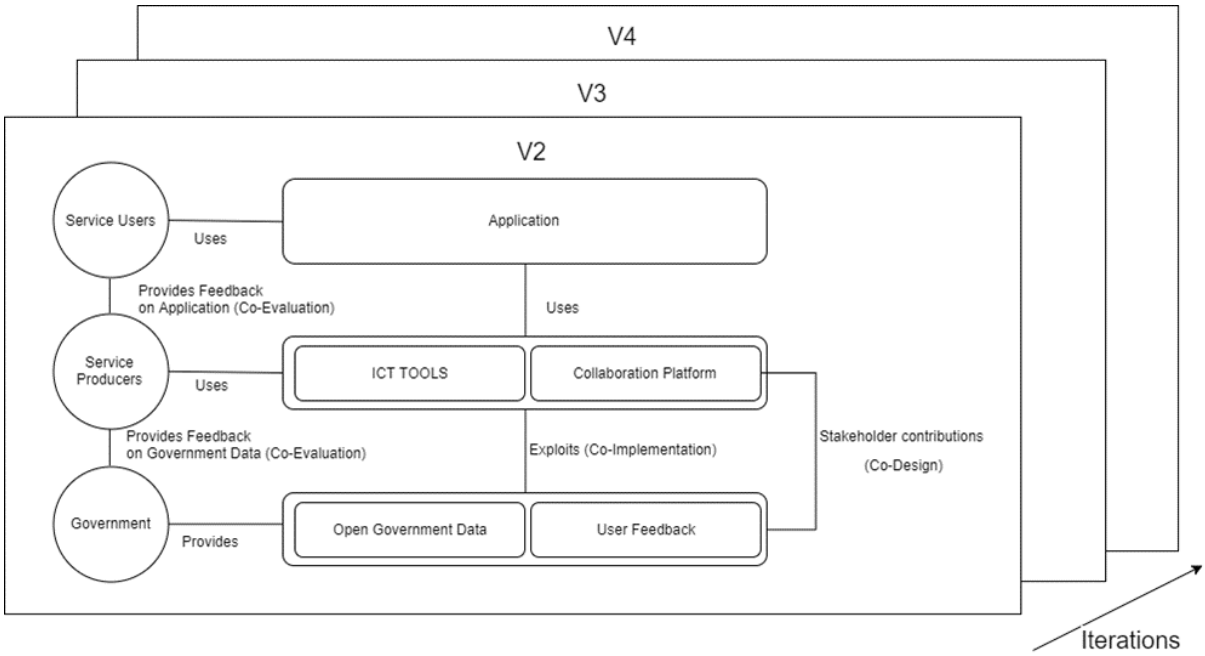


Figure 9. OpenGovIntelligence Architecture Future Iterations. Source: authors



7 Recommendations for policies and strategies

In the long term, the proper functioning and sustainability of the OGD-driven public service co-creation ecosystem requires the following conditions to be present:

- **Open Government Data needs to be available**. This means that to the extent possible, all government data, especially statistical data, should become available as open data which is easily linkable and exploitable for the co-creation of new services;
- **Different stakeholders need to engage in the co-creation of services that generate public value**. This means that a new, **public value-centric understanding** of public services needs to take root among societal stakeholders; in relation to this, a new understanding of the roles of **stakeholders** in the public service creation process is needed which allows non-governmental actors to take an active role in the co-creation of data-driven services.

Based on the results of WP1, government policies and strategies are seen to hold a considerable potential to foster open data-based innovation and catalyse the above-mentioned changes. Below, some recommendations are given on policies and strategies that governments are encouraged to adopt or strengthen to support the elements of the co-creation system. In the end of this chapter, a few strategic tips are also given to non-governmental stakeholders.

7.1 Recommendations to government

1. **Provide high quality open data**

According to Section 5.3, Open Government Data is one of the core entities in the co-creation system. This makes the availability of OGD one of the most important drivers of the co-creation of new services, if OGD is not present then it is not possible for the system to function. Opening up government data lowers the threshold for the creation of new services and increases the circle of societal actors that can become co-creators of these services, lifting some of the burden of service provision from the government's shoulders. Therefore, governments are encouraged to:

- Apply the "open by default" principle to all public sector data. Within the European Union, this essentially means strengthening and enforcing the national implementation of the directive on the re-use of public sector information ("PSI Directive").
- Review data licensing and copyright policies to ensure that licences on public sector data are compatible with open data goals and public interest. The adoption of free software licences with minimal restrictions is recommended.
- Review – and, if necessary, revise – intellectual property rights regulations to ensure that barriers to public access and re-use of public sector data are minimized.
- Engage in cross-border collaboration for the harmonization of data standards.
- Introduce a centralized semantic classification scheme for easier linking between different databases.

In order to ensure the quality of data and easy access to datasets, governments are also recommended to invest in infrastructures that support the publication and re-use of open data. Some of the elements of such infrastructures include:

- Providing a central free open data portal where local and national governments could publish their data. Such open data portals should have the ability to host data, sign-post to remote data, cache datasets, and provide tools for data transformation across various formats or via various web services requests.
- If necessary, data infrastructure legislation should be adopted to regulate the maintenance and access to data assets, and the rights, roles and responsibilities connected to that.
- Providing APIs. Implementation of the "API First" policy means that governments should prioritize providing good APIs along with open data (rather than make external stakeholders download data dumps) to increase the reliability of data and facilitate the reuse of open government data by external stakeholders.

2. Support change and collaboration in public sector organizations

Section 5.3 suggested that an enabling organizational context is one of the critical preconditions for the provision of OGD and openness to co-creation. Due to the complexity of organizational change, this is clearly one of the areas where quick changes are unlikely to occur. However, there are ways in which government agencies can encourage open data-driven innovation and co-creation with external stakeholders. The following measures may be useful in this regard:

- Create innovation labs involving governmental and non-governmental stakeholders (private companies, civil society organizations, academia, etc.) to enable co-creation and experimentation.
- Adopt open innovation approaches to involve end users and societal stakeholders in the design of new government-provided services. Among other methods, government agencies could organize open challenges and crowdsourcing competitions with prizes for participants, or hackathons to allow a diverse group of people to work on particular issues or generate ideas how existing government datasets could be used for the creation of new services.
- Apply agile development methods to develop new co-created services.
- Create inter-departmental innovation teams within the public sector and allocate them time and money to experiment with new ideas for using data to improve decision-making and governance processes within the public sector.

3. Provide incentives and funding

The results of WP1 brought out the importance of resources and funding for the provision and reuse of OGD. Therefore, governments should envisage funding schemes for public sector organisations to make their data open and engage in different forms of collaboration and co-creation. In particular, governments can take the following steps:

- Set up funding schemes to provide financial incentives for local and central government agencies for opening up their data and help them cover the costs of publishing open data.
- Consider including the publication of open data among the qualification criteria of public grant submissions and public tenders and making the publication of open data an obligatory condition in public contracts and grants, in line with privacy regulations.
- Financially support inter-organisational and cross-sectoral collaboration and co-creation initiatives to enhance cooperation between data providers and data users, support learning from each other's experience, and foster the adoption of common approaches and methodologies.

4. Nurture awareness and skills of co-creators

One of the key elements in the co-creation system is the "group of co-creators", i.e. governmental and external stakeholders who participate in the co-creation of data-driven public services. In order to build the necessary knowledge and skills of co-creators, governments should:

- Organize systematic training programs for civil servants on open data publication, the related privacy regulations, data analytics, linked open data, data management and archiving and general digital skills which support better understanding of open data.
- Provide guidelines and handbooks on open data (e.g. http://opendatahandbook.org/guide/en/what-is-open-data/#what-data-are-you-talking-about) that explain open data to civil servants and politicians.
- Establish dedicated teams of developers to assist public institutions in opening their data.

5. Share experience

As some of the key barriers to open data are connected to a widespread lack of understanding of the benefits and possible uses of open data among stakeholders, the demonstration and dissemination of real use cases is seen as a major way forward. There are some simple steps that governments can do:

- Publish information about cases where open data has been used to co-create new services or improve processes within the public sector (via webpages, media, social media). Concrete successful cases should also be included as examples in open data handbooks.
- Disseminate these cases and best practices in workshops, conferences and other awareness-raising events.
- Share and promote existing applications that utilize open government data.

6. Take a comprehensive approach to open data and open government

One of the main lessons that can be learned from successful adopters of open data is the importance of a comprehensive and strategic policy agenda for open data and open government that includes hard regulatory measures as well as softer coordination initiatives and instruments for technical and financial support. The active provision and value co-creation out of open government data can be

greatly encouraged by a comprehensive, systematic and strategic policy approach which is able to support the whole ecosystem around open government data. This means that governments should:

- Make open government data an integral part of a broader open government and transparency policy.
- Make sure the policy is well integrated with the current state of the art and sufficiently flexible to be able to respond to emerging trends in technology.
- Combine regulatory and policy measures with supportive technical infrastructures (e.g. open data portals), hands-on guidelines, dissemination of case studies and best practices, and funding schemes to support the publication of open data.

7.2 Recommendations to non-governmental stakeholders

In addition to government's efforts, there are also small things that citizens, private and non-governmental actors can do to encourage data-driven co-creation and drive changes bottom-up. Among other things, they should:

1. **Demand open data**

In order to push public sector organisations to publish open government data, citizens and other stakeholders should express a clear demand for open data. Vocal grassroots groups who demand open government data are important motivators for public sector organisations to publish government information and datasets.

2. **Lead by example**

In line with the emerging approach to public services as public value-adding services, non-governmental stakeholders can take initiative in using the open data that exists to build small applications and services to show how data can be employed to meet user needs.

3. **Show the value of open data**

Among other means, the value of open data can be demonstrated and communicated by prototyping and disseminating applications for data analysis and interactive data visualization, disseminating the success stories of particular initiatives of public service co-creation, and sharing best practices with peers.

4. **Train and educate**

Non-governmental stakeholders who believe in the value of open data as an enabler of improved services, better informed decisions, government transparency, civic participation and economic opportunities should make awareness-raising around open data their priority. Private and non-profit organisations should initiate capacity-building and training programs for their own employees and volunteers to develop the necessary skills, knowledge and abilities to work with open data and participate in public service co-creation. Such training programs could also be offered to a broader circle of interested organisations and individuals.

8 Conclusions

The increasing availability and accessibility of datasets, combined with freely available tools for data analytics and data exploitation, has given rise to a new way of performing co-creation, thus also creating a new way for public services to be created and delivered. The provision of data through user-friendly interfaces can constitute the core of new services, however, the widespread availability of open data also has the potential to 'democratize' public service creation by allowing any stakeholder to initiate the co-creation of a new data-driven service.

Though this potential exists, a fundamental rethinking of the concept of public services is needed, especially in regards to the roles of stakeholders in the process and the ways in which services are produced. OpenGovIntelligence endorses the emerging vision of public services as any service that generates public value irrespective of where the service was initiated. This vision can be realized by adopting a systems based approach, which allows for a more holistic understanding of co-created data-driven public services. As the system of data-driven public service co-creation becomes better understood, it becomes possible to draft a general architecture that aims to foster co-creation and public value creation.

This deliverable also argues that the traditional waterfall-like process of service creation no longer fits the changing vision of public services. Instead, a model that incorporates iterative development and agile production methods is proposed, which allows for faster creation of public services that are more responsive and more efficient.

The proposed systems model and architecture provide a way of understanding and enabling a shift towards user-centric data-driven public services. As the next step, the applicability of this framework will be tested and evaluated in the six OpenGovIntelligence pilot projects. The outputs of the pilot tests will serve as an important test in the validation of the OpenGovIntelligence project's understanding of the data-driven co-creation system. More specifically, the pilots will demonstrate whether this framework may be put to practice in six very different contexts and provide information in regards to the exact effects of the different systemic elements and environmental factors on the co-creating process.

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Appendix 1. Key Terms in Object Process Methodology

All definitions appearing here and used in the deliverable are taken from Crawley et al. (2015).

- System – “A system is a set of entities and their relationships, whose functionality is greater than the sum of the individual entities”.
- Entity – “Chunks that make up the whole”.
- Form – “What the system *is*; it is the physical or informational embodiment that exists or has the potential to exist. Form has shape, configuration, arrangement, or layout”
- Function – “Function is the activity, operation, or transformation that causes or contributes to performance”. NB! Function normally consists of an operand and a process.
- Process – “Pattern of transformation undergone by an object. Processes generally involve creation of, destruction of, or a change in an operand”.
- Concept – “A product or system vision, idea, notion, or mental image that maps function to form. It is a scheme for the system and how it works”.
- Operand – “May be created, modified, or consumed by the process part of function”.
- Value – “Value is benefit at cost. Benefit is synonymous with the worth, importance, or utility created by a system. An observer judges benefit subjectively. Cost is a measure of the contribution that must be made in exchange for the benefit”.
- Value Related Operand – “The operand that the system exists to influence: to create, destroy, or affect”.
- Architecture – “The embodiment of concept, and the allocation of physical/informational function (process) to elements of form (objects) and definition of structural interfaces among the objects”.
- Emergence – “What appears, materializes, or surfaces when a system operates”.