

Digital Public Service Innovation: Framework Proposal

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ABSTRACT

This paper proposes the Digital Public Service Innovation Framework that extends the “standard” provision of digital public services according to the emerging, enhanced, transactional and connected stages underpinning the United Nations Global e-Government Survey, with seven example “innovations” in digital public service delivery – transparent, participatory, anticipatory, personalized, co-created, context-aware and context-smart. Unlike the “standard” provisions, innovations in digital public service delivery are open-ended – new forms may continuously emerge in response to new policy demands and technological progress, and are non-linear – one innovation may or may not depend on others. The framework builds on the foundations of public sector innovation and Digital Government Evolution model. In line with the latter, the paper equips each innovation with sharp logical characterization, body of research literature and real-life cases from around the world to simultaneously serve the illustration and validation goals. The paper also identifies some policy implications of the framework, covering a broad range of issues from infrastructure, capacity, eco-system and partnerships, to inclusion, value, channels, security, privacy and authentication.

CCS Concepts

• Applied computing~E-government

Keywords

Digital Public Service Innovation; Digital Government Evolution; Public Sector Innovation; Policy Implications

1. INTRODUCTION

The rising income inequality makes continuing provision of essential public services to all, i.e. independent of income levels, more important than ever. In 2013, the richest 10% of individuals earned 9.6 times the income of the poorest 10% of individuals, compared to 7.2 times in the 1980s. The profile of poverty is changing from pensioners in the 1980s to the youth and families with children today [1], and there is growing evidence of the “powerful and corrosive effects of inequality on economic growth, poverty reduction, social and economic stability and socially-

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ICEGOV '15-16, March 01 - 03, 2016, Montevideo, Uruguay
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ACM 978-1-4503-3640-6/16/03...\$15.00

DOI: <http://dx.doi.org/10.1145/2910019.2910108>

sustainable development” [2]. Such provision is also considered a moral obligation and, in cases of “water, food, energy, income security, health services and other essential public goods and services,” a human right [3]. Recently, in addition to universality, quality and sustainability of public service provision are becoming a concern as well [4].

The provision of public service is increasingly challenged by diverse social needs, ageing societies, digitally informed populations, economic pressure, and unequal conditions for public service delivery existing within and across countries. For example, the failure of public service delivery in many developing countries is not just due to the scarcity of resources but also to the problems of incentives, accountability and governance that vary from one context to another [5]. Overcoming such challenges requires innovation in public service delivery that creates and maintains an eco-system of government, businesses, non-profits, universities, citizens, and other actors that participate in the provision, consumption, and intermediation in public service delivery; and bringing services closer to the consumers through, for example, multi-service centers and the use of diverse delivery channels. It also requires digitizing public services, tailoring them to local needs, and delivering them through digital channels using new social and organizational innovation models [6]. The focus of this paper is on public service innovation with digital technology.

Today, digital public services are routinely produced by governments and delivered to entities under their jurisdictions. There are as many as 25 models to compare the maturity of such services [7], including the four-stage model underpinning the United Nations Global e-Government Survey. The survey tracks the progress in e-Government by UN member states and the four stages – Emerging, Enhanced, Transactional and Connected – remained unchanged from the first edition in 2001 [8] until the latest one [9] despite advances in technology and services.

The Digital Public Service Innovation Framework introduced by this paper considers the UN’s four-stage model as “standard” and foundational to seven identified innovations in digital public service delivery identified in the literature. The innovations are: 1) citizens know about service decisions made by government – transparent; 2) citizens participate in decisions – participatory; 3) government initiates service delivery to citizens – anticipatory; 4) citizens can choose how they wish to receive services – personalized; 5) government and citizens engage in collaborative service delivery – co-created; 6) service providers are aware of the service delivery context – context-aware; and 7) service providers utilize context awareness for better service delivery – context-smart. Unlike the four standard stages, the innovations are open-ended – innovations can emerge in response to policy needs and technological inventions, and non-linear – one innovation may not depend on another. The paper also presents some evidence of public services delivered at the standard and innovative levels, and

introduces implications including policy recommendations for government and benchmark organizations that deliver and measure innovative digital public services.

The goals and structure of this paper are to: provide a background to public sector innovation in general (Section 2); outline the concept of Digital Government as foundation for digital innovation in the public sector (Section 3); present the Digital Public Service Innovation Framework (Section 4); validate the framework through a set of case studies (Section 5); identify some implications for policymakers and governments (Section 6); and offer some conclusions (Section 7). The paper is a starting point for assessing digital public service innovation that will require additional research for further validation and development.

2. BACKGROUND – PUBLIC SECTOR INNOVATION

At its core, innovation is the creation of something new – a practice, idea, approach, technology – in a way that creates value. Public service innovation combines both the notion of innovation and what it means to innovate in the public sector. Schumpeter [10] [11] studied innovation and posited that entrepreneurship was a critical motivating force that would change practice through “creative destruction”. In his further work [12], Schumpeter emphasized two characteristics of the entrepreneurship-innovation relationship: 1) the recognition of the value of different components to a system and that these components could be in some way reassembled to create something new and novel; and 2) the recognition that innovation and entrepreneurship could be both the act of a single individual and one that was social, cooperative, and co-created. Thus innovation has three critical aspects: entrepreneurship, “creative destruction” that leads to novelty and value, and individual or collective value generation.

Osborne and Gaebler [13] extended the concept of innovation to the public sector through their book *Reinventing Government* (RG). This coincided with the emergence of New Public Management (NPM) [14]. NPM and RG were in many ways two sides of a coin:

RG focused on entrepreneurship and innovation, while NPM focused on accountability, efficiency, effectiveness, and general performance of the public sector and its services [15]. An added aspect came from the National Performance Review initiative introduced in the United States, which included the leveraging of digital technology to facilitate innovation and efficient and effective government [16].

Public sector innovation differs from innovation in the private or non-profit sectors. Critics of both the RG and NPM movements cite the lack of placing, both philosophically and pragmatically, of innovation in the government context [17][18][19]. Governments are often bureaucratic by design and thus incremental in their approach to change. To those who reinvent, this bureaucracy is an impediment to reform, creativity and entrepreneurship [20]. But to others, this deliberative and incremental approach is designed to balance brash behavior that could have unintended negative consequences [21]. In addition, government operations are typically embedded in a legal, regulatory, and administrative set of frameworks that would require policy changes to enact.

This does not mean that innovation is not possible within a public service, but that public and private sector innovations follow different paths. Table 1 offers innovation taxonomies and their applicability to both sectors [22, p.8][23][24, p.9]. It demonstrates that the introduction of new ideas, processes, services, and/or products require consideration of the political, policy, governance, and institutional contexts of public service delivery.

As [22] notes, service, service delivery, and administrative and organizational innovation have direct private sector comparability. So too do conceptual, systematic, process, and communication innovation [23] [24]. As defined by the authors, however, policy and governance innovation apply primarily to public sector entities, though additional research is needed to further study, for example, the applicability of governance innovation by the private sector – as social media and other forms of engagement can be used by the private sector to engage their communities.

Table 1. Public versus Private Sector Innovations

Innovation	Definition	Application	Source
Service Innovation	New service or improvement to an existing service	Public and Private	[22]
Service Delivery Innovation	New or modified approach to providing a public service or services	Public and Private	[22]
Organizational Innovation	Changes in organizational structures and routines	Public and Private	[22]
Conceptual Innovation	Development of new ways of thinking that challenge assumptions that underlie processes, services and products	Public and Private	[22]
Policy Innovation	Changes to behavioral intentions underlying policy development	Public	[22]
Systematic Innovation	New or improved ways of interacting with other organizations and/or knowledge bases	Public and Private	[22]
Governance Innovation	New ways of engaging citizens and democratic institutions	Public	[23]
Rhetorical Innovation	New languages and concepts	Public and Private	[23]
Process Innovation	Implementation of methods of production and provision of services and goods that is new or significantly improved compared to existing ones	Public and Private	[24]
Communication Innovation	Implementation of a new method of promoting the organization or its services, or new methods to influence the behavior of individuals	Public and Private	[24]

3. FOUNDATIONS – DIGITAL GOVERNMENT AS PUBLIC SECTOR INNOVATION

Public sector innovation with digital technology is also called Digital Government (DG). In 23 years since the concept was first

systematically introduced by the National Performance Review [16], the DG understanding and practice of has evolved to “reflect how governments are trying to find innovative digital solutions to social, economic, political and other pressures, and how they transform themselves in the process” towards “more complexity and greater contextualization and specialization” [24].

Consequently, [24] introduced four stages of the DG evolution depending whether the application of digital technology transforms the internal working of government or merely digitizes what exists (Digitization); whether the transformation is internal to government (Transformation); whether it affects external relationships with citizens and other actors (Engagement); and whether the transformation accounts for specific national, local or sectoral context where a given government organization serves its customers and fulfills its mandate (Contextualization).

Following [24], Figure 1 depicts the DG Evolution model. The figure also presents the logical characterization of each stage considering the values of three binary variables about the presence

of internal government transformation, whether the transformation affects relationships between government and its customers, and whether the transformation is specific to the application context.

In order to explain and possibly anticipate the trajectory of the DG evolution, [24] posits that at every stage, governments are under pressure from economic, social, political and other factors, and respond to them by innovating with digital technologies available at the time. In the process, through repeated application, they institutionalize such innovations to become a standard part of government practice, transforming DG innovation and eventually into Government Practice and, in turn, strengthening government capacity to pursue public policy and development [25].

STAGE	APPLICATION CONTEXT	CHARACTERIZATION		
		Internal government transformation	Transformation affects external relationships	Transformation is context-specific
Digitization	Technology in government	no	no	no
Transformation	Technology impacting government organization	yes	no	no
Engagement	Technology impacting government stakeholders	yes	yes	no
Contextualization	Technology impacting sectors and communities	yes	yes	yes

Figure 1: Digital Government Evolution Model [24]

4. FRAMEWORK – DIGITAL PUBLIC SERVICE INNOVATION

This section presents the Digital Public Service Innovation Framework, depicted in Table 2 and elaborated in subsequent sections. Section 4.1 introduces the standard four-stage model for digital public services. Section 4.2 presents the case for innovation, and Section 4.3 introduces seven innovations.

4.1. Standard Digital Public Services

The foundation for the framework is the United Nations four-stage digital public service maturity model [26][27]:

- Emergent Stage. In this stage, government websites provide information on policies, laws, regulations, available government services and documentation. Citizens are able to find and access a range of current and archived information government information. The key question asked is: *Can agencies disseminate information (one-way) to citizens?*
- Enhanced Stage. In this stage, one-way or basic two-way communication between government and citizens take place including downloadable forms, audio, video, and content in multiple languages. Capabilities may also include abilities to submit requests for personal information or non-electronic forms. The key question asked is: *Can agencies and citizens engage in (two-way) discrete interactions?*
- Transactional Stage. In this stage, governments engage in two-way communication with citizens, including completing license applications, permit applications, tax filings and other forms. The key question asked is: *Can agencies and citizens engage in linked interactions (transactions)?*

- Connected Stage. In this stage, governments engage in cross-agency e-services, using multiple technologies and platforms, and pursuing greater engagement with citizens. The key question asked is: *Can agencies coordinate internally (seamlessly) between themselves?*

The model can be characterized in four ways. First, the stages are linear, beginning with emergent services, moving into enhanced services, then transactional and connected services. Second, each stage requires greater knowhow and technical infrastructure for both governments and citizens, e.g. connected services require multiple service delivery capabilities by governments, citizens having access to and knowing how to use devices, and a robust telecommunications infrastructure. Third, the model transcends government, political, and other issues of governance. Finally, with each successive stage in public service delivery, technology interoperability; cross-government integration; organizational, policy and citizen abilities; and complexity all increase.

4.2. From Standard to Innovative Digital Public Services

As discussed previously, innovation is entrepreneurial, novel, and creates value. In this sense, the standard model of electronic public services does not meet the definitions of innovative DG [28][29][30][31]. Although for some governments lower stages of DG maturity may be innovative in their own contexts, we would argue that connected services are a pre-requisite to innovation in digital public services as identified in the proposed framework.

Table 2. Digital Public Service Innovation Framework

CHARACTERISTIC VARIABLES	STAGES										
	STANDARD				INNOVATIVE						
	Emergent	Enhanced	Transactional	Connected	Transparent	Participatory	Anticipatory	Personalized	Co-created	Context-aware	Context-smart
Can agencies disseminate information (one-way) to citizens?	x	x	x	x	x	x	x	x	x	x	x
Can agencies and citizens engage in (two-way) discrete interactions?		x	x	x	x	x	x	x	x	x	x
Can agencies and citizens engage in linked interactions (transactions)?			x	x	x	x	x	x	x	x	x
Can agencies coordinate internally (seamlessly) between themselves?				x	x	x	x	x	x	x	x
Can citizens know about how service decisions are made by government?					x	x					
Can citizens participate in service decision-making by government?						x					
Can government initiate (proactively) service delivery to citizens?							x				
Can citizens choose how they wish to receive services from government?								x			
Can government and citizens engage in collaborative service delivery?									x		
Is the service provider(s) aware of the service delivery context?										x	x
Is the service provider(s) utilizing context awareness for better service delivery?											x

Specifically, the baseline for innovation in digital public services includes [32][33][34][35]: government’s ability to interact with citizens and other service recipients, thus providing a foundation of engagement; the ability to engage in cross-agency or even whole-of-government service design, production and delivery; and the ability of governments to deliver, and of citizens to use digital public services on multiple technology platforms. The following section describes a range of such innovations.

4.3. Innovative Digital Public Services

By nature of being disruptive, innovation is a non-linear. As such, the innovations in Table 2 do not follow in sequence. It may well be that governments adopt different innovations, e.g. transparent, participatory or co-created, based on demographics, citizen needs and demands and other contextual factors [24][36][37]. Each digital service innovation is therefore presented independently, though governments may choose to connect them as part of their overall DG strategy. The seven innovations, as identified through literature review and validated through case studies (Section 5), are presented in Sections 4.3.1 to 4.3.7.

4.3.1. Transparent Digital Public Services

Open, transparent, and accountable government is foundational to an informed citizenry [38]. Advances in social media, data analytics, open and big data, and citizen demands all conflate to create an unprecedented open government context, based upon an increasingly ongoing, interactive, and iterative transparency cycle between the public and governments [39][40][41][42]. Openness, however, requires processes, infrastructure and policies to ensure that citizens, civil society, and others have access to government information and data today, but also in the future through the preservation of records regardless of format [43][44][33][45].

Thus a critical question is: *Can citizens know about how service decisions are made by government?* Answering this question requires governments to move beyond the posting of, e.g. budgets,

meeting announcements, or minutes of meetings on government websites. Rather, governments need to proactively disseminate through multiple channels and formats information products, e.g. documents or data; information about government operations, e.g. events or contacts; and information about deliberations and decisions, e.g. hearings or votes, to ensure that citizens are aware of what governments are doing on their behalf [46][47][48][49].

4.3.2. Participatory Digital Public Services

The introduction of digital technology, particularly social media and engagement techniques such as crowdsourcing have combined to create innovative abilities for governments and citizens to interact. Governments are developing digital platforms for engagement [50][46][51], use social media to engender participation [52][53], and develop policies and processes to foster technology-enabled participation [54][55][56][45][57][58]. Critical to participatory innovation is the ability of citizens and governments to fluidly engage one another through digital technology and thus move beyond one-way government-to-citizen communications such as notices of policy drafts [23][21].

Thus a critical question is: *Can citizens participate in service decision-making by government?* This requires not only seamless integration between governments and citizens intermediated by technology, but also government capacity to incorporate citizen feedback into deliberations and policy-making processes [30][59].

4.3.3. Anticipatory Digital Public Services

Anticipatory innovation focuses on digital public services that anticipate citizen needs [60][61]. Anticipation can be based on demographics, e.g. age or marital status; life circumstances, e.g. change in employment, disaster recovery or movement to a new location; or some other contextual factors. Anticipatory services are predicated on governments and citizens being able to share information and data that enable the prediction of citizen needs.

Thus a critical question is: *Can government initiate (proactively) service delivery to citizens?* Anticipatory services are based upon data, analytics, predictive modeling and trust-based relationships between citizens and governments. Both need to consensually and routinely exchange personal and preference data; engage in analysis of large-scale data for predictive purposes; engage in a continual assessment and improvement process; and ensure security and integrity of data [62][63][64][65].

4.3.4. *Personalized Digital Public Services*

Personalized services refer to one-on-one digital public services between governments and citizens that are based on user profiles, customization and authentication [66]. Personalization enables the development and selection of user profiles, preferences, and choice; a back-end operation that enables the creation, storage, retrieval, and authentication of profiles; digital public service integration across agencies and across sectors for services that are delivered by public-private partnerships; ability to activate digital service preferences across different technology types; and ability to integrate preferences and services for an integrative digital service provision [67][68][69][49][70]. In this approach, citizens can create a customized interaction with government – services that they wish to receive and how they wish to receive them.

Thus a critical question is: *Can citizens choose how they wish to receive services from government?* It is important to distinguish between meeting government obligations, e.g. to pay one's taxes, and how a citizen wishes to be informed about and mechanisms through which it can comply with such mandates. Personalization focuses on the latter aspects of citizen-government interactions.

4.3.5. *Co-created Digital Public Services*

Co-creation refers to a collaborative process facilitated by digital technology between governments, citizens, industry, etc. challenges, processes and other aspects of governance [59][35]. It involves active participation with governments to form and inform decisions, and potential transformation in the relationships between governments and the governed, with more power and decision-making shifting towards local entities [71][72][73]. Through this innovation, the role of government shifts towards facilitation with communities to make decisions and policies (bottom-up) rather than direct decision- and policy-making (top-down) [74]. Through co-creation, citizens and governments work collaboratively to form policies and make decisions.

Thus a critical question is: *Can government and citizens engage in collaborative service delivery?* Co-creation does not suggest that citizens will implement policies or decisions directly, as the innovation is in the collaborative process. For example, while co-creation may yield decisions about transit, roads, and environmental policies, it would be a government role to build the transportation infrastructure and enforce environmental policies.

4.3.6. *Context-aware Digital Public Services*

Context-aware digital public services, sometimes referred to as ubiquitous government, refer to digital services that leverage pervasive applications that are flexible, adaptable, cross-platform, and capable of acting autonomously on behalf of citizens. The notion of context-aware services is derived from human-computer interaction that focuses on technologies that sense user's context, e.g. work, home or vehicle, and provide context-specific content and services [75][76][77]. Relying on a combination of intelligent code (e.g. bots), digital technology (e.g. mobile) and Internet-enabled sensors on arrays of devices (e.g. meters) in locations (e.g. community spaces, highways or mass transit vehicles) context-

aware services are in a constant state of interaction with citizens, their devices, and current environment, and thus able to engage in timely and contextual fulfillment of needs [78][79][80].

With its focus on the intersection of users, contexts, technology, and governments, a critical question is: *Is the service provider(s) aware of the service delivery context?* Key to this innovation is seamless integration across governments, contexts, devices, and citizens, and the ability of digital services to make sense of the context and take appropriate responses and actions [81].

4.3.7. *Context-smart Digital Public Services*

Context-smart services encompass digital public services that leverages context-awareness to provide contextually-relevant actions at the moment of need or desire [82][83]. In doing so, context-smart services bring together smart, cross-platform technologies with an increasing emphasis on mobile; smart city infrastructure; smart technology applications across governments, citizens, and industries; citizen preferences; proactivity; the instant and continuous interaction between governments, citizens, devices, sensors, and applications; analytics that assess trends, contexts, and needs; and continual learning and sharing processes [84][85][86][87][88][89][90]. Such services are likely to develop rapidly as wearable technologies become more common [91].

Thus a critical question is: *Is the service provider(s) utilizing context awareness for better service delivery?* This requires a continual integration and learning across contexts, locations, devices, data sources, governments, industries and services. This also requires policies and other coordinating or governance mechanisms to assure accuracy, reliability, security, and value.

4.3.8. *Further Innovation in Digital Public Services*

Each innovation in digital public service delivery presented in Sections 4.3.1 to 4.3.7 above could stand on its own. For example, personalized services provide value to citizens by enabling customization of their interactions with governments; anticipatory services proactively identify citizen needs based on a range of demographic, economic and other factors; and context-aware services account for real-time situational factors and yield responses based on the location, circumstances and context of a citizen. However, further innovation in digital public services is possible by combining existing innovations. For example, by blending personalization and context-awareness, citizens would be able to set their preferences and/or profiles for work, transit, home and other contexts, thus enabling a greater degree of customization, contextualization, and value.

5. CASES AND EXAMPLES OF DIGITAL PUBLIC SERVICE INNOVATION

This section presents cases in support of the Digital Public Service Innovation Framework. The criteria for case selection included: 1) to what extent the initiatives extended beyond the "standard" DG framework; 2) the value added by the initiative to the context in which it was introduced; 3) the transformation of government in support of public service innovation; and 4) the deployment of technologies to support public service innovation. The cases exist within a broader public service innovation context, and continue to emerge. They may remain at the conceptual rather than implementation stage that future research will need to assess.

5.1. Transparent Services

The Ohio House of Representatives portal provides one-stop access for citizens to access information about activities conducted by their representatives [92]. The services include: 1) Directory –

addresses, phones and emails of representatives; 2) Video Library – videos of the house sessions and for each session at which time contributions took place to facilitate access; 3) Agenda – the dates when the session took place; 4) Committees –Committee members, bills studied, fiscal notes, bill analysis, and documents produced by witnesses; and 5) Blogs – blogs and social media pages of the majority and minority caucuses. Through various services, citizens can understand how bills are passed and deliberations are conducted. Digital technology facilitates one stop access to information, made available through texts, maps, downloadable files, videos, and other formats.

The Federal Entities Tracking Resource platform implemented by the Government of Mexico, is an awarded example of innovation on budget transparency [93]. The platform promotes transparency on the sides of providers and receivers of public funds. On the one hand, it enables the federal government to report on funds transferred to state and local governments. On the other, state and local governments report how the received funds are being used, detailing various projects, their impact on the society, and the allocated resources and progress per project. The initiative enables the promotion of transparency and accountability on the use of federal public funds by state and local governments. Digital technology enables access to information in various formats, such as spreadsheet files, visual maps, and open data sets, as well as through a data dictionary and advanced search services.

5.2. Participatory Services

The winner of the UN Public Service Award for fostering participation in policy-making decisions through innovation, the Irekia Open-Government portal provides citizens an opportunity to learn, comment and express opinion on the initiatives of the Basque Government [94]. The portal provides two spaces: 1) Citizen Petitions, which enable a citizen to formulate a petition to government and other citizens to argue and vote in favor or against such petitions, and 2) Government Proposals, which allow government to provide information about proposals and draft laws, as well as agencies to present their initiatives, and citizens to express their comments and doubts about government projects. The portal provides a direct channel for two-way communication between citizens and government, enabling citizens to request services from government and express their opinions on decision-making processes, and government to respond to citizen needs. Technology provides a platform for citizen participation.

The Citizen Involvement in Fight against Grey Economy is a participatory innovation initiative implemented in Montenegro [95]. The initiative enables citizens to participate in a socially responsible project such as reporting on business wrongdoing or collecting funds for socially beneficial projects, e.g. reconstruction of health-care centers for children. Citizens fight against the grey economy by reporting related incidents, and government invests half of each fine issued based on a citizen report in socially beneficial projects. Through a web page, mobile application, and phone channel, citizens are able to report the issuance of non-fiscal receipts, violation of labor regulations, breach of consumer protection legislations, and irregularities regarding beaches and resorts. The initiative facilitates two types of citizen participation: 1) crowdsourcing instances of violation to economic rules, and 2) voting on the use of funds raised through participation. Digital technology provides easy access channels to promote citizen participation.

5.3. Anticipatory Services

Although anticipatory innovation is explored in academic literature [61], it is still scarce in government practice. Two evidences provided by businesses are explained below, with potential transferability to DG.

Based on patterns of daily activities, a mobile app proactively offers information about the time it may take a user to commute to the usual place. Digital technology enables collection of geo-data about the user's commuting patterns, and combines such data with other contextual data such as the day of the week, weather conditions, traffic, etc. to provide accurate informational service.

Using consumption trends such as books bought online or courses selected online, a service suggests new items that might be of interest to the user. Examples are provided by Amazon and Coursera respectively. Digital technology is used to anticipate future choices based on historical data, identification of behavioral patterns, and data mining techniques.

5.4. Personalized Services

My Page is a secure section within the Danish Citizen Portal where citizens can access personalized data and services through digital signature [96]. Based on personal data maintained by authorities, citizens can access personalized services such as financial data, e.g. the salary received during the past months; taxes paid; housing, e.g. property value; and civil registry data, e.g. social security numbers. In addition, a link is provided to update personal data and print relevant documents. The solution enables grouping and delivering relevant services for citizens into a single personalized space. Digital technology and user-design techniques facilitate user interaction with government services.

The Spanish Tax Agency provides a personalized income tax return service [97]. Citizens can access personalized information and services: 1) income tax returns, 2) income tax returns with power of attorney, and 3) income tax returns with collaborators. In addition, citizens can personalize the preferred mechanism for accessing the portal, including access with a digital identification certificate or electronic national identification, with a personal identification number, or with a reference number provided by the Tax Agency. After obtaining access, a visible message informs the user about the status of his/her income tax return and a menu provides access to other services. The available services depend on the status of the procedure and the mechanism used to access the portal. By personalizing the interface, the interaction between citizens and the agency delivering the services are facilitated. Digital technology is used to design personalized web pages.

5.5. Co-created Services

The USA Environmental Protection Agency (EPA) provides an Air Sensor Toolbox for Citizen Scientists [98] to engage citizens in monitoring air quality. The toolbox provides information, guidance, and low-cost technologies for citizens to collect, analyze, interpret, and share air quality data. The toolbox includes information about sampling techniques, calibration and validation, measurement methods, data interpretation, training materials and sensor performance. By collecting and sharing data, citizens collaborate with EPA in monitoring air quality. An example of a co-created service, digital technology enables data collection and sharing, and more broadly data management. Digital technology is also used to deliver training to citizen scientists, since techniques are explained and shared through videos and community portal.

The Municipality of Amsterdam provides a crowdsourcing platform that enables co-creation of ideas and applications [99]. Through the platform, citizens are encouraged to publish ideas about new applications that can add value to Amsterdam dwellers, and other citizens can comment on or discuss the ideas. From the discussions, a combination of ideas creating value for citizens can emerge. The proponents are also welcome to discuss their ideas with government officials and experts through email or during workshops. Digital technology provides a platform that facilitates online citizen interactions, as part of the co-creation process.

5.6. Context-aware Services

An example of the context-aware innovation, the Government Offices of Sweden portal provides different interfaces depending on the device used. The portal adjusts its interface depending if the user connects through a computer or a mobile device. Further interface customization depends on the usage context.

Another example of context-aware innovation refers to situational awareness, i.e. knowing and understanding what is happening around you, predicting how it will change with time, and being unified with the dynamics of your environment [100]. A study conducted by the U.S. Department of Homeland Security [101] produced guidelines explaining how social media can be used for situational awareness in delivering services for public safety, e.g. using social media to manage rumors, and using a disaster reporter app <http://www.fema.gov/disaster-reporter> offered by the U.S. Federal Emergency Management Agency (FEMA). The app enables users to take and upload photos and send short texts about a disaster area. Through the app, users and survivors can access useful information on a map and FEMA officials can obtain situational awareness to help decide on the type of resources that are needed. Digital tools for situational awareness include social media, GIS, sensors, big data, bio-data, and environmental data, as well as prediction and outcome modeling, and tools to assist in decision-making, resource allocation, and response strategies.

5.7. Context-smart Services

Traffic signal optimization systems constitute evidence of context-smart innovations. For instance, the Washington State Department of Transportation collects detailed data about traffic volumes and speeding vehicle to analyze traffic patterns, part of a traffic signal optimization system [102]. Based on the analysis, coordinated signal systems are created to maximize traffic flow including traffic Closed Circuit TV cameras; traffic detectors, including induction loop, i.e. a low-voltage wire buried in the road that sends an electric pulse when a vehicle pass over it; infrared; radars; sound and video imaging; and Bluetooth. These systems are enhanced through algorithms that simulate traffic patterns.

6. IMPLICATIONS

Based on the assessment of the framework's innovations in digital public services, it is possible to identify several initial implications that warrant further analysis:

- Infrastructure. Digital infrastructure is a necessary pre-requisite, including robust digital technology infrastructure within governments and among citizens and industry. Without broadband and high-capacity wireless connectivity, access to devices, particularly mobile devices, and cross-government interoperable service systems and applications, these innovations would not be possible or take hold.
- Capacity. Different capacities including organizational, human, regulatory, collaborative, and other must be present across governments, industry, communities and citizens.

These capacities are necessary to leverage the digital technology infrastructure and diffuse digital innovations.

- Eco-systems. Innovative services, enabled by governments, should be part of a broader social innovation eco-system, e.g. promoting innovation as an economic activity for the youth, developing entrepreneurial skills, facilitating cultural change for adopting a positive attitude towards risk and acceptance of failure, and nurturing entrepreneurs through professional advice and facilities for start-up development.
- Partnerships. While governments can face challenges with their capacity to innovate, they can leverage the innovative capacity and resources of partners. Developing partnership capacity with the private and nonprofit sectors and engaging citizens in defining new services are important mechanisms for delivering innovative public services.
- Inclusion. If innovative services are to be ubiquitous and benefit all, they need to be available to and usable by all. The innovations identified above have a high threshold in technology implementation, ability to use digital services, ability to set service preferences, and leveraging on service capabilities. Consideration must be given to ensuring that all actors have the ability to use and benefit from such services.
- Value. Innovations must deliver public value and be valued. A key to innovative technologies is that they need to deliver a real value to citizens, governments, etc. For example, the personalization of digital public services could be innovative as citizens can personalize their interaction with government. However, are personalized digital spaces valued by citizens? If so, under what circumstances and with what parameters?
- Channels. Many factors including age, preferences, digital literacy, infrastructure, etc. affect the take up of digital services and the opportunities for citizens to engage. Therefore, multiple service delivery channels for engagement are needed, as well as multi-channel delivery strategies to decide the most suitable channels for each service.
- Security. Digital service innovations cannot be deployed without ensuring the security of the interactions and stored content, e.g. users' profiles and preferences, and personal data, choices and activities. Without security, there can be no trust and therefore usage of digital public services.
- Privacy. Security focuses on the protection of content, whereas privacy pertains to the ability of citizens to opt in or out of digital public services. Innovations cannot be mandated, but citizens must retain the right to select the services they wish to receive, use, or with which they wish to engage. For this to happen, privacy must be ensured.
- Authentication. Secure and verifiable authentication are necessary, but we also need appropriate authentication measures to guarantee that service recipients are indeed the intended recipients. This requires layers of security and authentication throughout the services.

The identified implications appear to cut across issues of digital technology infrastructure, innovation strategies, regulatory frameworks, government and citizen capacity, partnership and collaboration capacity, and operational strategies, thus demonstrating the complexity of digital public service innovation.

7. CONCLUSIONS

This paper examined how digital technology transforms the delivery of public services, and gives rise to innovations in the provision of digital public services. The study is set against the background of public sector innovation, represented by the RG [13] and NPM [14] movements with their respective interests in

entrepreneurship and innovation versus accountability and performance, and the tension between transformative and incremental approaches to improving the working of government.

The Digital Public Service Innovation Framework introduced by the paper adopts the four-stage model underpinning the United Nations Global e-Government Survey as the “standard” level for digital public service provision compared to the “innovative” level. In doing so, the article suggests that progress in digital public service innovation is non-linear, with various examples provided of the emerging innovations in governments.

The paper also observes that: universal access to essential public services for all, i.e. regardless of income levels, is critical; continuing innovation in public service delivery is essential to address diverse social needs, raising social aspirations, economic pressure and unequal conditions for public service provision within and across countries; and, new technological inventions are gradually being assimilated, giving rise to case-by-case innovation in the provision of services in the process to be institutionalized.

The proposed framework and its identified implications require additional study to further our understanding of the policy and practice of digital innovation in public service delivery. Furthermore, to maintain relevance and to provide guidance to policymakers, it is important for the research community and those responsible for benchmark instruments like e.g. the UN Survey to further study and measure digital public service innovation, particularly as DG implementations move beyond the stages identified in the UN Survey’s maturity model.

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