Public Administration and Information Technology 32

Adegboyega Ojo
Jeremy Millard *Editors*

Government 3.0 – Next Generation Government Technology Infrastructure and Services

Roadmaps, Enabling Technologies & Challenges

Springer

Public Administration and Information Technology

Volume 32

Series editor

Christopher G. Reddick, San Antonio, TX, USA

More information about this series at http://www.springer.com/series/10796

Adegboyega Ojo • Jeremy Millard
Editors

Government 3.0 – Next Generation Government Technology Infrastructure and Services

Roadmaps, Enabling Technologies & Challenges

Springer

Editors
Adegboyega Ojo
Insight Centre for Data Analytics
National University of Ireland Galway
Lower Dangan, Galway, Ireland

Jeremy Millard
Danish Technological Institute
Taastrup, Denmark

ISSN 2512-1812 ISSN 2512-1839 (electronic)
Public Administration and Information Technology
ISBN 978-3-319-63741-9 ISBN 978-3-319-63743-3 (eBook)
DOI 10.1007/978-3-319-63743-3

Library of Congress Control Number: 2017951722

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

To my dear wife, Lauretta, and our beautiful children Seun, Ore, Jimmy, Jojo and Benny. Also to my parents Julius and Mary, my father-in-law George and to the loving memory of my mother-in-law, Beatrice.
Adegboyega Ojo

To my loving wife and lifelong friend, Inger Marie, who keeps me happy and sane when deadlines converge, and to our wonderful children Simon, Teresa and Peter, who together keep me on my toes intellectually and well and truly grounded.
Jeremy Millard

Preface

Policymakers and academics largely recognise the need for a fresh vision for public sector innovation and the use of technology in government given the challenging and turbulent contexts in which most public administrations operate. In response, recent studies have sought to better understand the forces that will shape the future evolution of the PA environment. For instance, in a report on Future Trends in European Public Administration and Management, some megatrends that are already shaping the future of PAs were identified (Pollitt 2014). These changes include demographic change, climate change, economic trajectories, technological developments, public trust in government and changes in the political environment.

Historically, technological change has had a significant effect on the locus of administrative activity, the costs involved, the nature of administrative tasks, the skill sets needed by officials, rules and regulations and the types of interactions citizens have with their public authorities (Pollitt 2014). In 2007, Frissen et al. (2007) identified some disruptive technologies with strong potentials to transform government functions, including mobile devices; intelligent agents (and robotics); sensors; language processing technologies; semantic technologies; serious games; RFID and biometrics; ICT infrastructures such as WiFi, WiMAX and broadband; Web 2.0 technologies (social software); and grid infrastructure. While mobile devices and Web 2.0 and ICT connectivity technologies such as WiFi have had a transformational effect, some of these technologies are yet to have any major impact in the government space. Unfortunately, we are yet to fully understand the reasons for this very slow adoption of these technologies.

A recent study by the European Commission on 'Powering European Public Sector Innovation: Towards a New Architecture' (EC-DG Research and Innovation 2013) has also identified new technology paradigms considered as enablers of innovation and core to the delivery of public services or the design of public policy. These technologies include the following:

- *Social* – social networking offers new ways to deliver public services and to enable citizens to participate.

- *Analytics* – big data and predictive analytics offer new service opportunities for citizens and businesses.
- *Mobile* – the advent of the smartphone enables citizens to access public services from anywhere at any time.
- *Cloud* – cloud-based solutions, both public and private, can transform interoperability and service provision.
- *Open and big data paradigm* – new public services, transparency/democracy, economic growth potential.
- *Sensors and Internet of Things* – harnessing an enormous amount of data generated from everything around with an Internet address for better decision-making and problem-solving.

Among these new technological paradigms, open and big data stands out regarding attention by policymakers. It is widely believed that big data will enable hitherto slow-moving public services to move much faster and to treat citizens on an individual rather than a categorised basis.

However, despite these exciting possibilities, many questions remain unresolved: Can these new technologies deliver the radical innovation needed for the 'entrepreneurial' and 'directing' (Pollitt 2014) state? How should governments (at different levels) reconfigure their relationships with citizens, the social sector and businesses to effectively leverage these technologies to deliver public outcomes effectively? To what extent can open data enable greater transparency that can increase social capital and public trust in the government? How can the public sector effectively tap into the 'data tsunami' already engulfing us due to the explosion of social media and the introduction of new low-cost data gathering tools that effectively make every citizen with a smartphone a data source? What are the new data gathering trends most likely to impact public services (Millard 2013)? What kind of capabilities must the government develop to leverage these technologies? Finally, what are the negative consequences (such as an exacerbation of the digital divide or threats to citizen privacy) that the adoption of these technologies may present and what strategies are available to mitigate undesirable effects?

This book attempts to answer some of these questions. Specifically, this book will shed some light on the question about the next steps of e-government initiatives and public sector innovation. This next generation public sector innovation is what we have labelled 'Government 3.0'. Technology policymakers should benefit from the visions created by the various roadmaps in the first three chapters of the book which describe some of the common strategies of the European Union member states in the areas of open data and services, open processes and the use of digital technologies in policymaking. The book also discusses in its fourth chapter some of the issues associated with existing models for tracking progress in e-government development and highlights how some of these shortcomings could be addressed. Examples of emerging innovations in the areas of process engineering and open innovation in the government domain based on linked open data are described in chapters "Techniques for Reuse in Business Process Modeling in Public Administration, Capability Development in Open Data Driven Organizations, Water

Analytics and Management with Real-time Linked Dataspaces, Fostering Citizens' Participation and Transparency with Social Tools and Personalization, The 6 – Values Open Data Business Model Framework, Technology Innovations in Public Service Delivery for Sustainable Development, and Blockchain as a Next Generation Government Information Infrastructure: A Review of Initiatives in D5 Countries". One of the new developments highlighted in chapter "Fostering Citizens' Participation and Transparency with Social Tools and Personalization" is how new generations of open data platforms are addressing the weak exploitation of available open data resources through explicit support for social interactions among community members of common interest on the platform. Given the increasing centrality of United Nations (UN) Sustainable Development Goals (SDG) for governments in different parts of the world, chapter "Technology Innovations in Public Service Delivery for Sustainable Development" examines how ICT can be deployed to assist in the design and delivery of innovative public services in support of sustainable development around the world. Chapter "Blockchain as a Next Generation Government Information Infrastructure: A Review of Initiatives in D5 Countries" discusses early adoption of blockchain and distributed ledger technology, a next-generation information infrastructure in the Digital 5 (D5) countries. Chapter "Governance, Transparency and the Collaborative Design of Open Data Collaboration Platforms: Understanding Barriers, Options, and Needs Discusses the Barriers and Design Options for Next-Generation Open Data Platforms". The book closes in chapter "The Privacy/Transparency Balance in Open Government" with a critical analysis of how to balance the transparency goals and privacy needs of citizens in the open government era.

Galway, Ireland — Adegboyega Ojo
Taastrup, Denmark — Jeremy Millard

References

EC-DG Research and Innovation (2013) Powering European public sector innovation: towards a new architecture, Brussels, pp 1–64

Frissen AV, Millard J, Huijboom N (2007) The future of eGovernment – an exploration of ICT-driven models of eGovernment for the EU in 2020, vol 2020. pp 1–15

Millard J (2013) ICT-enabled public sector innovation : trends and prospects. In ICEGOV'13, October 22–25, 2013, Seoul, Republic of Korea. ACM International Conference Proceedings Series, ACM Press, pp 77–86

Pollitt C (2014) Future trends in European public administration and management: an outside-in perspective, pp 1–45. Retrieved from www.cocops.eu.

Acknowledgment

The publication of this book would not have been possible without the contributions and support of many people. We use this medium to express our profound appreciation to all these people who helped and supported us from the conception of the book to its publication. First on the list of these people is the PAIT book series editor, Chris Reddick, whose guidance was key in getting the project off the ground. Next, we thank all the authors for sharing their work through our book. Very special thanks to all the reviewers who gave their time, effort and constructive comments that enhanced the overall quality of the chapters in the book. We particularly recognise the dedication and commitments of Ed Curry, Peter Winstanley, Michael Hogan, Fatemeh Ahmadi Zeleti, Niall O'Brolchain and Lukasz Porwol as reviewers. Last but not least, we are grateful for the support of Samuel Adebayo (the book project manager) and the Springer staff members for guidance in the final steps of the publication process.

Ireland — Adegboyega Ojo
Denmark — Jeremy Millard

Contents

Contributors

Samuel Adebayo Insight Centre for Data Analytics, National University of Ireland Galway (NUIG), IDA Business Park, Lower Dangan, Galway, Ireland

Jerry Andriessen Wise & Munro Learning Res, Den Haag, The Netherlands

Michael Baker CNRS – Telecom ParisTech, Paris, France

Sami Bhiri ISIMM, University of Monastir, Monastir, Tunisia

Paolo Boscolo Comune di Prato, Prato, Italy

Eoghan Clifford College of Engineering & Informatics, National University of Ireland Galway, Galway, Ireland

Amy Conroy Carleton University, Department of Law and Legal Studies, Ottawa, ON, Canada

Edward Curry Insight Centre for Data Analytics, National University of Ireland Galway, Galway, Ireland

Wassim Derguech Insight Centre for Data Analytics, National University of Ireland, Galway, Galway, Ireland

Françoise Détienne CNRS – Telecom ParisTech, Paris, France

Jonathan Groff CNRS – Telecom ParisTech, Paris, France

Louise Hannon College of Engineering & Informatics, National University of Ireland Galway, Galway, Ireland

Owen Harney National University of Ireland, Galway, Ireland

Souleiman Hasan Insight Centre for Data Analytics, National University of Ireland Galway, Galway, Ireland

Umair ul Hassan Insight Centre for Data Analytics, National University of Ireland Galway, Galway, Ireland

Johann Höchtl Department for E-Governance and Administration, Danube University Krems, Krems, Austria

Michael Hogan National University of Ireland, Galway, Ireland

Christos Kouroupetroglou Ultra4, Thessaloniki, Greece

Thomas J. Lampoltshammer Department for E-Governance and Administration, Danube University Krems, Krems, Austria

Delfina Malandrino Dipartimento di Informatica, Università degli Studi di Salerno, Salerno, Italy

University of Salerno, Fisciano (Salerno), Italy

Albert Meijer Utrecht School of Governance, Utrecht, The Netherlands

Utrecht University, School of Governance, Utrecht, The Netherlands

Morten Meyerhoff Nielsen Tallinn University of Technology, Ragnar Nurkse Department of Innovation and Governance, Akadeemia tee, Tallinn, Estonia

Jeremy Millard Danish Technological Institute, Taastrup, Denmark

Adegboyega Ojo Insight Centre for Data Analytics, National University of Ireland Galway, Lower Dangan, Galway, Ireland

Elena Palmisano Comune di Prato, Prato, Italy

Mirjam Pardijs Wise & Munro Learning Res, Den Haag, The Netherlands

Peter Parycek Department for E-Governance and Administration, Danube University Krems, Krems, Austria

Lukasz Porwol Insight Centre for Data Analytics, National University of Ireland, Galway, Ireland

Erna Ruijer Utrecht School of Governance, Utrecht, The Netherlands

Utrecht University, School of Governance, Utrecht, The Netherlands

Matteo Satta Issy-Média and Ville d'Issy-les-Moulineaux, Issey-les-Moulineaux, France

Vittorio Scarano Dipartimento di Informatica, Università degli Studi di Salerno, Salerno, Italy

University of Salerno, Fisciano (Salerno), Italy

Teresa Scassa University of Ottawa, Faculty of Law, Ottawa, ON, Canada

Judith Schossböck Department for E-Governance and Administration, Danube University Krems, Krems, Austria

Sander Smit BM-Change, Eindhoven, The Netherlands

Peter Winstanley Semantechs Consulting Limited, Glasgow, UK

Fatemeh Ahmadi Zeleti INSIGHT Centre for Data Analytics @NUI Galway, Insight Centre, IDA Business Park, Lower Dangan, Galway, Ireland

Editors' Biography

Adegboyega Ojo is senior research fellow and head of the e-Government Unit at Insight Centre for Data Analytics, National University of Ireland, Galway (NUIG). His expertise is in the areas of open data strategies and infrastructures, data-intensive public services, e-government services, e-participation infrastructure and governance of smart cities. He is currently principal investigator on a number of EU Horizon 2020 projects in the area of open data platforms and co-creation of data-driven public services. He has served as expert advisor to different UN organisations such as the e-Government Branch of the United Nations Department of Economic and Social Affairs/Division for Public Administration and Development Management on the use of open and big data for integrating Sustainable Development Goals (SDG2030). Adegboyega also led the development of technical paper for the Open Government Partnership on how to benchmark initiatives from participating countries. While at the United Nations University as research fellow and academic programme officer at the Centre for Electronic Governance in Macao SAR, Adegboyega led the development of National e-Government and IT Strategies for countries in Asia and Africa. He has served as programme and track chair and programme committee member in well over 70 international conference editions in the domains of e-government, smart cities and formal software engineering. He currently serves as editorial board member for Elsevier's *Government Information Quarterly* journal and *International Journal of Public Administration in the Digital Age*. He was elected secretary of the Digital Government Society (DGS) in December 2016. Adegboyega obtained his doctorate in computer science from the University of Lagos, Nigeria, in 1998.

Jeremy Millard director of the non-profit consultancy Third Millennium Governance, senior research fellow at Brunel University (London) and senior policy advisor at Danish Technological Institute, has 40 years[1] global experience working with governments, development agencies and private and civil sectors in all parts of the world. In the last 20 years, he has focused on how new technical and organisational innovations transform the government and the public sector. Recent assignments for the European Commission include studies on administrative burden reduction and on developing business models for ICT and ageing. He also recently led an impact assessment of the European e-Government Action Plan and a large-scale Europe-wide survey and analysis of participation and developed the e-Government 2020 Vision Study on Future Directions of Public Service Delivery. He has worked on the European e-Government annual benchmark since 2009 and has assisted the EC in planning their research programme for ICT for governance and policy modelling between 2008 and 2012 and then in designing inputs to the Horizon 2020 research work programme (2014–2015) on ICT-enabled public sector innovation. He is currently leading the EC[1] Advisory Group providing inputs to the Horizon 2020 work programme for 2016–2017, including public governance and new economic models, and is a member of the EC[1] Digital Entrepreneurship Forum. Jeremy has also worked since 2008 as an expert for the UN on their successive global e-government development surveys and has undertaken work adapted from the UN approach in Oman, Georgia, China and Russia. He also provided inputs to the UN[1] debate on the post-2015 development agenda in relation to governance issues and how these can be measured and to the World Bank on digital public sector services. He recently led the assignment for ReSPA on the Western Balkans Comparative e-Government Study, as well as a survey for the OECD on back-office developments in support of user-centred e-government strategies. In the Gulf, he assists Oman develop their e-government services, prepared an e-government strategy for the six nations of the Gulf Cooperation Council and has supported the development of the Bahraini e-government strategy. Currently, he is undertaking a study for ESCWA on integrated service delivery across the Arab Region. He also provides e-government support services in India, Malaysia and Brunei.

European Strategies for e-Governance to 2020 and Beyond

Jeremy Millard

Abstract This chapter examines both academic and grey literature on the transitions and developments in e-government towards notions of open government and open governance. This is viewed through the prism of European level strategies, the EU's research and innovation programmes, as well as common strategies like the European E-Government Action Plan agreed to by all EU Member States. The three strands of the proposed European open governance setting, consisting of open data, open service and open process, are examined, as is the conceptualization of government as an open source service platform as well as a broader platform for collaboration between all societal actors. The purpose is to support societal-wide innovation for tackling pressing societal challenges where the role of ICT is seen more broadly than has traditionally been the case, i.e. as a general purpose technology. In this context, the chapter also examines emerging technologies likely to impact government in the short as well as longer-term, such as big data, artificial intelligence, drones and blockchain.

Introduction and Context

From Electronic Government to Open Government: Responding to Market Changes

This chapter derives from both the academic and grey literature of e-government and similar developments by examining the main conceptual paradigms which have had real impact on how Information and Communication Technology (ICT) is used by, and impacts, government over the last 20 years in Europe. Drawing on a review by Millard (2015), the notion of electronic (e)-government, starting in the late 1990s, was explicitly linked to the 'New Public Management' philosophy which emphasised *inter alia* how ICT could make the public sector much more efficient by adopting private sector management disciplines which had already shown how to

J. Millard (✉)
Danish Technological Institute, Taastrup, Denmark
e-mail: Jeremy.millard@3mg.org

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_1

maximise efficiency (Hood 1991).[1] This typically meant focusing on measurement, target setting and the outsourcing of some government functions to the private sector which was deemed to be more efficient in fulfilling them. In the 2000s, critics of this approach included Dunleavy and Margetts (2006) as well as Stoker (2006) in his proposals for Public Value Management[2] which linked the changes seen or required in the public sector to networked government and the need for open systems to ensure that ICT was not only used to improve efficiency but also the effectiveness and reach of public services.

Other literature extended and nuanced these debates, notably work on the role of strategic management in government (Moore 1995) and on the embeddedness of public sector innovation in the politico-administrative system (Niehaves 2007). A focus on public value in the context of ICT enabled public sector reforms started to emerge (for example as crystalised by Cordella and Bonina 2012), and was seen as contributing to making government processes, not only more efficient and effective but also more transparent and accountable through transformational (t)-government and business process reengineering (Weerakkody and Dhillon 2008; Van Veenstra and Janssen 2012). Since the financial crisis of 2007–2008, the focus has shifted again towards lean (l)-government, doing "more for less" and platform-based governance which is seen as a new wave emphaising the orchestration role of government where innovation, experimentation and user requirements are key factors (Janssen and Estevez 2013).

In the last few years there has also been a new attempt to bring these threads together through the lens of open (o)-government. For example, McDermott (2012) looked at President Obama's 'Open Government Directive' in early 2009[3] and the launch of the global Open Government Partnership[4] aimed to establish a system of transparency, public participation and collaboration, whilst Lee and Kwak (2012) proposed a five-level open government maturity model for social media-based public engagement in response to Obama's directive. Harrison et al. (2012) examined the concept of open government from an ecosystem perspective as interdependent social systems of actors, organisations, material infrastructures and symbolic resources, and suggested that policy makers need to engage in such strategic ecosystem thinking. More recently, Gascó-Hernández (2014) edited a wide-ranging collection of papers on open government and the opportunities and challenges for

[1] The terms 'public sector' and 'government' are in practice used interchangeably in this paper as in many others. The term 'governance' refers to public governance as "the role of governments, working alongside other actors, in building, facilitating and overseeing political, social and economic development. Irrespective of any intrinsic value it might have, public governance is therefore a crucial means to desired development outcomes." (Bevir 2013)

[2] There are many established definitions of 'public value', for example "public value refers to the value created by government through services, laws, regulation and other actions" (Kelly et al. 2002). For the present purpose it can be also thought of as similar to the older notions of 'public goods' and 'good governance'.

[3] https://www.whitehouse.gov/the_press_office/TransparencyandOpenGovernment/ (accessed 10 May 2015).

[4] http://www.opengovpartnership.org (accessed 10 May 2015).

public governance. These included papers proposing open government models, their contextual and cultural underpinnings, the development and dynamics of open data and big data for public governance, open government collaboration, and how open government is developing in different countries and in smart cities. Millard (2015) attempted to summarise and bring many of these strands together through an overarching concept of open governance systems – see also below.

In a nutshell, it might be argued that these successive developments reflect changing perceptions and uses of ICT by government. Whereas e-government simply took ICT, largely from the private sector, into an existing system making it more efficient but without much change to its structures and *modus operandi*, the subsequent notion of t-government stressed how ICT could be used alongside other drivers to transform these characteristics of government so that it became not only more efficient but also more effective. In turn, l-government has been a dramatic response to the financial and economic crisis in the aftermath of 2007–2008, whilst today o-government is starting to form a cohesive conceptual framework, body of evidence and policy programme to return the attention of government to the burgeoning long-term global challenges the world is facing in close collaboration with non-public actors. Indeed, some of these challenges have resulted directly from the financial crisis itself and many governments' immediate response to it.

From Open Government to Open Governance: Responding to Global Challenges

Some clear conclusions emerge from the development of o-government. The operations of the public sector, public policy and public services are seen as needing to become more open and innovative as well as efficient and effective. Indeed it is argued in this chapter that these attributes are complementary, especially if seen over the medium to longer term, but also that the public sector cannot successfully tackle the global challenges on its own. The chapter goes further and argues that an understanding of open government within an open governance system cannot simply look at what is taking place inside the public sector, but must also examine wider developments in society and the manner in which other societal actors are changing their roles and ways of operating. Government, as an actor, needs to collaborate, and a powerful tool in this context is ICT. This is the basic message of this chapter which examines a new approach to public sector innovation based around the notion of 'open governance systems', and which attempts to unpick its main components as we can presently see them (Millard 2013, 2015).

The global financial crisis of 2007–2008 tended to mask the fact that there are longer term and deeper rooted global societal challenges which preceded it, many of which have since become even more acute. These include climate change, increasing inequalities within countries, poverty, corruption, energy and job shortages, health and education under pressure, rapidly changing demographics (ageing, migration, urbanisation), and governance deficits at all levels. As a result public services are under severe strain and trust is being lost in governments' ability to collect taxes and provide good regulation. Indeed, Klein (2014) argues that the financial crisis was both caused by underlying societal system failures alongside these other global challenges but that it is also itself a cause of exacerbating them. Many of the proposed solutions to these challenges are today being influenced by new bottom-up forms of open innovation and new open business models (Chesbrough 2003). They focus on societal goals and societal as well as technological means in which new actors directly participate, especially the direct beneficiaries of such innovations themselves. In Europe as elsewhere, these new trends are today often termed 'social innovation' defined "as new approaches to addressing social needs. They are social in their means and in their ends. They engage and mobilise the beneficiaries and help to transform social relations by improving beneficiaries' access to power and resources." (Tepsie 2014). Critical to such approaches is the need for innovations to actually meet real social needs and to do so in a way that involves the whole value chain, and specifically the beneficiaries of the innovation. This provides both challenges and opportunities for the public sector in its traditional role in addressing societal needs, as well as how it relates to other societal actors in meeting these. It is this issue that this chapter addresses, and in particular looks at the critical role played by ICT.

The Need for a Societal Level Perspective and a New Open Governance Framework

As sketched above, the discourse and most literature to date have focused on responses to the crisis which envisage the public sector, enabled and perhaps driven by ICT, as becoming transformed, for example through business process reengineering, as well as shrinking in size and becoming 'lean' in order to "do more with less". As also noted, these trends are well documented by Janssen and Estevez (2013). The present chapter argues that the next step, and certainly a complementary perspective, is a notion of open government which is itself embedded in broader open governance systems encompassing all of society's actors. In this context, the public sector needs to adapt its roles and relationships with these others actors. But, according to Millard (2015) these adaptations do not insist that the public sector necessarily reduces in size or becomes 'lean', although indeed that may happen in some manifestations of the open governance system. Downsizing the public sector is not a given nor is it always efficacious, but where it happens it is a politico-economic response to specific situations and may not always be relevant, although of course it can be so. Assuming that a smaller leaner government is always the answer to every challenge or context is a very fundamentalist approach.

The open governance system, just as in lean government, orchestrates networks of actors to tackle society's needs, but unlike in lean government, the public sector does not thereby always need to become smaller. Instead it leverages and coordinates unrealised and untapped assets and resources which otherwise lie dormant or need catalysing and are thus in effect 'wasted'. The public sector does this both internally and across society, so it may need to remain the same size or in some instances even grow larger depending on the context and the challenge. The public sector might flexibly decrease or increase or otherwise transform in size, influence and role in different sectors and localities at different times for different purposes in a constant 'dance' with other actors to maximise public as well as private value across the whole of society. Becoming a lean government is just one option along this continuum, even though the driving features of lean as efficiency and productivity always remain important. Instead, such features need to be seen as interlinked between actors across the whole of society and not just confined to the government. Thus, efficiencies and productivity improvements are conceptualised at the societal level over at least the medium-term where trade-offs and interactions are present between actors, not only at the individual actor level.

According to Millard (2015), this is a very important observation. A lean government might indeed save some money in a narrow context over the short-term, but this could lead to overall loss of public value and thus additional costs on society, especially in the longer term, if other actors or actor configurations are not able to produce the value needed in the context of a shrunken public sector. Examples include environmental degradation, social and economic inequalities and in mainstream services like health, care and education, and these would be false economies indeed.[5] As shown below, such a flexible response to address the global challenges is now possible in the context of ICT, although of course political, governance and other issues are also critical. This is not an argument against lean government which may often be relevant, but an argument for flexibility in the context of open governance systems made possible for the first time by ICT.

The current, but admittedly still tentative, move from 'l-government' to 'o-government' is illustrated in Fig. 1, whilst emphasising that the four waves are not mutually exclusive but instead complementary even though a clear progression is envisaged. Open government (o-government) is the *sine qua non* for ICT-enabled public sector innovation which is today one of the main policy agendas in Europe and elsewhere (for example European Commission 2013a and 2013b, deriving from European Commission 2010, and European Commission 2016, as well as the OECD[6]).

---

[5] A recent example is the Danish tax system which has for many years been driven by an NPM approach leading to downsizing, outsourcing and seeing hastily developed IT systems as a panacea. In 2016, it became clear that this has strongly contributed to losses amounting to billions of Euros of tax revenue, both internationally and domestically. In August 2016, the tax minister announced a reversal of these policies with massive re-investment in the tax system, the re-employment of dismissed tax personnel, and employment of thousands of new personnel, and in much better IT. This is a clear example where political decisions leading to cutting and blind over-optimistic faith in untested IT can lead to massive inefficiencies and losses.

[6] See the OECD's Observatory of Public Sector Innovation: https://www.oecd.org/governance/observatory-public-sector-innovation/events/

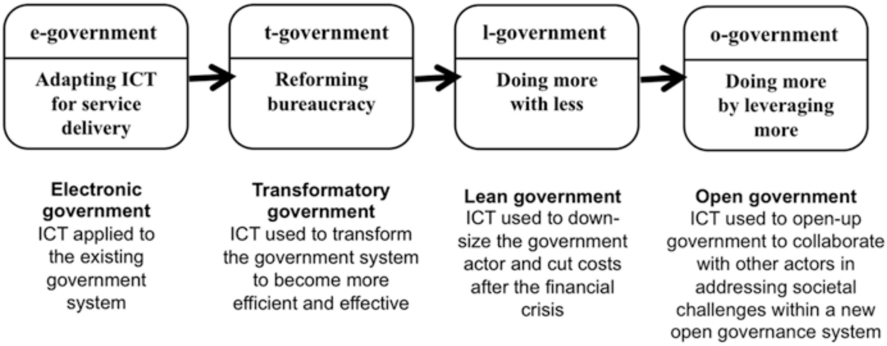


Fig. 1 Four waves of e-government evolution (Source: Millard (2015), adapted from Janssen and Estevez (2013))

Open government (o-government) is the *sine qua non* for ICT-enabled public sector innovation which is today one of the main policy agendas in Europe and elsewhere (for example European Commission 2013a and 2013b, deriving from European Commission 2010, and European Commission 2016, as well as the OECD[7]).

European Policy and Research

Although in a European Union context, the 28 Member States have full powers over their own policies and strategies for the public sector and electronic government, they have for many years participated in different types of mutually beneficial collaboration around the latter in particular. Since the early 2000s, one of the main frameworks for this has been the regular five-yearly eGovernment Action Plans, which, by the end of the eGovernment Action Plan 2011–2015, have assisted Member States in putting many eGovernment enablers in place, both technical and non-technical.

The rationale for the new 2016–2020 European eGovernment Action Plan (European Commission 2016) is to promote efficient and effective digital public services as important components of the EU's Digital Single Market,[8] and which together enable cross-border public services. To achieve this, the underlying vision is threefold:

- By 2020, public administrations and public institutions in the European Union should be open, efficient and inclusive, providing borderless, personalised, user-friendly, end-to-end digital public services to all citizens and businesses in the EU.

[7] See the OECD's Observatory of Public Sector Innovation: https://www.oecd.org/governance/observatory-public-sector-innovation/events/

[8] http://ec.europa.eu/priorities/digital-single-market_en

- Innovative approaches should be used to design and deliver better services in line with the needs and demands of citizens and businesses.
- Public administrations should use the opportunities offered by the new digital environment to facilitate their interactions with stakeholders.

The 2016–2020 Action Plan further stipulates that the following underlying principles should be observed:

- Digital by default
- Once only principle
- Administrative burden reduction
- Inclusiveness and accessibility
- Openness and transparency
- Cross-border by default
- Interoperability by default
- Trustworthiness and Security

The policy framework for the Action Plan rests on the goal of opening up the public sector between public administrations, across Member States and between public administrations and other stakeholders. Three policy priorities make up the framework of pillars:

- Pillar 1: Modernising public administration with ICT, using key digital enablers
- Pillar 2: Enabling cross-border mobility with interoperable digital public services
- Pillar 3: Facilitating digital interaction between administrations and citizens/businesses for high-quality public services, for example which are modular for re-use, user-friendly and personalised, as well as for better policies based on opening up.

The 2016–2020 Action Plan contains some new features compared with previous plans.[9] In order to remain relevant, up-to-date and to reflect as closely as possible an evolving Europe, flexibility is being built-in to accommodate adjustments over the next 5 years. The Action Plan is thus seen as a platform and catalyst where new ideas, both for actions in the Action Plan itself as well as elsewhere, can be proposed by Member States or other actors. A monitoring framework is being introduced to track progress both on individual actions as well as overall using an appropriate mix of indicators. In support of the dynamic nature of the Action Plan, a stakeholder engagement plan is also being put in place, one aim of which is to engage citizen and business interest groups through visits by the European Commission to Member States. It relies on the use of multipliers, for example the support of other Directorates General through inter-service collaboration and the Regional and Structural Funds.

[9] Parts of this text are derived from the author's participation in an Expert Consultation Workshop on eGovernment in the Horizon 2020 Work Programme for 2018–2020, held on 27 April 2016 in Brussels.

To back-up the eGovernment Action Plan, research and innovation funding provides complementary support designed to involve a wide range of actors from the public, private and civil sectors, as well as from academia. The main vehicle for this is the Horizon 2020 Research and Innovation Programme, 2014–2020,[10] with a rolling schedule of work programmes, which up to 2017 have been designed around the conceptualisation of an 'open governance framework', as illustrated in Fig. 2. This is made up of three components which are open by default, i.e. open data, open service and open process, at the confluence of which is 'joined-up government'. The focus of the Public Services Unit in the European Commission, which supports these activities, is on modelling the public administration in the context of the impact of ICT and other emerging technologies. The unit does not itself develop new technology but has a strong interest in emerging technologies including those developed in other areas that can be used in the public sector.

New European Strategies for 2020 and Beyond

In a European context, on-going strategies to 2020 and beyond require continuing focus and effort on back-office arrangements and on enablers in order to meet and support on-going European and national policies. However, these should be seen as a means to the ends of societal impact and the overall European strategic goals, so there is need to shift emphasis more towards digital services, front-office arrangements and impacts on society, in order to meet the goals of the Europe 2020 Strategy (European Commission 2010) in tackling its major societal challenges. The innovative use of ICT, and particularly the emerging technologies underpinned by ICT, constitute important game changers in addressing these challenges. Indeed this is inherent in the 'open governance framework' depicted in Fig. 2 which continues to be the overarching conceptual and operational approach of European policy, but re-orientated to take account of new challenges, perspectives and technologies to 2020 and beyond.

Taking account of this, three areas and strands of development are proposed by the European Commission.[11] First, the further development of the open governance setting; second, the concept of government as a platform deriving from this; and third in this context, the potential transformational implications of new and emerging technologies.

[10] https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020

[11] Expert Consultation Workshop on eGovernment in the Horizon 2020 Work Programme for 2018–2020, held on 27 April 2016 in Brussels.

Open Governance Setting

As depicted in Fig. 2, the open government setting examines open data, open service and open process, within an overarching open governance framework, where each of these three components is open by default. It recognises that, given that government cannot address societal problems on its own, it needs to collaborate openly, transparently and participatively using ICT, both within and across the public sector and with all legitimate external actors. We need greater understanding of how shared services (across government and with non-government actors) can be developed through co-creation, and rolled out in order to improve take-up, personalisation and impact. Standards are required for this, open by default, not only in technical terms such as semantic interoperability, but also to support quality of service standards to ensure universality and cross-border applicability where appropriate, for example through procurement, planning and decision-making. It is not immediately clear how these objectives can be achieved and what specific roles the government should play as compared to the other actors, particularly in the digital context. How to ensure that privacy and security issues are adequately taken into account also needs careful consideration.

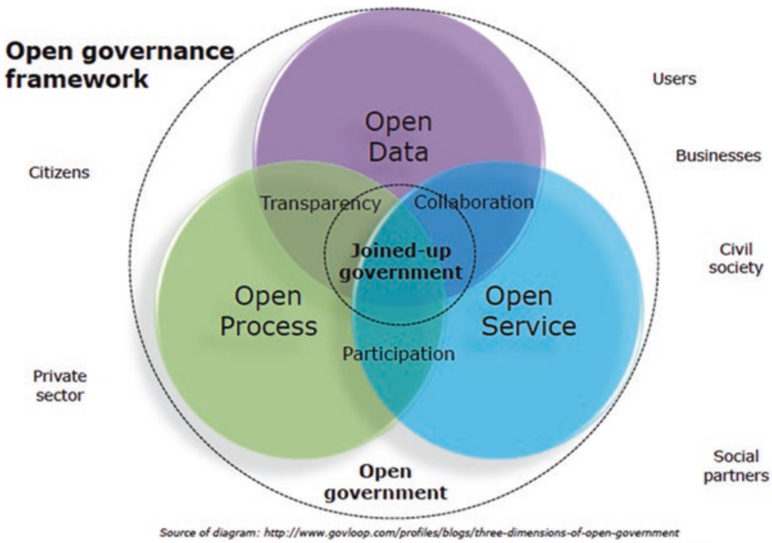


Fig. 2 Open governance framework ("Open, Innovative and Collaborative Government: towards a new action plan", 1 July 2015: https://joinup.ec.europa.eu/sites/default/files/open_and_collaborative_government.pdf)

Open Data

Open data is seen as essential for facilitating collaboration, co-creation and policy making, but the barrier is that for many users this is a blackbox requiring new capacities, skills and incentives, so government needs to provide much more support and many more incentives. Some countries are starting to make much of their data available publically as so-called open government data (OGD). To date there is still only a limited number of governments which have substantially embarked down this path, and even fewer local and regional governments where the benefits are likely to be greater. In order to maximise the benefits of OGD, it normally needs to be suitably aggregated so individual persons or organisations cannot be identified, and to make this available in machine readable linked datasets which can also be searched, analysed and mashed with other data. Standards for data, quality, licensing, structuring, linking, searching, etc., need to be developed as well as standard tool modules for compiling, analysing and visualisation. Appropriate cloud and other systems to provide the underlying infrastructure and services both across government and between different actors are also necessary.

Apart from OGD made available by the public sector, citizens also collectively generate an enormous amount of economically valuable data through interactions with companies and government. Such data is a public sector asset, but the value created does not always go to the benefit of the individual, particularly when third parties (whether governments, businesses or civil organisations) collect and keep it closed. Smart disclosure is a tool that helps provide people with greater access to the information they need to make their own informed choices, for example in health care, education, employment, etc. In comparison, traditional OGD focuses on transparency, accountability and decreasing corruption in government.

The smart disclosure approach is a step on from this and starts from the premise that people, when given access to data and useful decision tools built for example by governments, can use both their own personal data disclosed by them together with other appropriate data. Smart disclosure could be a useful way forward so needs much greater emphasis as it strives to enable the user to mash their own personal and private data together with those of one or more service providers, including commercial services from the private sector. This is starting to be an important feature in both the USA and UK, for example in the utilities sector, such as energy, water and gas, as well as mobile phone usage. In both countries, the government provides an appropriate regulatory framework and works with the service providers (which can be other parts of government) to make it as easy as possible for users to see their own consumption patterns, for example via a personal dashboard, and thereby adjust future consumption. The aim is to assist users in reducing waste or over-use and to take account of often highly complex tariffs and service charges from typically multiple potential providers. Users need as much support and advice as possible, but although most examples are still only pilots, they seem to hold much potential for users to take more control of their service use. In this context, however, there are serious issues around transparency in terms of who is seeing and using whose data and whether or not the data owners can correct it? For example, can technical solutions be developed which incorporate privacy by design?

Open Service

An important strategy should be to focus strongly on accelerating the development of highly personalised services rather than one-size-fits-all common services. The use of alerts, invitations, prompts, as well as typical life events, user profiles and locations, are all steps towards full personalisation. New forms of interaction need to be devised which draw the user into a co-creative and collaborative relationship, for example in specially designed public spaces and hubs, as well as by deploying living labs methods. Personalisation means departing from the average, so it must be accompanied by minimum, but still high, quality standards. Many services also need to be universally available to all in the target group, given that government cannot say no to a legitimate user, unlike a commercial service provider. This may cause problems when services are outsourced to commercial and other non-public providers, so marketization and who pays also become issues (Millard 2011).

The challenges of open service are however immense, technically, organisationally and legally. For example, shared services will only fully work with semantic interoperability across silos, between levels, cross-border and between service providers whether or not from the public sector. What is the extent to which state-of-the-art solutions from elsewhere should be used, how much should be developed and tailored in-house (which can be much more expensive), and how can governments at the same time prepare for the impact of emerging technologies? As with open data, there is also a demand-side weakness challenging open services with their generally low or weak take-up, so again incentives, user-friendliness and high impact need to be prioritised.

Another main driver of open service is the incorporation of behavioural approaches and design thinking into creating, delivering and using both traditional and e-services by using a holistic approach that attempts to understand the 'full architecture of a problem' from end-to-end. It is an evolving and experiential practice pushing the boundaries, learning, experimenting and applying successful approaches as it develops. A number of practitioners see design thinking as a paradigm shift away from traditional top-down, expert- and often technology-driven service design traditions. Instead it deploys a growing repertoire of techniques, including those borrowed from the ethnographic and anthropological traditions, observation, contextual dialogue and creative ideation processes (Bason 2010). Related to these developments is the so-called 'nudge' approach which recognises that, although traditional attempts to change behaviour by regulation are of course important, they just as often fail and may even provoke opposite responses (Thaler and Sunstein 2008). Nudge theory focuses on changing peoples' behaviour without binding regulation or legislation, for example using the insight that a very powerful influence on an individual's behaviour is linking this to what other people are doing through social networks and social norms in behavior patterns.

Open Process

Open process is an important component of the open governance framework in which all legitimate actors are able to participate in the policies, decisions and arrangements of the public sector as long as this participation is itself open and enhances public value. Open process goes much further than traditional e-participation of enhancing the democratic process using ICT, but although this is a very important element, on its own it is a restrictive view of involving people in government. Experiments in e-participation have so far provided mixed and mainly disappointing results overall given original expectations. This has tended to lead to reduced interest in e-participation at the very time that technology advances in areas like social media and mobile have started to overcome the obstacles which enable a much wider vision of open process. Apart from e-participation in public decision making, it can increasingly encompass inputs to the processes, workings and arrangements of the public sector and public governance more widely; planning and development issues (for example through participative budgeting and where scarce resources are allocated); dispute and conflict resolution; and in managing societal assets, including data, land and buildings.

Given that open process, especially as enabled by ICT, is a relatively new concept, a good approach for the public sector is to undertake many small experiments with existing tools. This is likely to be much more successful than focusing on a small number of 'big-bang' initiatives which experience shows are prone to high failure rates leading to a waste of resources and reduced motivation. A bottom-up, user-driven engagement process is more likely to succeed which takes account of the drivers and incentives for citizens to engage in open process. At present, as with open data and open service, there is a demand side deficit that needs to be addressed by incentives, simplification and personalisation. There are also issues of the sustainability and adaptability of open processes and economies of scale and scope to ensure that it is efficient as well as effective. Involving all citizens in determining public spending, for example through participatory budgeting, is often a useful approach.

Another main driver of open service is the incorporation of behavioural approaches and design thinking into creating, delivering and using both traditional and e-services, as a holistic approach that attempts to understand the 'full architecture of a problem' from end-to-end. It is an evolving and experiential practice pushing the boundaries, learning, experimenting and applying successful approaches as it develops. A number of practitioners see design thinking as a paradigm shift away from traditional top-down, expert- and often technology-driven service design traditions, and instead deploying a growing repertoire of techniques is evolving and being applied in practice, including those borrowed from the ethnographic and anthropological traditions, observation, contextual dialogue and creative ideation processes (Bason, 2010). Related to these developments is the so-called 'nudge' approach which recognises that, although traditional attempts to change behaviour by regulation are of course important, they just as often fail and may even provoke opposite responses (Thaler and Sunstein 2008). Nudge theory focuses on changing peoples' behaviour without binding regulation or legislation, for example using the insight that a very powerful influence on an individual's behaviour is linking this to what other people are doing through social networks and social norms in behavior patterns.

Government as a Platform

Conceiving of government as a platform arises directly out of the open governance approach. In one manifestation, this might be an open source service platform in the cloud providing government services, data and enablers as building blocks which promise significant increases in both efficiency and effectiveness. There is a need to examine both digital and non-digital platforms, as well as their inter-relationships, to support the creation of public value through co-creation with other actors, so better understanding is needed as to how government can adapt its roles as facilitator and orchestrator, to provide appropriate tools and supports including big open and linked data, to better manage assets, and to ensure sustainability and balanced public value. Experience has shown that it is often at city level that governments are successfully experimenting with these new roles especially enabled by ICT, so better understanding is required of how such practices can become more widespread at a variety of governance levels and across different national, political and cultural contexts.

Government as a platform can support a range of actors to collaborate with each other, as well as with government itself, to generate public value. Using ICT, citizens, communities, civil groups, as well as businesses, are no longer simply passive consumers of data and knowledge but increasingly become active producers. For example, citizens share more and more with each other on social media platforms and tend to consult other citizens, rather than the government for advice – they increasingly use the 'social signal' and 'social search' to organise and improve their lives. A similar trend is now also being seen in the physical world, where the rapidly growing 'makers movement' sees people exchanging, adapting and personalising digital designs for the fabrication of physical objects, often as unique bespoke products for highly specialised purposes, using 3D–printers and related equipment (Anderson 2012). Government thus needs to recognise the value of collaboration and crowdsourcing which citizens and others can contribute as 'co-creators'. Although government should mobilise its own resources and talent better, there is always more relevant talent outside any organisation (including government) than inside.

The public sector as a platform facilitating public value creation in the most efficient and effective way possible will support an ecosystem of actors with changing roles and relationships. There are already numerous examples, including where other actors have 'usurped' the erstwhile role of government using ICT. For example, noise measurement around Amsterdam Airport in the Netherlands undertaken by residents in the flight path[12]; Microsoft's 'health vault' storing citizens' health records in the cloud[13]; 'Fix-My-Street' in the UK developed by the civil society organisation MySociety not by government[14]; and the website 'Patients know best' which is a service provided by a social enterprise enabling patients to control their own medical data when negotiating with public health authorities about their treatment.[15] An example from the 'makers' world uses digital technologies to open new perspectives for locally manufactured and very cheap products for people who otherwise have no chance of being helped. For example, in the health sector, using the Internet to send algorithms for 3D printed prosthetic limbs designed for war victims in developing countries for local production and use.[16] These are examples where ordinary citizens, civil organisations and many other actors have seen holes in what government is doing and stepped in without always being invited to do so.

For the 'government as a platform' approach to succeed, Millard (2015) proposes that at least four types of role and relationship changes are needed, and some are already starting to be seen, as outlined below.

Government as Facilitator and Orchestrator

When government sets up collaboration platforms at many levels, its role changes to become coordinator, facilitator and enabler, as well as regulator and arbiter for the activities others undertake in delivering public value. Government's role is to ensure that public value is created by the most appropriate means in terms of what works best in a given context and for given needs. As described earlier, this could involve government having either a minor or major role in creating public value, but even in the latter case government needs to be a facilitator and orchestrator to ensure that it does.

Government as Provider of Tools, Guidance and Incentives for Co-creation

The second new role for government is to provide tools, guidance and incentives for collaboration. Although, the bottom-up, participatory co-creation of services can lead to more effective and personalised experiences, doing so can increase the burden placed on citizens and other actors to participate. The adoption of e-government

[12] http://www.sensornet.nl/english

[13] https://www.healthvault.com

[14] https://www.fixmystreet.com

[15] https://www.patientsknowbest.com

[16] http://3dprintingindustry.com/2014/12/08/3d-life-print-3d-printing-prosthetics/

services often results in government outsourcing some of the work it has previously done itself to the user. Co-created, or even fully user created, services take this step much further. Developing more cost-effective and efficient public services should mean more than assuming citizens will contribute time and other resources to create their own services. To counter this, governments should provide structured guidance within which service co-creation with service users can take place. 'Guided' support for co-creation should also be designed to reduce the burden on service users of participating in this way, whilst optimising benefits for both public administrations and citizens. In addition, governments should provide incentives by highlighting the benefits service users can derive from the co-creation process, giving them more power to make decisions about their services in adapting them to their own needs, and supporting them with relevant data and other resources.

Government as Manager of Societal Assets

Third, government has an increasing role in managing the assets society has. Especially in the context of Europe's pressing global challenges, there is a need to identify and deploy all society's available assets and resources but which are often under-used or not at all. These available assets, including government's own, for example, could encompass people's time and expertise, finance, organisational structures and competences, data, knowledge, content, networks, capacity, infrastructures, service building blocks, things, places, buildings, spaces, vehicles, etc. The role of government in using the power of ICT, particularly in collaboration with other actors, is to identify, match, orchestrate, broker and coordinate assets which can be shared and converted into public value impacts, instead of, if unused, going to waste. Already many non-government actors are launching typically bottom-up and small scale examples of ICT-based platforms that have such a role, for example as part of the so-called sharing and collaborative economies, such as for example the civil society organisation *Shareable* based in the USA[17] (Gansky 2010). Government has in many cases, however, greater power and scope to do this by linking between actors as well as sharing its own assets internally, and this is both a growing challenge as well as a huge opportunity. This would involve widening the scope of ICT-based content management systems to become asset management systems.

[17] www.shareable.net

Government as Guarantor of Public Value over the Longer Term

Fourth, as outlined above, seeing the public sector as a platform ensures that public value is appropriately created and deployed. It is important to recognise, however, that even when government collaborates with other actors in producing public value, this does not necessarily imply that government becomes just one actor amongst many, given that it still needs to fulfil roles that other actors normally cannot. Such roles include being responsible for overall quality standards and mechanisms for asset sharing, quality and legal frameworks, even in situations when these are formally delegated to other actors. Accountability for services and performance, and responsibility especially if things go wrong, is a critical issue. Other such roles include data protection and security.

It is important to recognise that innovation and change in the public sector is not the same as in the private sector. Government cannot pick and choose its customers and government services cannot afford to 'fail' in the same way as in the private sector. Because government is the only institution democratically accountable to society as a whole, only it can ensure sustainable and balanced public value where all parts of society derive benefit and where trade-offs are seen as proportionate and fair. This shows how the overall sustainability of the governance system is important. Governments provide longer term stability and continuity which other actors are not able to do, and this is needed so that people and communities are able to live stable lives, as well as so the market can have confidence that unpredictable governance changes will not upset their investment and innovation strategies. Governance systems with short-term horizons encourage short-termism in business and an unstable society. Instead of always the sole actor, the public sector is becoming one player amongst many, albeit with unique responsibilities in new forms of open and collaborative governance.

The Role of the Citizen and the Reconfiguration of Transparency, Participation and Collaboration

As described and exemplified above, open governance gives critical roles to the whole range of non-government actors, and especially citizens. At the same time that government is changing and needs to change much more, citizens are also increasing their awareness and leverage on government but it is not yet clear whether their future partnership with government will be a positive one. Although they need strong support from a pro-active government as examined above, citizens should be ready take more responsibility and become more constructively critical and productive in their own right, but this is in many ways the biggest challenge of all. Members of the upcoming 'net generation' are already acting in this way in their private and working lives enabled by digital technology, and are starting to demand that their relationships and dealings with the public sector should take place on the same basis

(Tapscott 2009). The challenge is whether government can and will respond to these demands, and this depends a lot on the adoption of appropriate policies, structures and mindsets, as well as the education and incentives for citizens to support this. Critically, it depends on government changing its roles in the ways described above.

Since President Obama launched the open government movement in early 2009 with his focus on transparency, participation and collaboration, making the USA the first country to explicitly do so, there have been clear developments in how these three pillars are perceived and are playing out in practice, particularly vis à vis citizens. First, transparency has increasingly become the *sine qua non* of the successful development of open governance systems but is also becoming better understood. It is clear that total transparency is not the goal given that citizens, public employees and politicians all have areas of legitimate privacy, the former in terms of the protection of their personal data and the latter two as they need confidential spaces for dialogue and brainstorming as long as decisions themselves, as well as the evidence and rationales for them, are transparent. Limits to transparency also need to be set by legitimate interests, the potential for the misuse of information, slander, disrespect, etc., but the nature of such limits and their definitions need to be clear and open to debate. However, robust transparency is clearly necessary as this is the basis for accountability and for tackling corruption in government as well as in the rest of society (European Commission 2014; OECD 2014).

Second, the understanding of participation in open governance is moving towards a broader notion of engagement in open process. The latter sees citizens and other actors being invited to engage in all legitimate aspects of public sector activities, not just decision making which, in Europe at least, has tended to be the focus of e-participation. In some ways therefore, participation perceived like this only requires a re-active citizen, whilst engagement is more mixed and can—through transparency and accountability—imply that citizens are more pro-active and take into their own hands activities which traditionally have been purely public sector responsibilities.

Third, collaboration is starting to be exemplified through co-creation and innovation, as discussed above, and especially in the context of new forms of open, social and inclusive innovation. The current governance and market systems are becoming extremely good at 'sweating' assets on the supply side, so that both pubic ad private producers become incentivized to squeeze their financial, human and other assets to the maximum extent, and thereby increase their performance and productivity. However, on the demand and consumption side, there is often massive asset waste, resulting from the widespread practice of exclusive asset ownership. This has started to be challenged in the last decade by a new sharing economy growing from a small base, in which organisations, companies and individuals share with each other an increasing range of their assets. These include skills, competences, time, spaces, vehicles, tools, buildings, facilities of all types, organisational capacities and even financial resources. Much of this sharing is enabled by ICT developments like crowdsourcing and crowdfunding.

The sharing economy is starting to supplement exclusive asset ownership with new forms of common, collective and collaborative ownership. The sharing movement started as mainly non-profit activities but is now spreading to the entrepreneurial and profit sector with examples like ZipCar, Uber and Airbnb for renting out shared cars and accommodation space respectively, and which have since grown into global market leaders. In turn, this is threatening incumbent market and public actors, current legal and regulatory systems as well as the frameworks of trust and ethics we wish to maintain and build. In addition to the sharing of existing underused assets, a new important trend is their use for the collaborative creation, innovation and production of new products, services and other assets. This collaborative economy is already underway starting with 'pro-sumers' (individuals who are both producers and consumers) mainly in the digital sector, but is now rapidly expanding into the collaborative innovation of physical goods and services, as discussed above. (See also Rifkin 2014).

An important underpinning of both the sharing and collaboration economy is the trend towards co-creation, originally conceived as a business strategy for identifying new forms of customer engagement, it is being increasingly applied in other environments including in the public sector and by non-profits and citizen groups. Co-creation is understood as the active flow and exchange of ideas, information, components and products across society which allows for a better understanding of, as well as participation, engagement and empowerment in, policy development, creating and improving services and tackling societal challenges. Co-creation encompasses co-innovation, co-configuration, and co-production of products, services and content through modularisation and digitisation, the role of social entrepreneurs in these new processes, and creating platforms for creative organisations, for example around 'standard toolboxes' for niche needs or markets.

Emerging Technologies Likely to Impact Government

As noted earlier in this chapter, government is typically one of the largest single users of ICT and other new technologies, but also is often the most hesitant. There are arguably understandable explanations for this, but it is also clear that, sooner or later, governments will wish or need to avail of new and emerging technologies. This is not least in order to save resources and become more efficient, but also because the demands on governments for new and better services of all types is growing, including from the Internet generation.

However, it is also important to recognise that ICT has become a general purpose technology (Perez 2009) underpinning most if not all technological innovation and development. This means that examining 'digital' government purely in the traditional arrow sense, of back-office and process re-engineering and front-office online services, no longer makes much sense. Many of the main emerging technologies which are having, and are likely to have in the future, significant impacts on the way governments are organised and operated, as well as on how governments are perceived and used, are arising out of the so-called Fourth Industrial Revolution (World Economic Forum 2016): *"The First Industrial Revolution used water and steam* *power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres".*

Many of these emerging technologies have potentially profound implications for the way governance for both the near and longer-term future is configured and experienced, as outlined in the following.

Big Data and the Internet of Things

The value and role of big data, and specifically big open linked data (BOLD), has, as noted above, rapidly become as essential asset for developing and delivering both commercial ad public services, as well as helping to determine and design public policy. For example, for public sector resource planning and real time management based on real time and archived data, for use by the police, hospitals, fire services, the selection of politicians, staff recruitment by algorithm, etc. Big data is increasingly derived, not only from archived information, but from real time sources through the Internet of Things (IoT) as the network of physical objects and devices, vehicles, buildings and other items that are embedded with electronics, software, sensors, and network connectivity enabling them to collect and exchange data and thereby also to interoperate. The IoT can optimise the use of physical objects, constructs and systems, such as buildings, electricity grids and utility systems, ensuring efficient performance and reducing the carbon footprint through environmental monitoring, disaster forecasting and management. IoT can enable the public sector to better control and deploy its assets in real-time, such as vehicle fleets, buildings, supplies and equipment, as well as for example manage and direct traffic flows and other unfolding situations. In addition, geo-enabled service delivery and geo-related information, for example on ownership, activities, functions and history, can be used for tourism, cultural and business development.

Artificial Intelligence

Artificial intelligence (AI) and machine learning is the intelligence exhibited by a machine as a flexible rational agent that perceives its environment and takes action to maximize its chance of success in achieving a specific goal. Big data is typically a major input mediated by advanced algorithms. According to the Work Economic Forum, WEF (2016), AI systems are now able to make many decisions, both routine and complex, which should improve the efficiency and quality of decisions in the public sector, but thereby also threaten middle management and even senior jobs.

For example, Benedikt Frey and Osborne (2013) estimate that 47% of US jobs will be at risk from automation, whilst the WEF (2016) suggest that by 2025, "robots could jeopardise between 40m and 75m jobs worldwide". The WEF also estimates that "65% of children entering school today will end up working in jobs that currently do not exist." There is little doubt that this will dramatically alter the lives of most people employed in the public sector.

Virtual and Augmented Reality

Virtual reality (VR) is a computer technology that uses software-generated realistic images, sounds and other sensations to replicate a real environment or an imaginary setting, and simulates a user's physical presence in this environment to enable the user to interact with it as well as with other people at another location. A person using VR equipment is typically able to "look around" the artificial world, move about in it and interact with features or items that are depicted. Virtual realities artificially create sensory experiences, which can include sight, touch, hearing, and, less commonly, smell. Related to VR is Augmented Reality (AR) whereby people are still acting in the real physical world but augment this by being given access to relevant content of different types so that such action becomes more effective or meaningful. There are huge potential implication for both VR and AR in the public sector, as well as in society more broadly, such as in education, training, meetings, negotiations and remote interventions.

Robotics

Robotics are automating much physical work across all sectors. In the public sector, this includes, for example, routine maintenance, fabricating spare parts or specialised components for machines, as well as accessing difficult and dangerous environments (as in disasters, fires and floods). Robots are also starting to be deployed in human-interface situations, such as in caring and supporting older, disabled or ill people, although such use is proving controversial in some contexts and also raises potential ethical issues. In the public sector context, robotics can thus have immense impacts on care, health, elderly and frail people, cleaning and maintenance, as well as component assembly (including components from digital fabrication).

Drones

Drones are unmanned aerial vehicles (UAVs) utilised to transport packages, food or other goods, as well as to provide real-time surveillance of unfolding situations. They can be used in the public sector to facilitate the delivery or collection of small items, such as post, medical equipment and spare parts. Drones are highly flexible and manoeuvrable vehicles that are indispensable for low-height monitoring of natural disasters and dangerous situations, as well as for example in traffic and security related incidents. Thus, drones have huge potential for postal services, surveillance, climatic and environmental monitoring, the delivery of equipment and supplies, etc.

Digital and Biological Fabrication

Digital fabrication is the use of 3D printers, laser cutters and sinterers and other equipment, to fabricate one-off or small production runs of unique, typically relatively small objects using specifically designed algorithms. A variety of materials is used, including metals, ceramics, plastics, glass, and increasingly organic matter such as food and living tissue. This enables the public sector, for example, to drastically reduce its stock of equipment and components, given that these can be cheaply fabricated only when required to highly precise and individual designs. Applications in the health sector which are already significant include the decentralised fabrication of personalised prosthetic limbs as well as of dental replacements and implants, and in the care sector of customised meals for people in hospitals or care homes who have specific dietary needs. Further, and often more ethically controversial, implications include the development of genetically modified organisms (GMOs), especially in the context of rapidly advancing gene editing techniques such as CRISPR, in sectors such as health, agriculture and food.

Blockchain Technology

Blockchain technology is a relative new, and still largely unknown, concept, particularly in the public sector, given that its main applications to date are in financial technologies, for example as the basis of the ‘Bitcoin’. Blockchains are basically decentralised databases that could be used, for example, for legitimation purposes, registers, participatory decision-making, automatic taxation, social security, counteracting fraud and corruption, fighting crime, etc. The impact of blockchain technology in particular on governance systems could thus be profound and lead to the end of governance as we have known it for millennia to be replaced by, in effect, an autonomous and independent system which everyone can contribute to and benefit from, but which no one controls. There might be immense ‘democratic’ benefits arising from such a scenario, but also dangers inherent in the fact that blockchains are, in effect, an impenetrable black box.[18]

[18] This brief analysis is partially based on the Wikipedia entry for blockchains (accessed 24–4-16) and the Nesta blog of 24–3-16 “Why you should care about blockchains: the non-financial uses of

A blockchain is a distributed database that maintains a continuously growing list of data records hardened against tampering and revision. It consists of data structure blocks holding data exclusively in initial blockchain implementations, as well as both data and programmes in some of the more recent implementations, with each block holding batches of individual transactions and the results of any blockchain actions. Each block contains a timestamp and information linking it to a previous block. The blockchain is seen as the main technical innovation of Bitcoin, where it serves as the public ledger of all Bitcoin transactions. Bitcoin is peer-to-peer, so every user is allowed to connect to the network, send new transactions to it, verify transactions, and create new blocks, which is why it is called ‘permissionless’. This original design has been the inspiration for other cryptocurrencies and distributed databases.

In essence, therefore, blockchain technology can be seen as a programmable distributed trust infrastructure. Transactions are the content which is stored in the blockchain. Blocks timestamp, record and confirm when and in what sequence transactions enter and are logged. Blocks are created by users known as ‘miners’ who use specialized software or equipment designed specifically to create blocks. Every user in the decentralised system has a copy of the complete blockchain. This avoids the need to have a centralised database managed or controlled by any party. Thus, blockchains can be summarised as distributed databases but they exhibit new and significant properties, including:

- Autonomous: no one person, group or organisation is in charge
- Permanent: no one can delete or tamper with the data
- Secure and cryptographically auditable: security has never been broken and it is claimed that it is mathematically certain that entries cannot be forged. This property signals a shift in thinking about security from one based on closed systems to one based on security through transparency.
- Open: anyone can develop services and products on blockchains, control their own data and audit the code.
- Whole and complete, i.e. blockchains cannot be fragmented or divided up: fragmentation is open to fraud.
- Trustworthy: the above properties and the fact that blockchains are open source means they are also ‘trustless’, i.e. not reliant on any human agency but instead on the consensus of the whole network.

In terms of applications, apart from financial such as in Bitcoin, blockchain technology can enable both the Internet of Things and supply chains to function efficiently, effectively and securely, as well as ensure highly secure identity. In the public sector and governance context, blockchains could, for example, protect critical infrastructures, register and protect assets (such as intellectual property, health, pension and other data), tackle tax and benefit fraud, and ensure that public spending is transparent and traceable.

blockchain technology” related to public (permissionless) blockchain: http://www.nesta.org.uk/blog/why-you-should-care-about-blockchains-non-financial-uses-blockchain-technology

Conclusion and Reflection

Moving from electronic government to a broader vision of open governance, in which the government is also perceived as a platform for the wider innovation and support of society as a whole and in tackling pressing societal challenges and where the role of ICT is seen more broadly than has traditionally been the case as a general purpose technology, is likely to characterise much European strategy to 2020 and beyond. This vision of open collaborative governance enabled by ICT refers to the ability of the public sector, as appropriate to its mandate and resources, to become more innovative and responsive to society's needs in the way it operates. It encompasses open data, open service and open process. It involves breaking down, or at least cooperation between, silos across different administrations, levels and locations, through sharing infrastructures, processes, data, assets, resources, content and tools. It implies forms of federation and coordination which balance centralisation and decentralisation as well as top-down and bottom-up approaches. This involves huge challenges technically, politically, legally, organisationally and in terms of working cultures. The vision is a 'whole-of-government' approach in which the public sector acts as one entity, especially in its interactions with other actors including citizens and businesses.

In changing and adapting the roles of government and other actors in these ways, however, there are also real concerns that such changes will result in new types of risk, for example related to loss of control and blurred accountability of services (by whom to whom?). Quality standards are more difficult to determine and maintain with many active designers and suppliers of services, and not least new digital divides as the already better endowed and more competent segments of society are able to reap the benefits of openness and of ICT more readily than others. There are also dangers in putting too much faith in using OGD, and indeed big data in general, as issues like its representative, mis-use or even corruption are ever present, as is the need to apply a common sense test to algorithm-driven decisions and policies. Data should always be put in the context of 'soft data' like values, ethics and responsibility.

The side effects, risks, shortcomings, unanticipated and even negative consequences of emerging technologies also need to be examined, including social impacts, ethical concerns, uncertainty and lack of transparency of what is happening and who is in control, etc. Trust and transparency are thus important implications as algorithms can become impenetrable blackboxes. Careful and comprehensive technology impact assessments will need to be undertaken concerning such effects, including in relation to security and crime.

Despite these caveats, however, government as the only institution backed by democratic accountability, is best placed to address these risks. It will need to retain basic roles including setting overall quality standards, providing mechanisms for resource sharing, and determining legal frameworks.

References

Anderson C (2012) Makers: the new industrial revolution. Random House, New York

Bason C (2010) Leading public sector innovation: co-creating for a better society. Policy Press, Bristol, UK

Benedikt Frey C, Osborne MA (2013) The future of employment: how susceptible are jobs to computerization? Oxford University Press, Oxford

Bevir M (2013) A theory of governance. University of California Press

Chesbrough HW (2003) Open innovation: the new imperative for creating and profiting from technology. Harvard Business School Press, Boston

Cordella A, Bonina CM (2012) A public value perspec-tive for ICT enabled public sector reforms: a theoretical reflection. Gov Inf Q 29:512–520

Dunleavy, P and Margetts H "New public management is dead: long live digital era governance", J Public Adm Res Theory, July 2006

European Commission (2010) A European strategy for smart, sustainable and inclusive growth, 2010–2010. http://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20-%20Europe%202020%20-%20EN%20version.pdf

European Commission (2013a) A vision for public services. Prepared by DG CONNECT after an expert workshop and open public consultation. http://ec.europa.eu/digital-agenda/en/news/vision-public-services

European Commission (2013b) Powering European Public Sector Innovation: towards a new architecture. Report of the Expert Group on Public Sector Innovation, Directorate-General for Research and Innovation Innovation Union

European Commission (2014) EU anti-corruption report. Report from the Commission to the Council and the European Parliament, Brussels, 3.2.2014 COM(2014) 38 final. http://ec.europa.eu/dgs/home-affairs/e-library/documents/policies/organized-crime-and-human-trafficking/corruption/docs/acr_2014_en.pdf

European Commission (2016) Communication on EU eGovernment Action Plan 2016–2020 – accelerating the digital transformation of government. 19 April 2016: https://ec.europa.eu/digital-single-market/en/news/communication-eu-egovernment-action-plan-2016-2020-accelerating-digital-transformation

Gansky L (2010) The mesh – why the future of business is sharing. Penguin Group, New York

Gascó-Hernández (2014) Open government: opportunities and challenges for public governance. Springer Science + Business Media, New York

Harrison TM, Pardo TA, Cook M (2012) Creating open government ecosystems: a research and development agenda. Future Internet 4(4):900–928

Hood C (1991) A public management for all seasons. Public Adm 69(Spring):3–19

Janssen M, Estevez E (2013) Lean government and platform-based governance: doing more with less. Gov Inf Q 30 Suppl 1:S1–S8

Klein N (2014) This changes everything. Penguin, Random House UK

Lee G, Kwak YH (2012) An open government maturity model for social media-based public engagement. Gov Inf Q 29(4):492–503

McDermott P (2012) Building open government. Gov Inf Q 27(4):401–413

Millard J (2011) Are you being served? Transforming e-government through service personalization. Int J Electron Govern Res 7(4)

Millard J (2013) ICT-enabled public sector innovation: trends and prospects. Published in the proceedings of the 7th international conference on the Theory and Practice of Electronic Governance (ICEGOV2012), Seoul, 22–25 Octo 2013, the ACM Press

Millard J (2015) Open governance systems: doing ore with less. Gov Inf Q. doi:10.1016/j.giq.2015.08.003

Moore MH (1995) Creating public value: strategic management in government. Harvard University Press, Cambridge, MA

Niehaves B (2007) Innovation processes in the public sector – new vistas for an interdisciplinary perspective on e-government research? Electron Gov, vol. LCNS 4656. Springer, pp 23–34

OECD (2014) OECD Foreign Bribery Report: an analysis of the crime of Bribery of Foreign Public Officials. http://www.oecd.org/corruption/oecd-foreign-bribery-report-9789264226616-en.htm

Perez C (2009) Technological revolutions and techno-economic paradigms. TOC/TUT working paper No. 20, 2009

Rifkin J (2014) The zero-marginal cost society: the internet of things, the collaborative commons and the eclipse of capitalism. Palgrave Macmillan, New York

Stoker G (2006) Public value management: a new narrative for networked governance? Am Rev Public Adm 3(1):41–57

Tapscott D (2009) Grown up digital: how the net generation is changing your world. McGraw-Hill, New York

Tepsie (2014) Research Programme Synthesis Report: final reports for practitioners, researchers, and policymakers. A deliverable of the project: "The theoretical, empirical and policy foundations for building social innovation in Europe" (TEPSIE), European Commission – 7th Framework, Brussels: European Commission, DG Research. http://www.tepsie.eu. Accessed 30 Jan 2015

Thaler RH, Sunstein CR (2008) Nudge: improving decisions about health, wealth, and happiness. Yale University Press

Van Veenstra AF, Janssen M (2012) Investigating out-comes of t-government using a public value management approach. In Scholl HJ et al (eds) IFIP EGOV 2012, Springer LNCS 7443, Kristiansand, pp 187–197

Weerakkody V, Dhillon G (2008) Moving from e-government to t-government: a study of process re-engineering challenges in a UK local authority perspective. Int J Electron Gov Res 4(4):1–16

World Economic Forum (2016) The fourth industrial revolution: what it means and how to respond. http://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond

Jeremy Millard is Director of the consultancy Third Millennium Governance, as well as having senior research positions at the Danish Technological Institute in Denmark and Bradford University in the UK. He has over forty years' global experience on issues ranging from governance, ICT, open and social innovation, participation, sustainable and socio-economic development, tackling poverty and exclusion, the new economy, urbanization and nature-based solutions for growth, and has published extensively in these and related fields. His many clients include governments, the European Commission, United Nations, OECD and World Bank, as well as many non-profits and companies around the world. Recent assignments in the area of e-government include on-going support to both the United Nations regarding their biennial eGovernment Survey, and the European Commission regarding e-government research and innovation, as well as a survey on back-office developments in support of user-centred e-government strategies for the OECD. He has also worked with the UN on ICT and governance issues for the 2030 sustainable development agenda, and with ESCWA on integrated service delivery across the Arab Region.

Public Administration for the Next Generation

Peter Winstanley

Abstract Public Administration incorporates the development of statutes and regulations to bring order and control to aspects of society. In democratic societies this is accompanied by gathering opinion from the population on the span and degree of this control and on some of the details. This essay explores ways in which developments in digital technologies can facilitate this process, aid policymakers in ensuring consistency of regulations, and streamline the process between regulation and software in situations where this is relevant and helpful. It looks forward to what the coming generation of citizens might expect from their public administrators.

Exposition

From the times of Hammurabi, and slightly later, Moses, people have used written law and regulation to guide the focus and interactions within states and communities. Both the law of Hammurabi and the Ten Commandments given by God to Moses were writings in stone and this indicates the degree of consideration given to them and to some extent too the duration for which they were expected to be effective. They were also conveyed in words, and in the case of Hammurabi's Code we know that it was written in Akkadian, the local language of the people, so that it might be read and understood by all – it wasn't in some language only understood by learned judges and civil servants. Another feature that is worthy of note in the case of Hammurabi's Code is the "if this, then that" approach. Specific penalties were appropriate for specified behaviors and acts.

The world of laws and the regulation of society had its ups and downs over the past 4000 years since these early Biblical times, and the process of developing laws and regulations has moved from it being the efforts of one or a small number of people involved in the determination, documentation and publication process to a formidable coordinated effort that in many instances spans multiple organisations and, in the case of trade regulations, many continents. The development of a professional civil service skilled in regulatory policy (Organisation for Economic

P. Winstanley (✉)
Semantechs Consulting Limited, Glasgow, UK
e-mail: p.w@semantechs.co.uk

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_2

Co-operation and Development 2016a) and practice has moved on from small numbers of scribes and sculptors to large teams covering a very wide range of disciplines and capabilities. This development of a professional civil service hasn't been without its problems. In the United Kingdom, for example, the development of a modern civil service that works with the legislature of the day to provide expert and impartial assistance in the business of government was set on its modern course by the work in the mid-nineteenth century of Stafford H Northcote and Charles Edward Trevelyan that derived lessons learned from the operation of the British government and trading companies in colonial India to develop a set of minimum educational standards, remuneration, and principles of behavior for a professional and permanent civil service (Wikipedia 2016a). The point of the competency is obvious, but sometimes lost on people who see the outputs from the civil service in the area of public administration as being less that of developing a smooth-running machine to being a burden to their ease of living and transacting the business of commerce and, in some cases such as the regulations relating to the public availability of medication, the business of life itself (Australian Government Department of Health 2016). In more recent times the skills and competencies of the civil services in most countries and pan-national organization (e.g. United Nations, European Commission, etc.), together with the routes to expressing their outputs in the area of secondary legislation and regulation have been modernising to adopt digital technologies.

In this chapter I will take a look at the ways in which computing technologies and the Internet are operating within some areas of public administration, and speculate as to the areas for future benefit from more widespread adoption of existing tools and technologies. This is a personal and perhaps predominantly Euro-centric approach rather than a systematic review, but its intention is to stimulate the reader to further investigation and action. The field is extremely dynamic and any review would quickly be getting out of date, but I hope that these views might give impetus to further work in this area.

Development

Reading the Runes

The first part that I am addressing relates to the forces within which any government operates where, as described in the early twentieth century by A.F. Bentley, it is the attitudes and activities of groups within society that will determine the course of government (Lemman 2008). Gauging and defining the interests and activities of these groups is not only the core of the pollsters' art in "reading the runes" prior to any democratic election, but it is also part of the public administrator's required assessment when providing impartial advice to government on the likely impact of particular proposed courses of action (Organisation for Economic Co-operation and Development 2016b). Toolkits such as that used within the UK Government (UK Government 2014) look to include some assessment of both monetized and non-monetized costs/burdens of proposed regulation. In the UK the assessment of reaction to new regulation was traditionally undertaken by randomized, stratified sampling of opinion in formal surveys combined with consultation with interested parties including representative bodies. The advent of social media and large streams of computer-friendly data has spawned multiple projects and services within government (Mikoleit 2014) to reduce political exclusion, increase the democratic 'footprint' of the opinion-gauging and opinion-forming consultation processes, and act as one of the components to improve the efficiency, and effectiveness of service-delivery, amongst other things (Chilean Government 2016). Just bringing the traditional to-ing and fro-ing of information to a greater scale doesn't really help the poor civil servant who has to make sense of this cognitive overload, and this is where informatics has been starting to provide help. It is also an area where the profession of the civil servant is needing to step up to the challenge by modernising specialist IT divisions (UK Government Digital Service 2016). This is an absolute requirement to make the most of the information available through social media, because although there are tools and framework for extracting topics, sentiment, and relationship amongst social network users and their contributions, the interpretation and the communication of the interpretation in ways that the non-specialist can comprehend are significant challenges (Moss et al. 2015; Pedersen et al. 2014). The timeliness of delivering insight from streams of social media such as Twitter are made possible by the advances in lambda architectures (Amazon Web Services 2015) (that give scope for both analysis of the stream of data and the aggregated data set) and the technology stack is being provided as orchestrated sets of cloud services (Taieb 2016). The key challenges for public administrators are access and validation – are they aware of and 'allowed' to use these tools in a timely manner, and can they be sure that the results can be interpreted and communicated accurately?

Policy Engineering

The policy engineering process involves the preparation of secondary legislation, regulations and associated guidance to provide some of the main levers of government. At one time the involvement of engineers and IT specialists in this stage of public administration was to some extent the promotion of self-interest, ensuring that the civil servants were aware of the "facts".

> However, to reap the benefits of these technologies in our everyday lives it is critical that industry, policy makers and the public support their development from ideas generated in the laboratory to the commercial marketplace. (Carnegie Mellon University, Scott Institute for Energy Innovation, Technology Guide 2014)

Increasingly, however, is the realisation that serious negative consequences come from ambiguity and lack of external validation of the integrity of statutes and regulations (DeLong 2002) and this can be mitigated by the application of (software) engineering principles where the purpose of the regulation is clearly stated in a "statement of basis and purpose" (U.S.C. § 553(c) 2006), which is in many ways analogous to the Behaviour Driven Development and Test Driven Development approaches taken in software engineering. "Am I doing the right thing?". "Am I doing the thing right?". This approach would be a step change from the usual usage of scientific computing where scientific or engineering knowledge base is taken into account in the couching of regulation, but neither in testing the drafting of regulation nor in determining consistency within and between regulations – this being the craft of parliamentary draftsmen and other legal experts. There have been several approaches using natural language processing and statistical analyses of natural language to extract meaning from written regulations/policies and converting this into an RDF or UML (Brodie et al. 2006) model in an attempt to validate the consistency of the regulation/policy and assess compliance, but these have the same underlying problem that they are making a best estimate of meaning. This is exactly the same uncertainty experienced with extracting meaning from social media streams. In order to develop a knowledge engineering approach to the crafting of regulation unconstrained natural language is too variable to be used with existing parsing and extraction tools such as UIMA, to give a high degree of parsing accuracy, and, unsurprisingly, having some constraint has been found to work much better (Brodie et al. 2006). Within the domain of legal XML markup, there are moves in the UK to use Akomo Ntoso in addition to the relatively more complex metamodel Crown Legislation Markup Language (CLML) for the markup of legal documents. The Akomo Ntoso model has been shown in comparative studies (McGibbney and Kumar 2013) to be more suited to marking up the end representation of the legislation. A related markup within this area is LegalRuleML (OASIS 2016) which is a specialization of RuleML (RuleML Inc 2016). This is less a presentation markup and more an exchange format for machine-to-machine communication of information (Paschke and Boley 2009). Although there are specific editors, such as LIME (LIME – CIRSFID, University of Bologna 2016), for XML markup of general rules, including policies and regulation, these editors have steep learning curves and the inputs and outputs tend to be difficult for non-specialists, including ordinary citizens, to understand (Beach et al. 2015). Communication of the reasoning underpinning decisions is something citizens have a right to in many countries, as for example in New Zealand (New Zealand Law Commission 2012). This points to the advantage of having a multi-purpose expression format for rules, policies, regulations/statutes etc. that can be understood by both people and machines and be serialized if a form that permits error-free transmission across machine and human interfaces is used. End-users of all types need system interfaces and rule bases that are easy to interact with. These types of interactions might be as part of the development route or feedback loop of policy development and refinement or the formal expression of policy for the purpose of implementation through regulation, and this latter more often than not in the modern world is mediated, at least in part, through software.

Formal Modelling

The work of Wimmer and colleagues in the "Open Collaboration for Policy Modelling" (OCOPOMO) project (OCOPOMO Project 2012) recognizes that there has to be a direct and discoverable link between the narrative texts contributing to the domain expertise introduced into the policymaking mix and the formal models that policymaking will use. Provenance is important. But so too is the approach for collecting stakeholder input. In the OCOPOMO approach narrative text is the raw material of policy making and from this there is a process of expert interpretation to develop a conceptual model based on the stakeholder textual inputs and other documents. Expert annotation and interpretation by the policy analyst is the key distillation process through which the input becomes crystallised as formal models that permit, through imperative code in "Declarative Rule-based Agent Modelling Software" (DRAMS) the running models to determine the effects of policies, including discovery of emergent behaviours. But DRAMS rules look like computer programme language rather than natural language (Lotzmann and Meyer 2011) and so might be impenetrable to the citizen who provided the original narrative text. The gap between the citizen with domain expertise or stakeholder position and the implementing specialist is perhaps too large to bridge to ensure effective feedback within the policy process.

Pictures of Policy

At the other extreme are approaches to bridge the communication between citizens and policymakers using mainly visualisations. "Policy Compass" (Policy Compass 2016) is looking to Fuzzy Cognitive Maps and other visual widgets and tools as the route to bridging the divide between the citizen and the policymaker. This presents issues of ambiguous interpretation due to the non-standardisation of symbols (unlike e.g. road signs), and the potential disenfranchising of the visually impaired. The development of 'personas' within policy modelling (Bennet 2015) is popular within some interested in trying to open up the policy-making process, but although it may provide scope for an inventive workshop, the longevity of the message in the graphic artefacts is questionable. The restricted semantics and semiotics of issue based information systems (Wikipedia 2016b) (IBIS) such as Compendium (Compendium Institute 2012) provide graphics that can be interpreted and the underlying arguments replayed long after they were crafted. I think that the similar level of replay from graphics such as in the 'personas' referred to above would be extremely challenging.

The Dominance of Natural Language

Given that across many cultures words are the preferred form communication, a focus on words provides the specificity and longevity required to pass around and debate about the direction and detail of policy and regulation. This is still the preferred way for citizens to respond to government proposals. The commentariat of the US government are prolific though, and Tyrus Manuel describes (Manuel 2015) not only the overwhelming volume of this feedback (e.g. 800,000 public comments to the US consultation on Net Neutrality) but also the palpable relief to some civil servants as they discover the benefits of natural language processing (NLP) in distilling the core messages (and isolating the "weak signals") from large volumes of information like this. Manuel sees NLP as a part of the answer.

> …We can also use NLP to gain a better understanding of what citizens are trying to tell us on any given issue or in general. It allows for a clearer understanding of items that may need to be addressed, from healthcare to consumer safety. NLPs can help us do a better job of not just listening to the people, but answering them as well.

My view is that persistence with NLP will only shift the problem to elsewhere. There is such a diversity of language that with NLP we don't arrive at a shared representation in a social and democratically consensual way, but are shoehorned into consensus by algorithm and heuristic. One simple improvement to soliciting text input from citizens is to augment it with some fixed sentiments. For example, the website patientopinion.org.uk (Patient Opinion website 2016) gets users to input anecdotes about the workings of the UK health service together with some marked up facts about what was good and what could be improved. This small change is an improvement on machine-determined sentiment, whilst allowing the contributor to use free text. There is also scope for selecting entities from a controlled vocabulary. An extension of this would be the proposition developed in the "Integrated Method for Policy making using Argument modeling and Computer assisted Text analysis" (IMPACT) EC FP7 project to use a controlled natural language for all of the textual input (Integrated Method for Policy making using Argument modelling and Computer assisted Text analysis 2012). There are many challenges in this approach, including tracking the argument both across sentences in the contribution from one individual, and also in the ping-pong of contrapuntal debate. In both these cases incorporation of globally-unique identifiers for 'things' and 'relationships' – the kernel of the Semantic Web – can provide this continuity. Illustrations of registries such as those for legal entities in the GLEIF project (GLEIF – Global Legal Entity Identifier Foundation 2016), Open Corporates (OpenCorporates 2016) and Open Charities (OpenCharities 2016) combined with identifiers for concepts (ConceptNet 5 2012) and diverse predicates (Linked Open Vocabularies 2016) are providing the Lego™ building blocks for a constrained but rich set of fixed points that can enrich an existing controlled natural language (CNL) approach to describe and comment on policy and statute. Simple "What You See Is What You Meant" (WYSIWYM) interfaces (Power and Scott 1998) have given way in recent years to sophisticated ontology editors such as Fluent Editor (Cognitum 2016) which uses the Ontorion Controlled Natural Language (OCNL) to guide the creation of WYSIWYM documents including ontologies and rules bases (Seganti et al. 2016).

Bridging the Gap

So my line of argument is clearly going in these lines: we need a dialogue between citizens and those who make policy and regulation so that they can understand what is being proposed and make comment in unambiguous ways to that the intent of citizens' comments in relation to proposed legislation are understood. But this has to be done in a way that copes with computational aggregation and summarization so that the 800,000 responses to a consultation are undertaken and the single thread of argument counter to the 799,999 others is discovered and considered on its merits. The computational capacity and transformational fidelity of controlled natural language allows this, and much more besides. Some of these additional benefits are being played out in work ongoing in the Dutch Finance and Customs Administration (Belastingdienst) where controlled natural language is being used to provide the rule bases that are parsed using ANTLR to an intermediary that can be compiled directly into code. This ability, even in a restricted domain such as finance and customs, to develop software artefacts directly from a human readable set of rules opens up a wide range of new possibilities in public administration. In short, business rules are prepared in "RegelSpraak", a Dutch CNL based on "RuleSpeak" (RuleSpeak 2016) that is fully consistent with Semantics for Business Vocabulary and Business Rules (SBVR) (Object Management Group 2015) and is easily human-readable. As Chris Maple of MMG Insurance (another organization that has adopted CNL rule language deep into its business processes) states, "A lot of really smart people have done really good thinking in this area." (Maple 2014). The business rules couched in the CNL can then be parsed and compiled into a form suitable for e.g. the DROOLS rule engine.

But just as NLP is not necessarily going to provide the magic wand that allows administrators to get computers to read their input from citizens, so the full-on application of CNL is not going to allow citizens to provide their input to the process of public administration in part because it requires some prior learning, and many people are not going to adapt to that. It also potentially constrains the concepts and constructs that a citizen might be able to use to connect with the administration, and that would be politically untenable as it is likely to be seen as coercive and restrictive. There is potential scope for the scenario where citizens could be using argumentation and debating technologies (IBM 2016) to facilitate constructing their response to an administration's proposals or actions in the same way that the legal profession has AI tools such as "Ross" (ROSS 2016) at its disposal, but the outputs are still in natural language and so there is an additional 'layer' or aspect needed to help people use computers to process more effectively and efficiently the points made and to aggregate them accurately and integrate them into other knowledge accurately and efficiently. Equally, this move to a wholly IT-mediated discourse based on argumentation alone fails to develop the trend to more inclusive and participative democracy that is gaining momentum in countries such as Scotland where recent conversations within the country have recognized that there needs to be both online and offline interactions between government and citizens and the creation of safe spaces for dialogue to help infuse ideas from all sectors of society into the mix, and to mitigate the political risks of "getting it wrong" and the fears that stoke risk aversion in administrations (Stoddart 2014). Collaborative Government that includes administrators going to where the conversations are taking place requires some mechanism of channel discovery, and this again is bringing us to the challenge of scale. How can government monitor the online dialogues to identify which to join? We are back to analyzing Twitter streams and the complexities and hazards of either getting administrators to do this job themselves or using some algorithmic approach.

Ideality?

Smaller populations such as Iceland have the capacity to sample opinion in a much more authoritative and interactive way and this was realized in 2009 and subsequent years during a period of constitutional reform (Bergsson and Blokker 2014). This exercise to update the constitution involved taking a random sample of c.1000 people and getting them to talk about issues and then 25 of this assembly were selected by the voting population (Iceland Review Online 2010) to address the issues identified by the larger assembly and write the revision of the constitution (Wikipedia 2016c). The large group was split into 128 smaller groups and their ideas were condensed into word clouds as a rapid means of determining the topics of interest (Blokker 2012). Clearly this is a circumstance where CNL could not only advance this Icelandic approach but also allow it to scale effectively to larger numbers of participants and provide in computable form greater complexity of input than simple word clouds.

Recapitulation

In summary, I see the incorporation of controlled languages, registries of identifiers and technologies such as RDF and tools for computer facilitated reasoning and discovery/description of arguments as underpinning the next generation of public administration in ways that allow greater individual contribution to the ideas mix from which policy is developed and more streamlined routes to the delivery of IT services that implement and monitor the regulations derived from public policy. I also see these technologies improving the quality of regulations as they provide routes to use computer approaches to test the logical consistency of complex sets of regulation to a scale that Hammurabi could only dream of.

References

Amazon Web Services (2015) Lambda architecture for batch and stream processing on AWS. Available at https://d0.awsstatic.com/whitepapers/lambda-architecure-on-for-batch-aws.pdf

Australian Government Department of Health (2016) Regulation and red tape reduction. Available at http://www.health.gov.au/internet/main/publishing.nsf/Content/regulation-and-red-tape-reduction

Beach T, Rezgui Y, Li H, Kasim T (2015) A rule-based semantic approach for automated regulatory compliance in the construction sector. Expert Syst Appl 42(12):5219–5231. doi:10.1016/j.eswa.2015.02.029

Bennet S (2015) Using design and open policy making techniques to address complex problems. In UK government “Future of Aging” blog. Available at https://futureofageing.blog.gov.uk/2015/10/01/design-and-open-policy-making/

Bergsson BT, Blokker P (2014) The constitutional experiment in Iceland (September 4, 2013). In: Pocza K (ed) Verfassunggebung in kon-solidierten Demokratien: Neubeginn oder Verfall eines Systems? Nomos Verlag. ISBN 3848709996. Available at SSRN: http://ssrn.com/abstract=2320748

Blokker P (2012) Grassroots constitutional politics in Iceland. Available at https://blokkerpaul.wordpress.com/2012/01/16/grassroots-constitutional-politics-in-iceland/
Brodie CA, Karat C-M, Karat J (2006) An empirical study of natural language parsing of privacy policy rules using the SPARCLE policy workbench. Symposium on usable privacy and security (SOUPS). Available at https://cups.cs.cmu.edu/soups/2006/proceedings/p8_brodie.pdf
Carnegie Mellon University, Scott Institute for Energy Innovation, Technology Guide. (2014) Innovative energy technologies: the next generation. Available at http://www.cmu.edu/epp/policy-briefs/briefs/Innovative-energy-technologies.pdf
Chilean Government (2016) Chile Atiende. Available at https://www.chileatiende.gob.cl/
Cognitum (2016) The Fluent Editor website. Available at http://www.cognitum.eu/semantics/FluentEditor/
Compendium Institute (2012) Website available at http://compendiuminstitute.net/index.htm
ConceptNet 5 Website (2012) available at http://conceptnet.io/
DeLong JV (2002) Out of bounds, out of control: regulatory enforcement at the EPA. Cato Institute
GLEIF – Global Legal Entity Identifier Foundation (2016) Website available at https://www.gleif.org/en
IBM (2016) IBM Debating Technologies website. Available at http://researcher.ibm.com/researcher/view_group.php?id=5443
Iceland Review Online (2010, 2014) Iceland election results announced. Available at http://icelandreview.com/news/2010/12/01/iceland-election-results-announced
Integrated Method for Policy making using Argument modelling and Computer assisted Text analysis (2012) Project site available at http://cordis.europa.eu/project/rcn/93720_en.html
Lemman N (2008) Conflict of interests. The New Yorker. Available at http://www.newyorker.com/magazine/2008/08/11/conflict-of-interests
LIME – CIRSFID, University of Bologna (2016) LIME: the Language Independent Markup Editor website. Available at http://lime.cirsfid.unibo.it/
Linked Open Vocabularies (2016) Website available at http://lov.okfn.org/dataset/lov/
Lotzmann U, Meyer R (2011) DRAMS – a declarative rule-based agent modelling system. In: Burczynski T, Kolodziej J, Byrski A, Carvalho M (eds) Proceedings 25th European conference on modelling and simulation. ©ECMS ISBN: 978-0-9564944-2-9 / ISBN: 978-0-9564944-3-6 (CD)
Manuel T (2015) The content corner: using natural language processing to improve rulemaking. DigitalGov website. Available at https://www.digitalgov.gov/2015/08/17/the-content-corner-using-natural-language-processing-to-improve-rulemaking/
Maple C (2014) Supporting a business rules approach with standards and patterns. Bus Rules J 15(9). Available at http://www.BRCommunity.com/a2014/b774.html
McGibbney LJ, Kumar B (2013) A comperative study to determine a suitable representional data model for UK building relations. J Inf Technol Constr (ITcon) 18:20–39. http://www.itcon.org/2013/
Mikoleit A (2014) Social media use by governments: a policy primer to discuss trends, identify policy opportunities and guide decision makers. OECD working papers on public governance no. 26. OECD Publishing, Paris. http://dx.doi.org/10.1787/5jxrcmghmk0s-en
Moss G, Kennedy HN, Moshonas S, Birchall C (2015) Knowing your publics: the use of social media analytics in local government. Information Polity 20(4):287–298. ISSN 1570-1255. http://dx.doi.org/10.3233/IP-150376. Available at http://eprints.whiterose.ac.uk/91927/3/Knowing_Your_Public.pdf
New Zealand Law Commission (2012) R125 the public's right to know. Available at http://r125.publications.lawcom.govt.nz/
OASIS (2016) LegalRuleML Technical Committee website. Available at https://www.oasis-open.org/committees/legalruleml/charter.php
Object Management Group (2015) Semantics of Business Vocabulary and Rules™ (SBVR™) website. Available at http://www.omg.org/spec/SBVR/Current/
OCOPOMO Project (2012) Open collaboration for policy modelling website. Available at http://www.ocopomo.eu
OpenCharities (2016) Website available at http://opencharities.org/
OpenCorporates (2016) Website available at https://opencorporates.com/
Organisation for Economic Co-operation and Development (2016a) Regulatory policy. Available at http://www.oecd.org/gov/regulatory-policy/

Organisation for Economic Co-operation and Development (2016b) Regulatory impact analysis. Available at http://www.oecd.org/gov/regulatory-policy/ria.htm

Paschke A, Boley H (2009) Rule markup languages and semantic web rule languages. In: Giurca A, Gasevic D, Taveter K (eds) Handbook of research on emerging rule-based languages and technologies: open solutions and approaches. Chapter: 1. IGI Global, pp 1–24

Patient Opinion website (2016) Available at https://www.patientopinion.org.uk/

Pedersen S, Baxter G, Burnett S, Goker A, Corney D, Martin C (2014) Backchannel chat: peaks and troughs in a twitter response to three televised debates during the Scottish independence referendum campaign 2014. Aberdeen Business School Working Paper Series 7(2). Available at https://openair.rgu.ac.uk/handle/10059/1086

Policy Compass (2016) Project website available at https://project.policycompass.eu/the-project/

Power R, Scott D (1998) WYSIWYM: knowledge editing with natural language feedback. Proceedings of the 9th international workshop on natural language generation (INLG 98), Niagara-on-the-Lake

ROSS (2016) Website available at http://www.rossintelligence.com/

RuleML Inc (2016) http://wiki.ruleml.org/index.php/RuleML_Home

RuleSpeak (2016) Website available at http://www.rulespeak.com/en/

Seganti A, Kapłański P, Zarzycki P (2016) Collaborative editing of ontologies using fluent editor and Ontorion. In: 12th international experiences and directions workshop on OWL, OWLED 2015, co-located with ISWC 2015, Bethlehem, 9–10 Oct 2015, pp 45–55

Stoddart A (2014) Collaborative government in Scotland. Available at http://www.gov.scot/Resource/0045/00459780.pdf

Taieb D (2016) Real-time sentiment analysis of twitter hashtags with spark. IBM cloud data services developer center. Available at https://developer.ibm.com/clouddataservices/2016/01/15/real-time-sentiment-analysis-of-twitter-hashtags-with-spark/

U.S.C. § 553(c) (2006) ([The agency shall incorporate in the rules adopted a concise general statement of their basis and purpose.). Quoted in Kevin M. Stack (2012) Interpreting regulations. Mich Law Rev 111(3):355–422. available at http://repository.law.umich.edu/cgi/viewcontent.cgi?article=1080&context=mlr

UK Government (2014) Regulatory impact assessments: guidance for government departments. Available at https://www.gov.uk/government/collections/impact-assessments-guidance-for-government-departments

UK Government Digital Service (2016) Digital People blog website. Available at https://digitalpeople.blog.gov.uk/

Wikipedia (2016a) Northcote–Trevelyan report. Available at https://en.wikipedia.org/wiki/Northcote-Trevelyan_Report

Wikipedia (2016b) Issue-based information system. Available at https://en.wikipedia.org/wiki/Issue-Based_Information_System

Wikipedia (2016c) Icelandic constitutional reform, 2010–13. Available at https://en.wikipedia.org/wiki/Icelandic_constitutional_reform,_2010%E2%80%9313

Peter Winstanley is a data and standards specialist with experience covering more than 25 years in both government and private sector operations. Peter is a member of the UK Government Data Standards Panel and Glasgow University School of Computing Science Industrial Advisory Board and is a Chartered Fellow of the British Computer Society. He has contributed to the development of European Community and W3C standards and recommendations on semantic interoperability. Peter works routinely with smart data structures such as XML and RDF to develop and deliver high impact, low maintenance solutions.

The Citizen Scientist in the ePolicy Cycle

Johann Höchtl, Judith Schossböck, Thomas J. Lampoltshammer, and Peter Parycek

Abstract This chapter discusses a participation and technology enabled model of the citizen scientist in relation to the policy cycle. With interconnected personal devices collecting a plethora of various data, citizens are capable to serendipitously contribute to crowded knowledge generation. In the governance domain, the trend towards more data-driven models of governance and decision-making has been considerable. Big data contains the methodologies to cope with the wealth of data generated by the citizen scientist and in turn provides the tools and technologies to draw actionable insights from this data, f.i. with predictive technologies that could optimise resources across government sectors. After discussing the changing role of science and the technological and participative enablers and methods of engagement relevant for citizen participation, this contribution discusses the role of the citizen scientist and his or her involvement in the big data enabled governance loop by defining three use cases within the policy cycle. Furthermore, it addresses the challenges that can arise in this context.

Introduction

The term science as well as the nature of conducting science evolved over time. Not always has research revolved around the methodological approach as we know it, and not always has it been driven by the measures of today. In this paper we start by describing the nature of conducting science and how some scientific paradigms changed over time. This is relevant for our analysis of citizen science in relation to the ePolicy cycle, as changes like the focus on the openness paradigm combined with available means for sharing and mass collaboration also changed how citizens can participate in the research process.

The section Citizen Science focuses on how openness in the research process combined with means for mass collaboration can empower citizens to enrich the

J. Höchtl • J. Schossböck • T.J. Lampoltshammer (✉) • P. Parycek
Department for E-Governance and Administration, Danube University Krems, Dr.-Karl-Dorrek-Str. 30, 3500 Krems, Austria
e-mail: Johann.Hoechtl@donau-uni.ac.at; thomas.lampoltshammer@donau-uni.ac.at

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_3

research arena. After describing these changes, we take a more detailed look at the possible ways to engage citizens in this process. The section Enablers and Methods of Citizen Engagement summarises some recent modes of citizen participation and engagement, mostly in relation to ICTs and digitalization, and the participatory and technological aspects of citizen engagement. We also briefly address the opposite of those enablers in the form of hurdles to citizen science.

In the Big Data Enabled Policy Cycle we present the policy cycle as a theoretical vehicle to structure public policy making in light of technological advance. Use Cases for the Citizen Scientist in the Policy Cycle ties together intrinsic motivation and external enablers in respect to the policy cycle. In Challenges, Issues and Future Implications we discuss existing impediments to unleash the potential of Citizen Science in policy making, ethical and cultural considerations as well as potential implications of future research.

By combining insights from different disciplinary fields, we hope to point towards the chance of engaging citizens on various stages of the policy cycle, in particular with view to an increased culture of sharing and related possibilities for evidenced-based and participatory policy making.

Changing Paradigms in Science

For the most part of history, science was not meant for everyone. In former times, many people lacked the basic foundations of what was perceived to be a pre-requisite for scientific work, namely mathematics, jurisprudence, medicine, theology, and philosophy. The *lingua scientia* was dependent on epoch and geography and differed many times from the *theodiscus*, the people's language. Thus, only people capable to communicate in the scientific language were able to participate in the discourse. Aristoteles created the nomenclature of practical science containing, f.i. politics and ethics, theoretical science, mathematics and theology and poietic science, including medicine and poetry. Elaborations meant for wider consumption were called exoteric, whereas those works targeting the circle of like brethren *esotheric*.

Methodology and reproducible results did not play the crucial role as they do today. Alchemy, occultism, and religion where all closely related disciplines and influenced what would become modern science. None of these areas is known for a deep methodological foundation and for good reasons: to believe rather than to know was an integral part of a scientific approach back in these days.

In his seminal work *Saggiatore*, published 1623, Galileo Galilei argued to understand nature requires understanding mathematics, otherwise the inner workings of nature would remain unintelligible. He also dismissed both Alchemy and Astrology as incapable to describe nature, a view Francis Bacon already shared 1597 in his essays: To master nature requires to understand nature. Bacons notion of understanding was freed from influential idols of its time like the Greek philosophers Platon and Aristoteles and, with Bacon's words, their *illusions*. However, even a generation later, science was still deeply embedded into religion, occultism and alchemy. Isaac

Newton described fundamental insights in the domain of optics, dynamics, mathematics, and chemistry, using a systematic, methodological approach. When we make use of the adage *standing on the shoulders of giants*, Newton is certainly at the very base of that pyramid. Lesser known is Newton's role as an alchemist. Three hundred sixty-nine of his personal books deal with mathematics and physics, whereas a stunning 170 books make reference to the Kabbala or Rosicrucianism to support his endeavour to find the philosopher's stone. So even Newton still believed in the unity of science, religion, and occultism.

In 1661, Robert Boyle published the book *The Sceptical Chymist,* 1 year after he and 11 further fellows founded the Royal Society. He called for experimental rigor and for describing chemical experiments in a way that others would be able to repeat and verify results. Robert Boyle and the many to follow him in spirit established the mental model of science as a white collar working activity, producing results with a small community, unintelligible to the people. Modern science, a science solidified in methodology, empirical evidence, and reproducibility of results dates back to the founding fathers of the Royal Society.

Over the years, the methodological aspect of conducting research increasingly gained traction, leaving the aspect of reproducibility behind. This changed due to an infamous Excel mistake, which happened to Harvard University economists Carmen Reinhart and Kenneth Rogoff in 2010, to erroneously conclude a significant correlation between high government debt and slow economic growth (Reinhart and Rogoff 2010). The model they employed in their research paper was grounded in theory, yet their results where irreproducible by others, due to not releasing their research data. As an increasing number of economists expressed disbelief in their findings, they finally published the Excel file they based their investigations on. Soon afterwards, other researchers identified that five rows were left out from a formula, which was used to support their argument. However, the damage was done and it is partly to this paper that Europe now experiences an era of government austerity as many statesmen took reference to it. This poses the question of what is more important to the scientific discourse: Methodological soundness or reproducibility of results through availability of data? While reproducibility is a defining feature of research, the extent to which it should characterize it is debated (Nosek 2015). It can be noted that newer movements, in particular in relation to scientific computing or computational social science, with the increasing importance of big data research, social network data, and machine-generated hypotheses (Lazer et al. 2009), emphasise the importance of reproducibility; in particular since there have been claims of its absence in some domains (f.i. in the area of psychology, where research subjects are rarely static). "In short, a computational social science is emerging that leverages the capacity to collect and analyse data with an unprecedented breadth and depth and scale." (Lazer et al. 2009, p. 722). Computation often reaches into traditionally qualitative fields, also in the area of dissemination, where data sharing and open standards are emerging, and sometimes endorsing pre-publication and open science on the complete research spectrum. Another popular example is Diederik Stapel, a professor of social psychology, who could not produce the data behind his work until he admitted in 2011 that he had been fabricating the data. Apart from these more extreme examples, a scientific movement called reproducibility movement has been formed, and the community pushes not only for publication and sharing of data, but also for the possibility to reproduce results. While irreproducible evidence does not mean that results are wrong, it could also refer to undetected variables.

In his highly disputed book *Against Method*, Paul Feyerabend claims that the idea of a method that contains firm, unchanging, and absolutely binding principles for conducting science meets considerable difficulty, when confronted with the results of historical research. There is not a single rule, however plausible, and however firmly grounded in epistemology that is not violated at some time or another. He claims that such violations are necessary for progress (Feyerabend and Hacking 2010). This and many more propositions discussed by Feyerabend bear lots of controversy, as they are shaking on the still young pillars of what just became "traditional" science.

Neglecting the discussion onto which more attention should be laid upon – the availability of scientific data or a sound methodological approach – there seems to be agreement that scientific research should become tangible for many more people than it is today. Furthermore, we observe a shift towards research impact, visible in the increasing importance of quantitative research measures and automatized citation indexes, like Google Scholar for impact monitoring[1] (Harzing and van der Wal 2008). With an increasing amount of people becoming part of the *scientific community*, a term, which constitutes no sharply-delineated area anyhow, new ways of how to conduct research are emerging.

Open Science

How science emerged and was conducted changed significantly over the past centuries and is still undergoing rapid shifts and changes today. In former times, scientific activities were rather performed by the aristocratic society than by common people, as the trustworthiness of the associated results was strongly interconnected with the scientist being a "gentleman". Yet the situation has changed more and more in favour of repeatability and availability of data than relying purely on big names and the reputation of huge organizations. While science has sought to include outside expertise (Carpenter 2001), the view on the notion of the expert itself also underwent a significant shift. Taleb notes that a great deal of important scientific discoveries with significant impact did not result from planning and foresight, but mostly resulted from a trial and error approach and the unexpected (Taleb 2007).

With view to the inclusion of expertise in ideation systems, different approaches to include outside knowledge or expertise have been classified, mostly focusing on

[1] Also in the e-government or e-policy domain, cp. f.i. Scholl, H.-J. (2016), Profiling the Academic Domain of Digital Democracy and Government, presentation at CeDEM16, conference for e-democracy and open government, 18th May 2016, Krems, Austria.

a top-down approach. Management theory distinguishes between flat or hierarchical forms of including outside perspectives: While the closed "elite cycle" is a more traditional way of production mostly lead by public institutions, other models like the "consortium" are based on a flat governance structure, but still focusing on closed participation. Between the closed hierarchical model and an open-model, communities of practice or creation have been proposed (Sawhney and Prandelli 2000). In particular with view to increased open research data output, community innovation could be fostered in the research context, focusing on the role of communities or crowds, networks, and less hierarchical structures (Parycek et al. 2016). Methods such as crowdsourcing and crowd-based initiatives can be seen as a way to use collective intelligence for innovation. Research further separates crowds and communities, which are distinguished by a set of organizing principles and by "light or heavy-weight models of peer-production" (Haythornthwaite 2009). An example would be Wikipedia, which is mainly crowdsourced, yet also contains structural aspects of communities. With view to citizen science, different levels of engagement, involvement and participation are distinguished, which will be addressed later in this chapter and related to the ePolicy cycle. It can be estimated that with increased experience in network structures and crowds, institutions such as governments and universities will gain more flexibility in utilizing the principles of the network society and opening up their processes on different stages of the cycle.

The open paradigm has certainly found its way into science, next to a counter movement of closed pay journals with other paradigms and goals. Looking at data as one important element and basis of scientific output, the increase of open data output in research as part of the open science concept is recently much supported by the European Union. This is visible in efforts to make the results of publicly funded research freely available within the next few years, as Competitiveness Council agreed on the target year 2020.[2] These changes are part of a set of recommendations including improved access to and storage of research data. The next step in such endeavours would be to enhance the value of open data by increasing activities to transfer it into knowledge and to foster further evidence-building by its usage.

Friesike et al. (2015) extract the main streams within open science and define the following four perspectives:

1. *Philanthropic perspective*: Until recently, scientific knowledge and outputs, paired with the required tools and infrastructure were restricted to a particular group. Yet, universities and research institutions are opening their courses and curricula to public audiences via f.i. downloads or video streaming services such as YouTube. In addition, the advance of open access journals distribute scientific contents to everybody interested in the research.
2. *Reflationary perspective*: Another trend is the publication of intermediate work results in form of pre-prints or even before submission. This approach supports

[2] Enserink, M., In dramatic statement, European leaders call for "immediate" open access to all scientific papers by 2020. Science, 27th May 2016, http://www.sciencemag.org/news/2016/05/dramatic-statement-european-leaders-call-immediate-open-access-all-scientific-papers (accessed 15th July 2016).

researchers in reflecting on their initial thoughts, while at the same time promoting new ideas within the scientific community and beyond; even influence entire research directions in the long run. These published ideas can be commented, evaluated, or even challenged by other scientists or amateurs. Furthermore, the initial starting point of a concept and its evolution over time can be traced more easily this way, as the pre-published versions stay within the Internet even after the final paper has been accepted and published by a publisher.

3. *Constructivistic perspective*: Arising co-creational processes open up new ways of publication development. This includes new and innovative business models as well as associated user models. A prominent example for such an approach is crowdsourcing in which the wisdom of the crowd is used solve problems in a fast and flexible manner and citizens are required to support professional scientists' work, but raising scientific issues or drawing upon problem-solving strategies are still done by professional scientists (Dickel and Franzen 2016). Open platforms with small groups of experts loosely moderated and support the discussion and dialogue between involved parties. But not only problem-solving but also data collection are part of these perspective.
4. *Exploitative perspective*: This perspective refers to real life applications and application-orientated knowledge exploitation in cooperation with practitioners.

Citizen Science

Finke notes that the English term "citizen science" is related to a predominance of the Anglo-Saxon countries in this research area. However, with view to the actual content, he constitutes no big national or cultural differences (Finke 2014, p. 37): everywhere people participate on the collective acquisition of knowledge and on forms of knowledge transfer. While his claim that scientific engagement is not based on profession, titles or control structures, but on interest, skills and activities can be debated, it seems obvious that citizen science can only be realized on the basis of such attitudes. For Finke, the term of the amateur or layman is significant for citizen science. Rationality (German: "Laienrationalität") enables citizen science in a continuously more complex world. Citizenship means to be engaged for something. Citizen science according to Finke satirizes a too narrow understanding of a science that is done only by professionals (Finke 2014, p. 40). Irwin defines the term: "Citizen Science" evokes a science which assists the needs and concerns of citizens. He further notes that the term also makes the point for a science that is *developed and enacted by citizens themselves*. (Irwin 1995, p. xi). Feyerabend (1978) even claims that the amateurs are the only citizens that can be trusted to criticize or monitor science independently. Crucial in this regard is that the distinction between citizens and scientists is blurred, and emphasis is put on the context of scientific work: on everyday life and the lifeworlds of citizens. This claim corresponds well with newer theories of citizenship and participation fostered by the affordances of everyday life, hybrid media environments, e.g. the concept of mundane citizenship by

Bakardjieva (2009) or, with reference to functions of monitoring and criticism, to the monitorial citizen as described by Schudson (2000). Consequently, Finke (2014) defines "being close to real life" as a principle of citizen science: everyday life knowledge is situated in the scientific community. Citizen science is science in the lifeworld of the people, whereas professional science decidedly seeks to abstract from it (Finke 2014, p. 65). Citizen science as a situated and bottom-up practice taking into account broad networks of people is also referred to as "extreme citizen science", taking the participatory element of citizen science to the extreme (Haklay 2010).[3] In this view, participatory science is the consequent next step of citizen science (Stevens et al. 2014).

Newman et al. (2012) provide a comprehensive overview of the overall evolution and current trends regarding the paradigm citizen science, which is summarized in the following.

In the past, people acted mostly on an individual basis and were driven through hobby-level scientific interests. In return, collaborations occurred on a local scale only. The research questions to be pursued were based heavily on a top-down approach. The process of collecting data was performed with the help of protocols designed by experts in paper-based forms and therefore access to these data was very limited in time and space. The analysis of the gathered data was solely performed by scientists, who published their results in scientific publications. The impact caused by the projects was not a focus and therefore was not a major concern at that time. The motivation behind the conducted experiments was most of the time based on individual interests, rooted in personal observations of the environment and was very limited in terms of technological possibility regarding data collection and analysis.

Today, people cooperate on a national and international level via common projects. While the main source for research questions still is top-down, more and more bottom-up methodologies are arising. Some approaches relate these methodologies and the proliferation of citizen science explicitly to the availability of new technologies, e.g. by mobile data submission (mobile applications or online submission forms) or social networking sites.

Data that have been collected in the course of the projects are now kept online, with a particular focus on aspects such as data quality and data integration. In former times, analyses have been available for local micro scales only. Today, analyses for macro scales are available as well. Further-more, additional efforts are put into the investigation of spatio-temporal phenomena. Yet, the core analyses are still performed by scientists. While the results are still published by scientists in most cases, research related data is made available only to be accessed by all involved/interested stakeholders. The evaluation of results is done via key performance indicators and specific to the current project context, which in turn makes it difficult if not impossible to transfer these assessments and often also to compare the results between projects. While the composition of research teams has improved in terms of diversity, demographic data still indicates the need for further developments in this

[3] The Extreme Citizen Science Group at UCL London is also working with marginalized communities in citizen science activities with the goal to enable wider participation by lay people.

regard. The main motivational driver for participation in these projects is based on individual interests regarding collaboration-related social aspects. The technological adoption rate has increased significantly, as online-based citizen science resources such as blogs offer data publicly to be integrated in own projects.

Enablers and Methods of Citizen Engagement

Citizen science has been described as participatory science (Conrad and Hilchey 2010; Carr 2004). While the use of volunteers has always been an important component, it has evolved into citizen science within the past two decades (Catlin-Groves 2012). This can partly be explained by the use of ICTs fostering forms of participatory science.

While some forms of citizen science refer to a more active form of engagement, a good deal of participation in digital late modernity is based on more mundane, implicit, opportunistic or more passive forms of engagement. As Bennett and Segerberg note on the characteristics of contemporary networked societies, a different form of organisational structure enabled by phenomena of connective individualism (Bennett and Segerberg 2012) and expressive issue-engagement (Svensson 2014) emerged. This has mostly been explained by a specific form of collective action, initiated by the personalisation of actions. With this different "logic of connective action" (Bennett and Segerberg 2012) and the ubiquitous utilization of new media and technologies, the structures of mobilisation and techniques for citizen engagement have transformed. The argument has been put forward that communication technologies replace the need for traditional communities of action, in other words: those technologies take over what has traditionally been done by humans, making it easier for humans to organise themselves and to reduce the cost of organization and sharing.

Research has emphasised the importance of civic engagement as the actual strength of citizen science (Finke 2014). This can also be done in a more continuous form. Also monitoring function thus does not have to come at the end of a process, but can be executed permanently. In this context the potential of online media can create a *multitude of responses and reactions* (Papacharissi 2009, p. 230).

While modern citizenship assumes an active role (cp. The term "DIY Citizenship" by Ratto and Boler 2014), not all modes of participation in the digital networked society have to be completely active. Research has also emphasised the importance of less active form of participation, e.g. in the form of so called "lurkers" (Nonnecke and Preece 2000), who are less active and remain silent, but nonetheless are an important factor of online engagement. In an extreme form, citizens can provide their data as sensors. Information can now be packed digitally and travel anywhere in the world. On the basis of this speed of flow of information coupled with its "relative uncensorability" (McNair 2009, p. 223) and the collapse of time-space "distantiation" (Giddens 1990) and the assumption that members of society have access to and can afford to buy the hardware, the sharing of information has become a commonplace of cultural life, leading to a different form of communication with a lot of

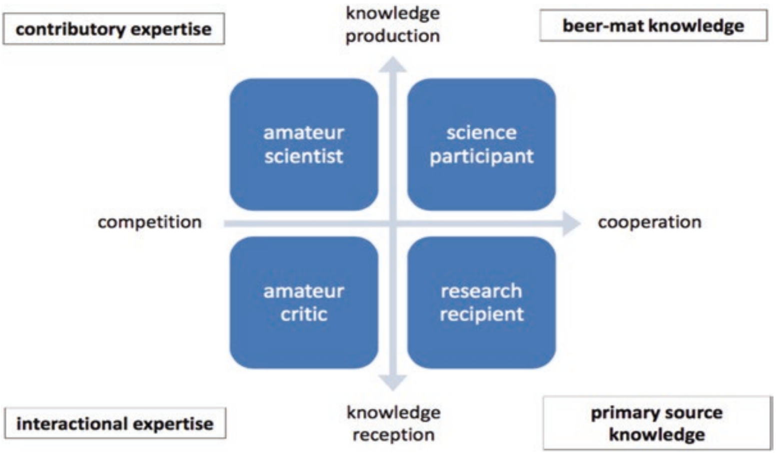


Fig. 1 A framework for engaging expertise, Dickel and Franzen (2016)

data remaining unused. This expanded information flow makes participants constant producers of data, amounting to a globalized public sphere (McNair 2009).

Catlin-Groves distinguishes on the citizen landscape from volunteers, citizen sensors and beyond (Catlin-Groves 2012). In this classification, virtual citizen science refers to data mining in a passive framework (f.i. via social networking sites), which can also have a more active form in the form of active participation. Furthermore, citizen science can comprise "citizen sensing" as an active framework via mobile submissions.[4] Catlin-Groves notes a move "from standardised data collection methods to data mining available datasets", well as the "blurring of the line between citizen science and citizen sensors and the need to further explore online social networks for data collection" (Catlin-Groves 2012). In the context of citizens providing data, (Cooper et al. 2007) emphasise a distinction between "citizen science" and "participatory action research". Citizen science should ideally not use citizens on unequal terms and treat them as scientists on equal terms and not foster a state of competition (cp. Finke 2014).[5] A framework for engaging expertise or knowledge has also been proposed by Dickel and Franzen (2016), who categorize two dimensions in four levels of expertise, which are comparable to science and relevant for policy makers (Fig. 1).

These roles are not found in empirically pure form, but seek to conceptualise inclusion efforts in citizen science. Apart from the differentiation along the needed expertise, these roles distinguish whether the link to the expertise is characterised by competition or cooperation. When characterized as competition, inclusion efforts are expected to be rejected (Dickel and Franzen 2016; Finke 2014), and competition

[4] It can be noted that these newer forms of citizen engagement re less standardized, but mostly opportunistic or directed.

[5] Data compilers should be able to utilize centralized data to produce scientific results in exactly the same way as anyone else should be allowed.

between amateur science and professional science is usually implicit. It can become explicit f.i. when publications of amateur scientists are criticised by the academic world or the other way round (Dickel and Franzen 2016).

Participation in the citizen science landscape can be based on more than intrinsic motivation. The willingness to share can be based on civic engagement, the joy of discovery, but also on more playful motives and play instinct (Finke 2014, p. 124). Another enabler is the private knowledge motives of participants or self-selected areas of interest, sometimes in the form of hobbies and the will to preserve and create knowledge. Behavioural approaches to spatial data sharing have also emphasised the importance of the following contextual factors for the willingness to share: attitude (f.i. strategic position or social outcomes), social pressure (f.i. of institutions, moral norms or the market) and perceived control (f.i. technical or interpersonal skills or finding sharing partners) (de Montalvo 2003).

While those motivational factors play a big enabling role it should also be noted that limited access to technology or technophobia can play a role, and factors explaining motivational access to technology can be of a social/cultural or a mental/psychological kind (Van Dijk 2009). Many technologies do not have appeal for the low-income or low-educated though, and if citizen science is to be appealing to such people, computer anxiety or technophobia as major barriers to access has to be taken into account, as these phenomena are not expected to disappear with the ubiquity of networks in the digital age (Van Dijk 2009). However, technologies of communities (Irwin 2001) make it easier for citizens to participate when they feel like.[6]

Another strategy in lowering the participation threshold is the integration of elements of gamification or game-related elements. Thiel (2016) undertook a meta-analysis of the use of such elements in the field of digital participation. She concludes that while gamification does not work similar in all domains, if situated carefully in the relevant context, gamification could increase the level of participation in some areas and under specific circumstances. However, several studies have already proven that the strategy of adding game elements to influence users' behaviour can be successful: "The most common objective behind gamification is to increase the usage of a system. Other scholars have shown that game elements can increase the perception of effort, make tasks or services more enjoyable and control behaviour." (Thiel 2016, p. 7).[7] Others have found that gamification had no effect in the context of a citizen science application (Bowser et al. 2013): it was found that in an intrinsically motivated user group the game elements in a citizen science application were almost incidental. This can be explained as citizens were intrinsically interested in the non-game context and did not need an additional motivator. Thiel concludes that only if game aspects are utilised correctly and contextualized, they can build a highly motivational user experience (Thiel 2016, p. 8). However, the gamification approach can be effective in terms of influencing or tapping into users' motivation

[6] Irwin explores the configuration of the scientific citizen within policy and consultation processes and accesses the significance of such technologies for the practice of scientific citizenship.

[7] Thiel also addresses that ethical considerations need to be considered.

up to a certain level in order to create a first motivating environment (cp. f.i. on the agenda setting level).

With view to digital infrastructures, methods of science-driven crowdsourcing enabled by the digital are described by Dickel and Franzen (2016), in which a task normally performed by members of an organization is outsourced. Forms of such crowd science relevant in our context also comprise delegating online data collection and assessment to the public. That way, crowd science enables the implementation of large data-intensive projects, which could otherwise hardly be implemented (Franzoni and Sauermann 2014). As Dickel and Franzen (2016) note, knowledge production and the reception of knowledge are becoming increasingly socially inclusive. This raises the question of how much more inclusive new institutions should be and how confidence can be guaranteed if the cycle of experts is expanded. They propose a typology of digitally-supported inclusion models, and on that basis conclude that the line between certified experts and laypeople is blurring (Dickel and Franzen 2016, p. 3).

Big Data as a Technological Enabler

The preceding section primarily dealt with intrinsic factors of motivating participation in citizen science, while this section focuses on extrinsic enablers, with a closer look on big data related technology. We further ask what this could mean for supporting and evaluating governance processes and policy.

It sometimes feels like our society is obsesses with numbers. Scientific theory mostly sees this as a good thing – reproducibility requires prove on the basis of facts, figures numbers. Deming, the inventor of modern quality management and heavy influencer of the reconstruction of post-World War 2 Japan towards the world economic powerhouse of the 1960s, 70s and 80s, coined the following phrase: “In God we trust; all others must bring data”. Books on Amazon with titles referring to data divination are selling well. What does this mean for the future role of the citizen scientist and how does it affects our society? More precisely: How will policy making be conducted in the future? Let’s start with some big numbers first.

Our known universe consists of roughly 10^{80} atoms, a number impossible to fathom. Written out it spells as one-hundred thousand quadrillion vigintillion. Yet Peter Norvig, Director of Research at Google, tends to disagree and argues the (small) number of atoms in the universe. In a blog post referring to Googles breakthrough in beating a human being in the board game of Go, Norvig addresses combinational theory. For example, the number of combinations made possible by a 40-character passphrase, consisting of uppercase, lowercase, numbers and special characters, already reaches the numbers of estimated atoms in our universe. Comparatively, the board game of Go with a 19 by 19 field setup entails 10^{170} legal positions. In other words, combinational theory, which is by nature multiplicative, dwarfs every number of our additive physical nature.[8] Translated to the citizen science domain, in 2015, 3.2 billion people had access to the internet and they are all potentially connected (ITU 2015). This theoretically entails an incredible number of possibilities to share and re-combine data and translate it into valuable knowledge for individuals, business making (What will be the next product a customer buys?) and government (Where is the best place to build a new hospital?)

Combinational theory is just one aspect of the transformational power of ICT enabled by network-connected infrastructure. It is reminiscent of Metcalfe's law, which states that the value of a telecommunications network is proportional to the square of the number of connected users of the system. In other words, every citizen creating data theoretically exponentially increases the value of the network.

The Digitization of Information and a New Breed of Intelligence

Around 2000, two remarkable events related to digitisation took place. First, the amount of digital information surpassed the amount of analogue information. Second, the speed of data and information creation significantly accelerated. Today, a multitude of devices is available at comparatively low costs, enabling the maintenance of networked connections and sensing a multitude of data points; be it RFID-chips, the Internet of things, city sensors or connected sports gadgets. General purpose computers with low power requirements like the Arduino[9] or the Raspberry Pi[10] sell for around 50 € and enable their owners to conceive all sorts of integrated gadgets like home automation devices, weather stations, and beer brewers[11]. However the most widespread digitisation device in use is the smartphone. According to Statista, in 2015 there were 1.8 billion smartphones in use worldwide,[12] which are connected to the Internet most of the time (Fig. 2).

How is this related to citizen science for twenty-first century policy making? Another puzzle piece in our line of argumentation is that of intelligence. When thinking about intelligence, what springs to our mind is human intelligence or secret services. We do not know for sure if people's intelligence changed much in the last three hundred years – the time frame in which modern science formed. Certainly the artefacts we create are increasingly impressive, but this may to a large extent be due to collective intelligence and how we are able to pass knowledge through objects rather than through genes. With view to citizen science something is of greater importance: the ability of algorithms to cope with the plethora of data and informa-

[8] http://norvig.com/atoms.html, retrieved 2016-07-12.

[9] https://www.arduino.cc/

[10] https://www.raspberrypi.org/

[11] http://www.networkworld.com/article/2290609/computers/computers-153240-20-cool-things-you-can-do-with-a-raspberry-pi.html, retrieved 2016-07-12.

[12] http://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/ (data from eMarketer), retrieved 2016-07-12.

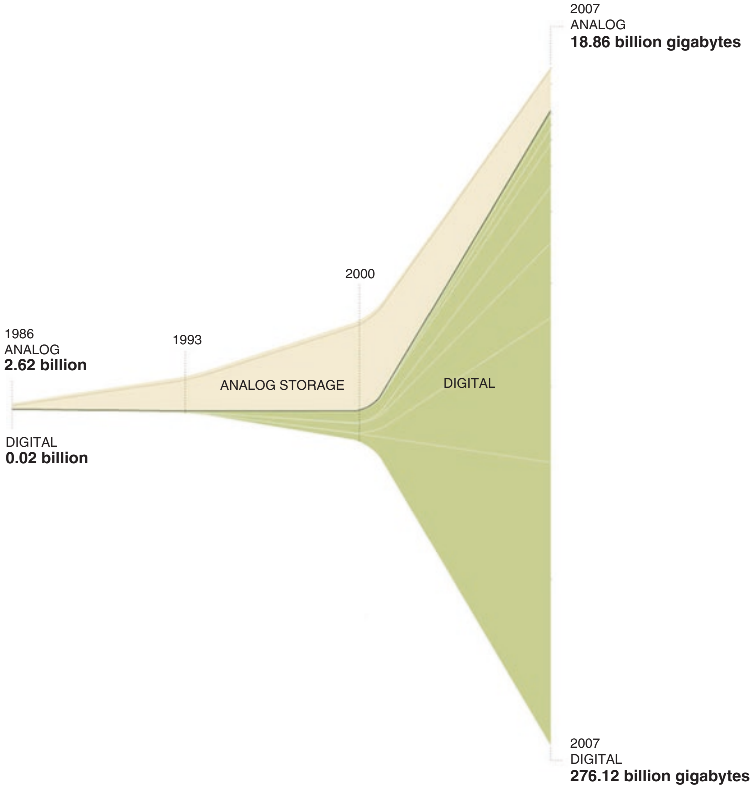


Fig. 2 As of 2000, more information is available in digital rather than analogue and the speed at which data and information accrues tremendously increased (Hilbert and López 2011)

tion generated every day. While the combination of networked devices, exchanging data and information can be the source for better decision-making, it's the algorithms that provide us with the means to actually do so.

Looking back at the combinatorial features we previously identified, the sheer amount of data would be far too large to store, inspect and analyse by any computer system using traditional algorithms. A new way of thinking about problem solving emerged. Striving for optimal solutions in Big Data requires the usage of algorithms which expose polynomial runtime behaviour. Dedicating more computational power in terms of available computing cycles, network speed and storage capacity becomes unfeasible and increasingly impossible. A practical solution outplays optimal solutions which, due to their runtime complexity, may only be able to process a fraction of the available data and thus lead to local optima. "Good-enough" algorithms become necessary if the amount of available data gets too large to be handled by traditional ICT systems (Mayer-Schönberger and Cukier 2013). Imagine an international online retailer. Even such seemingly simple questions such as "How many items of X have we sold today in region Y?" become impossible to answer, given the amount of data accrued over time.

Another crucial aspect of today's ICT systems is the capability to speedily react on external events. This requirement for speed may either be triggered from a single sensor continuously transmitting data, a sensor network whose collectively gathered data results in a continuous data stream, or diverse and heterogeneous data sources combined, like sensor and social media. Instant access to analysis results is paramount.

An illustrative example to this new sort of intelligence we would like to present is the HyperLogLog-Algorithm (Heule et al. 2013). This algorithm on the one hand can deal with enormous amounts of data, yet at the expense of being not 100% accurate. However, this is made up by the ability to analyse many facets in the database to potentially identify multi-perspective patterns. Additionally, this algorithm operates stream oriented, i.e. directly on the data as it arrives at ICT systems. Instead of requiring an additional analysis step, analysis data is available in real time. This is the sort of intelligence we introduced before and which completes the triangle of The Digital Virtuous Forces. It is also this breed to algorithms which prevents misinterpretations in data sets by an ill-chosen or arbitrarily chosen data sampling rate. The importance of correct sampling is well known to statisticians and an integral part of every 101 statistics course. The danger of taking adverse decisions based on incorrect or skewed samples can be adverse to harmful, depending on the consequences drawn from the data. If it's a million dollar business behind, correct sampling becomes paramount. Imagine an online retailer, collecting a vast amount of behavioural data (the "user journey") every day to improve the customer experience and to early react on changes to interaction patterns. Taking no decisions at all can be better at times instead of taking the wrong decision. That's what has happened to Internet giant Ebay in 2003. Back in 2003, Ebay collected a vast amount of web interaction patterns but was only able to analyse parts of that precious data. Future decisions were based on the reliance on correct or good sampling techniques. Analysts knew that due to their inability to incorporate all the data into their decision and alert models, valuable data patterns will remain undiscovered and spurious patterns arouse where there are actually none.[13] Using algorithms, which can inspect the data in its entirety yet at the cost at not arriving at absolutely exact results, was favourable for Ebay.

By describing the changed characteristics of ICT systems we introduced an important concept which we think will change the way government policy is made at each and every level in the future: big data analytics. Big data may be defined as the "cultural, technological and scholarly phenomenon" made up of the interplay of algorithmic analysis of large datasets in order to identify patterns (Boyd and Crawford 2012; Ulbricht 2016).

While the technological dimension is emphasised, it should also be noted that big data also entails an important cultural dimension, in our context referring to the

[13] Cliff Saran: How big data powers the eBay customer journey. Case study, Computer Weekly, 2014-04-29 (http://www.computerweekly.com/news/2240219736/Case-Study-How-big-data-powers-the-eBay-customer-journey, retrieved 2016-12-11).

growing significance and authority of quantified information in public administrations and decision making (Rieder and Simon 2016). Drawing on the thesis that big data is said to advance government efficiency and support evidence-decision making, potential risks and challenges should also be considered. We will briefly cover them in the last chapter.

This section explained the role of ICT to shape the digital citizen sphere and presented some methods to foster citizen engagement. The following section will discuss a big data powered policy cycle including the citizen scientist.

The Big Data Enabled Policy Cycle

The widely accepted model for the design of government policy making is the policy cycle. Originally described 1956 by US political science researcher Harold Dwight Lasswell, the policy cycle provides a theoretical frame to explain government policy making. Depending on the chosen abstraction level and granularity of the step model, (a) Agenda Setting, (b) Policy Discussion, (c) Policy Formulation, (d) Policy Acceptance, (e) Provision of Means, (f) Implementation and (g) Evaluation can be distinguished. The cycle is a helpful instrument for all affected stakeholders like politicians, public administration, NGOs, business entities, and the public when organizing campaigns to respect regulations, or which supportive or enabling ICT instruments can be considered. However, the policy cycle does not come without criticism. First it should be understood as a heuristic which requires tailoring to the actual needs. In practice, the sharply distinguished steps will overlap or certain steps left out altogether (Prozesse—Der Policy-Cycle 2009, p. 110). Everet et al. also identify an overemphasis on the process itself rather than quality or performance (Everett 2003).

Arguably the biggest factor of influence to this approved model is technological change. As we identified, the biggest amount of data today is digital, arrives at high speed and is, due to its plentiful sources, of varying structure. Looking at the traditional policy cycle, the model is iterative, with evaluation happening at the last step. This was justified at times when data was primarily analogue and information a scarce good. However, Big Data methodologies provide the means to inspect massive quantities of data in or near real time, to discover new insights through mining yet undiscovered patterns and to visualize complexities in such ways that actionable results can be immediately derived from Kim et al. (2014). The most problematic aspect of the traditional policy cycle is that evaluation happens as a separate and detached process at the end of the policy making process, which wastes time otherwise available for re-focusing of initiatives or dropping unsuccessful measures altogether. It also does not account for the possibility of a continuous inclusion of evaluation and simulation results to re-assess policies based on evidence (Höchtl et al. 2015) (Fig. 3).

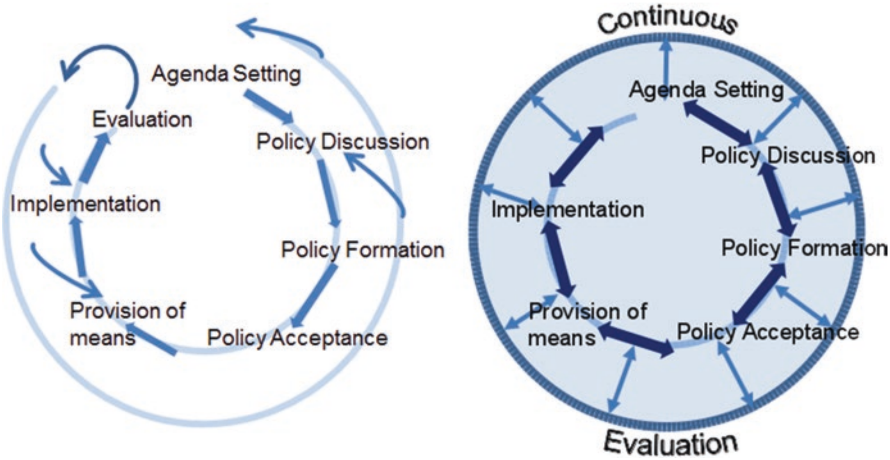


Fig. 3 *Left*: The policy cycle as described by Nachmias and Felbinger, 1982 (Nachmias and Felbinger 1982); *Right*: The big data enabled ePolicy cycle including continuous evaluation

The ePolicy Cycle and the Citizen Scientist

With view to the key concept introduced by Höchtl et al. (2015) of continuous evaluation happening all along the policy cycle, the crucial question is by whom and how evaluation is executed? The administration itself can, will and already does employ big data technologies to better detect tax evasion, forecast disasters based on past damage records, or to address climate change and its effect on the availability of food and water (Mather and Robinson 2016). The tighter integration of yet dispersed data sources is expected to make data based evidence available quicker with the aim to act or foresee large-scale, systemic changes. In the future, algorithms will play an important role in helping policy makers to rectify changes to agreed policies and to instantaneously act on change.

Despite algorithmic approaches, the human ingenuity still excels in detecting patterns in seemingly unrelated data sets. Moreover, citizens increasingly own and operate distributed computing and sensing devices, be it the smartphone or dedicated small scale computers like Arduinos or Raspberries. Therefore the inclusion of citizens into the policy evaluation phase in an organized, structured way including scientific means could draw on citizens' skills, creativity and curiosity for supporting the evaluation of government policy making.

While the inclusion of citizens into government policy making is not new, the ability of citizens to engage in evaluation and monitoring actions in a scientific way is fostered by the availability of big data tools, methodologies and means. However, in the same way as participation will not happen simply by providing the tools and means, incentives and supportive measures will be required to promote citizen participation in science. Depending on intrinsic motivations, personal skills, and interests, a different set of techniques can be employed to encourage citizens to engage in policy evaluation, which may vary from levels of passive participation (lurking), active participation, participation without taking explicit notice (implicit participation) up to coordinated citizen science leagues. Participation enhancing methods such as gamification approaches could also create a breed of citizen scientists without them actually taking notice. The ethical implications of this possibility have to be considered.

Use Cases for the Citizen Scientist in the Policy Cycle

In this section we deduct three use cases of citizen scienceship in policy making, summarise some evidence or enabling elements and analyse the required setup for the successful application of these elements between government and citizens.

Augmented Reality and Gamification Assuming a local authority is undecided whether it should invest in renovating a school or building a new park. There are no legal obligations to prioritize one measure over the other, and even experts are undecided. In a virtual reality environment the government city planners sketch a model of the actual city. People from all around the world subsequently connect to this open playfield and start to model their ideal city. Their activities will become immediately visible to all the other participants of this virtual city. Additionally, every virtual city planner can inspect the planning efforts of the others and what infrastructure he or she has built. After every planning period an election takes place to vote for the chief city planner.

The city has access to the process data of this virtual environment, containing information about which infrastructure was built, which was demolished and how the virtual residents are using their city. They can also see who was elected as chief city planner and replay and analyse the measures taken by her or him. By overlaying the design elements of the virtual city with the actual city by means of augmented reality, the virtual artefacts become immediately tangible.

Enabling elements Assuming that a lot of people enjoy engaging in virtual environments, augmented reality methods for city planning can be successful. One example of a city building simulation in the past is SimCity, which was a huge success even when computers where not yet connected to the Internet. Today peoples' interest in creating an alternate or ideal world has not waned. Minecraft[14] is one example of a game which can be played in a massive multiplayer online mode to design virtual worlds. In *Civic Crafting in Urban Planning*, Mather et al. discuss the potential of using Minecraft for public consultations and argue that serious games in planning can capture participants' attention for a longer period of time, educate the public about planning concepts and site-specific challenges (Mather and Robinson 2016).

[14] https://minecraft.net/en/, available on PC, handhelds and gaming consoles and found its way into many more applications but designing virtual worlds.

Analysis In this use case scenario, the city planning council takes the role of a facilitator by creating a model of the existing city. Additionally it sets the rules to keep people engaged in participating in the virtual planning process, for example by promoting participants to become planning directors, etc. through other players vote. The citizens need not necessarily know that they are taking part in a serious game and that their actions might have an influence in the real world. By choosing a gamification approach, the citizen scientist uses his devices and means to participate, yet the incentives of participation can be "hidden". Instead of scheduling assignments, it is the quest and challenge of the virtual environment which will attract the participants. By using virtual reality elements, the rules of the game can be kept within reasonable constraints, reducing the risk that the citizen scientists create infrastructure which in reality would be inconceivable. The application of augmented reality and gamification to support policy making could be used in the *Agenda Setting* step, where citizens' wishes in the virtual world can be used to prioritize actions in reality.

Ubiquitous computing devices Most smartphone apps fulfil a very specific user need and most users accept trading usability in exchange for granting access to her or his phones sensors (e.g. location) and even more so to contact details. The combination of increased tools usability in conjunction with communicating the goals of the authority could provide another use case. State services would need to provide increased usability levels compared to the offline version or the browser version, e.g. by being seamless integrated into more backend systems without requiring the service user to log into multiple sites to collect information just to enter this information onto another site. Users might then accept the fact that these apps access the phones sensors to deliver data to the authorities, which could support a number of goals, e.g. to reduce traffic jams, or to support early warning systems (rise of temperature in certain regions) in exchange for increased usability. Depending on whether the goal is communicated, users could become citizen sensors knowingly or unknowingly.

Enabling elements The University of Vienna engaged in a joint venture with Samsung to utilize the capacity of smartphones during charging. Cancer and Alzheimer research is computationally intense and involves scanning protein sequences for patterns. Only after the phone is fully charged, a roughly one megabyte large data package will be downloaded by the app Power Sleep,[15] which comes as an alarm clock. The App then inspects and analyses the data package and sends results back to the medical research units.

Analysis The capability to effectively distribute work to many participating nodes in such a way that only little effort is wasted in the coordination of work, combined with algorithms which can efficiently operate on a mere subset of the data, is an achievement of big data research. The citizens' role in the above scenario is that of an active facilitator – he or she will most likely deliberately participate out of altru-

[15] http://www.iflscience.com/technology/new-app-crunches-scientific-data-while-you-sleep/

istic motives. In this role the citizen scientist is unable to influence the details, like the used algorithms, of the performed analysis, which remains under the control of the institution or organisation who is issuing the data for inspection. This is also true for the research results: While the citizen scientist contributes resources, the benefits are harvested elsewhere. The usage of citizen resources by the government is best employed in the *Provision of Means* policy cycle step.

Co-creation Complementary to the voluntary offering of resources by citizen scientists via smartphones in exchange for usability is the idea of planning, designing, and implementing citizens' devices or even infrastructures to sense social and/or environmental phenomena, to collect and aggregate the associated data, and to stream them to a central repository or to provide access to the device/installation via an open API. Such an actively developed networking infrastructure goes beyond the concept of pure data collection and enable participants to actively develop and enhance the underlying scientific ICT infrastructure, transforming the associated projects into living environments. Additionally, the gathered data as well as the research results remain und the control of the.

Enabling elements A prominent example for such an user-implemented sensor network infrastructure can be found in form of the Citizen Weather Observer Program (CWOP),[16] in which private individuals host weather stations that are either using amateur radio or Internet connectivity to transmit collected data. The available sensors range from humidity and temperature sensors, up to sensors for wind speed, barometric pressure and rainfall. While a lot of vendor-sold setups for weather observation exist, a huge group of individuals works with small computerized boards such as the Arduino platform or Raspberry Pies, which provide a high level of extensibility and interconnectivity with other devices and electronic components. Furthermore, the open platforms enable users to freely program their setups in various computer languages. This opens up a plethora of possibilities with view to analytical processes or visualizations.

Analysis Extending the idea to use citizens computing resources, co-creation by citizens requires more intense and ongoing participation levels. Here, a crowd or community of citizen scientists needs to organize themselves, define the objectives, agree on the tools and infrastructure, schedule tasks and governance structures to accomplish a goal. In the most likely case, the government will profit from the results, but seek to secure methodological rigor and soundness of science projects' outcome. The government can support such efforts by legally endowing the opening up of government data and APIs, through specialized research grants also targeting individuals, by providing cloud computing infrastructure which can be used by the citizens like EU's FIWARE platform,[17] or by providing crucial software components as open source like NASA's open source building blocks.[18] Big data tools like platform as a

[16] http://wxqa.com/, retrieved 18.07.2016.

[17] https://www.fiware.org/

[18] https://code.nasa.gov/#/

service (PaaS) cloud-computing and cloud-backed decentralized code management services represent technological enablers for citizen science co-creation. Co-creation is best employed in the *Implementation* step of the ePolicy cycle.

Challenges, Issues and Future Implications

Citizen science in combination with big data and evidence-informed decision making raises some issues that should to be addressed at the beginning of projects and throughout the course of scientific investigation (Resnik et al. 2015). In this context, ethical, legal, social and project-related challenges can arise,[19] not only as technology is always situated in a political context (Feenberg 2010), and critical data studies, while in its infancy, have addressed such issues. It seems that all around the world, policy-makers have taken on a hype, and big data is often referred to as the “new oil of the digital age” (European Commission 2012), while at the same time criticised as support of techno-capitalism (Rieder and Simon 2016). Going even further, there is an increasing tendency among citizenry to ignore facts obtained by investigative and data driven journalism. The Trump election campaign or the Brexit were two examples of phenomenon which we might increasingly observe: Neglecting factual proof, irrespective of the efforts and clarity which has been laid on data gathering, model crafting and visualisation making. People believe in what they want to believe.[20] This raises questions of which areas in policy making do make sense to include the citizenry in data driven policy making and to what extend large scale policy making will always remain driven by sentiments rather than by facts, independent of how tangible and easy to understand these facts will ever be presented. This situation is likely to be aggravated by recent advances in non-deterministic and self-improving algorithms like Artificial Intelligence with feedback loops or stacking of algorithms in deep learning arrangements. While the results obtainable by these algorithms or algorithmic arrangements are stunning and are an important aspect to master the complexity of e.g. autonomous vehicles, they are hardly suited for automated decision making, affecting citizens life. Transparency involves many areas such as the availability of data and information for once - the ability to explain citizens why a decision has been made will rise in its importance. The jurisdictions of Germany and Austria have already reacted and grant citizens the right to access the algorithms which have been used to support decision making. This, however, requires the used algorithms to be accessible in a way so their inner working can be explained to the ordinary citizen.[21]

[19] Metcalf and Crawford identified several cases of an “ethics divide” in the big data context and address disputes about human-subjects research ethics in data science.

[20] Down on the Data: facts are not the only truth in life. Greg Jericho, The Guardian, 2016-09-19 (https://www.theguardian.com/commentisfree/2016/sep/19/down-on-the-data-facts-are-not-the-only-truth-in-life, retrieved 2016-12-11).

[21] Data Protection Act Austria (Datenschutzgesetz, DSG), BGBl. I Nr. 165/1999, §49 (3).

While the general consensus is that data analysis can lead to important insights, significant power shifts and advantages and disadvantages for individuals, groups or communities, can arise. Some voices, like cultural critic Slavoj Žižek, have emphasised that humans would not benefit from it, and leaders would probably make decisions not based on data evidence, but still on their own ideological fantasies, claiming that big data analytics would be like "showing Hegel's logic to a cow".[22]

Rieder and Simon (2016) argue that while the consequences of big data have been a concern, the *underlying culture of measurement and quantification has not*, and discussions have focused on modalities of change rather than forms of continuity, framed in a narrative of novelty and disruption. Culturally, this can be explained by an effort to reduce uncertainty in societies. The authors address the recent interest in evidence-based policy making and more data-driven forms of governance and relate big data to a distinct political culture based on public distrust and uncertainty. However, more data does not necessarily equal better insights (Rieder and Simon 2016). With the demand for quantitative rigor increasing in societies, a culture of quantification risks reducing the human element, and why the reasons for this shift can be explained as a strategy to adapt to new external pressures, it can also be interpreted as a chance to *de-politicize legislation* (Rieder and Simon 2016). A framework for addressing ethical challenges in citizen science has been provided by Resnik et al. (2015). They propose that for promotion of ethical research, scientists should develop guidelines and provide laymen with education and training on the conduct of research.

Conrad and Hilchey (2010) identified three main areas for challenges regarding the concept of citizen science. While these challenges are situated within their work in the field of community-based monitoring, the authors see them as generic issues regarding the concept of citizen science in general. The first area relates to the *aspect of the number of people involved as well as how to trigger their interest to participate*. This also interrelates to whether or not there exists an established and well-curated network for communication and exchange, which furthermore is also impacted by the provided funding, not only for the citizen science project itself but also for related environmental, organizational, and infrastructural aspects.

The second area covers *challenges in terms of data collection and associated processes*. In order to fulfil many analytical tasks, it is imperative that data are available on a continuous time basis. If the collected data is heavily fragmented, analyses over time become very difficult. Furthermore, there have to be processes defined which provide the necessary means of a guaranteed level of accuracy regarding measurements. Mistakes or measurement errors in the early phase of the project can negatively impact all other succeeding steps. Furthermore, data collected by individuals are always prone to a certain personal bias, and in a more general way, modern data analysis software is often not understandable for the average citizen.

The third area is the *actual use of the data collected within the actual policy/scientific context*, i.e., the adaption by policy-makers in their decision-making process or the publication in a suitable journal. Due to the before-mentioned quality

[22] https://www.youtube.com/watch?v=PBBzYG8szmc (accessed 15th July 2016).

aspects, results are often disregarded as invalid or processes not compatible with the expected level of scientific rigor.

Future citizen science projects have therefore to adapt their processes and overall strategy to overcome these challenges, therefore Newman et al. (2012) foresees future directions of citizen science strongly be based on concepts such as viral marketing, e.g., using social media, interconnected databases, and the initiation of cyberinfrastructures as flexible and scalable backbones. The development of research questions will be predominantly via bottom-up approaches, bringing together practices of amateur research and open science and open source (Dickel and Franzen 2016), supported by intuitive visualization for displaying and navigation data, available in real-time. High quality data will be available 24/7 via globally distributed, high-availability databases. In addition to accessibility, the newly designed cyberinfrastructures offer high-performance, cloud-based computing for everyone, fostering joint collaborations between quantitative and qualitative science fields such as natural and social sciences. The dissemination process will improve due to peer-assessments via social community platforms across the globe. At the same time, this will lead to overall community-accepted key performance indicators, which can be adapted to projects of various scales. The newly formed (virtual) citizen science communities will bridge existing geographical gaps, to enable better and faster exchange and adoption of gained knowledge. The motivation behind participating in these communities will be based on gamification-driven processes, which reward individuals not only with new technological insights but also with reputation within the community, e.g., expressed via achievement badges or ranks.

If citizen science wants to address these challenges, it will be necessary to ask the question how big data relates to power, and how we want to shape the big data society. It is important to note that unethical use of big data can be controlled, and unequal power balances can be recalibrated (Ulbricht 2016). Ulbricht mentions granting wider access to data and data analysis as one way to challenge the privileged position of data collectors and controllers, and also to provide data subjects with participation rights and comprehensible formation. Open data initiatives and increasing public transparency about datasets will be crucial in this context. However, every project should address questions of possible power shifts that might arise, and which unintended consequences they could cause. On the basis of wider knowledge, it will be possible for policy makers to choose the appropriate protection measurements against such threats (Ulbricht 2016). In this context, more empirical studies about the consequences of such projects in the governance field will be necessary in order to be able to make good use of the new instruments.

References

Bakardjieva M (2009) Subactivism: lifeworld and politics in the age of the internet. Inf Soc 25(2):91–104

Bennett WL, Segerberg A (2012) The logic of connective action. Digital media and the personalization of contentious politics. Commun Inf Soc 15(5):739–768. http://dx.doi.org/10.1080/1369118X.2012.670661

Bowser A, Hansen D, Preece J, He Y, Boston C, Hammock J (2013) Gamifying citizen science: a study of two user groups. Proceedings of the companion publication of the 17th ACM conference on computer supported cooperative work & social computing, ACM, pp 137–140
Boyd D, Crawford K (2012) Critical questions for big data. Inf Commun Soc 15(5):662–667. doi: 10.1080/1369118X.2012.678878
Carpenter DP (2001) The forging of bureaucratic autonomy: reputations, networks, and policy innovation in executive agencies, 1862–1928. Princeton University Press, Princeton
Carr AJL (2004) Why do we all need community science. Soc Nat Resour 17:841–849
Catlin-Groves C (2012) The citizen science landscape: from volunteers to citizen sensors and beyond. Int J Zool 2012(2012):349630. http://dx.doi.org/10.1155/2012/349630. http://www.hindawi.com/journals/ijz/2012/349630/. Accessed 15 July 2016
Conrad CC, Hilchey KG (2010) A review of citizen science and community-based environmental monitoring: issues and opportunities. Environ Monit Assess 176(1–4):273–291
Cooper CB, Dickinson J, Phillips T, Bonney R (2007) Citizen science as a tool for conservation in residential ecosystems. Ecol Soc 12(2). http://www.ecologyandsociety.org/vol12/iss2/art11/. Accessed 15 July 2016
de Montalvo UW (2003) In search of rigorous models for policy-oriented research: a behavioural approach to spatial data sharing. URISA J 15(1):19–28
Dickel S, Franzen M (2016) The ‘Problem of Extension’ revisited: new modes of digital participation in science. J Sci Commun 15:1–15
European Commission (2012) From crisis of trust to open governing. Http://europa.eu/rapid/press-release_SPEECH-12-149_en.htm. Accessed 15 July 2016
Everett S (2003) The policy cycle: democratic process or rational paradigm revisited? Aust J Public Adm 62:65–70
Feenberg A (2010) Between reason and experience. Essays in technology and modernity. MIT Press, Cambridge/London
Feyerabend P (1978) Science in a free society. Verso Books, New York
Feyerabend P, Hacking I (2010) Against method. Verso, London/New York
Finke P (2014) Citizen science. Das unterschätzte Wissen der Laien. oekom, München
Franzoni C, Sauermann H (2014) Crowd science: the organisation of scientific research in open collaborative projects. Res Policy 43(1):1–20. doi:10.1016/j.respol.2013.07.005
Friesike S, Widenmayer B, Gassmann O, Schildhauer T (2015) Opening science: towards an agenda of open science in academia and industry. J Technol Transf 40(4):581–601
Giddens A (1990) The consequences of modernity. Polity Press, Cambridge
Haklay M (2010) ‘Extreme’ citizen science, London Citizen Cyberscience Summit, London, 2–3 Sept
Harzing AW, van der Wal R (2008) Google scholar as a new source for citation analysis? Ethics Sci Environ Politics 8(1):61–73
Haythornthwaite C (2009) Crowds and communities: light and heavyweight models of peer production, in proceedings of the 42nd Hawaii international conference of system sciences. IEEE Computer Society, Los Alamitos
Heule S, Nunkesser M, Hall A (2013) HyperLogLog in practice: algorithmic engineering of a state of the art cardinality estimation algorithm. Proceedings of the EDBT 2013 conference, Genoa, 2013
Hilbert M, López P (2011) The world’s technological capacity to store, communicate, and compute information. Science 332:60–65
Höchtl J, Parycek P, Schöllhammer R (2015) Big data in the policy cycle: policy decision making in the digital era. J Organ Comput Electron Commer
Irwin A (1995) Citizen science. In: A study of people, expertise and sustainable development. Routledge, London/New York
Irwin A (2001) Constructing the scientific citizen. Science and democracy in the biosciences. Public Underst Sci 10(1):1–18
ITU: ICT facts and figures – the wold in 2015 (2015) Geneva
Kim G-H, Trimi S, Chung J-H (2014) Big-data applications in the government sector. Commun ACM 57:78–85

Lazer D, Pentland A, Adamic L, Aral S, Barabási A-L, Brewer D, Christakis N, Contractor N, Fowler J, Gutmann M, Jebara T, King G, Macy M, Roy D, Van Alstyne M (2009) Computational social science. Science 323(5915):721–723. doi:10.1126/science.1167742
Mather LW, Robinson P (2016) Civic crafting in urban planning public consultation: exploring Minecraft's potential. Int J E-Plan Res 5:42–58
Mayer-Schönberger V, Cukier K (2013) Big data: a revolution that will transform how we live, work, and think. Eamon Dolan/Houghton Mifflin Harcourt, Boston
McNair B (2009) The internet and the changing global media environment. In: Chadwick A, Howard PN (eds) The Routledge handbook of internet politics. Routeledge, New York, pp 217–229
Nachmias D, Felbinger C (1982) Utilization in the policy cycle: directions for research. Rev Policy Res 2:300–308
Newman G, Wiggins A, Wiggins A, Graham E, Newman S, Crowston K (2012) The future of citizen science: emerging technologies and shifting paradigms. Front Ecol Environ 10(6):298–230
Nonnecke B, Preece J (2000) Lurker demographics: counting the silent. Proceedings of CHI 2000. CHI 2000, ACM, The Hague
Nosek B (2015) Estimating the reproducibility of psychological science. Science 248(6251). doi:10.1126/science.aac4716
Papacharissi Z (2009) The public sphere and beyond. In: Chadwick A, Howard PN (eds) The Routledge handbook of internet politics. Routeledge, New York, pp 230–245
Parycek P, Schöllhammer R, Schoßböck J (2016) Governmental ideation systems. In: Carlsen A, Cerne M, Dysvik A, Skerlavaj M (eds) Capitalizing on creativity at work: fostering the implementation of creative ideas in organizations. Edward Elgar Publishing Inc., Cheltenham, pp 305–319
Prozesse—Der Policy-Cycle (2009) In: Politikfeldanalyse. VS Verlag für Sozialwissenschaften, pp 101–140
Ratto M, Boler M (2014) DIY citizenship. Critical making and social media. MIT Press, Cambridge, MA
Reinhart CM, Rogoff KS (2010) Growth in a time of debt. National Bureau of Economic Research
Resnik DB, Elliot KD, Miller AK (2015) A framework for addressing ethical issues in citizen science. Environ Sci Pol 54:475–481
Rieder G, Simon J (2016) Datatrust: or, the political quest for numerical evidence and the epistemologies of big data. Big Data Soc 2016:1–6. doi:10.1177/2053951716649398
Sawhney M, Prandelli E (2000) Communities of creation: managing distributed innovation in turbulent market. Calif Manag Rev 42(4):24–54
Schudson M (2000) Good citizens and bad history: today's political ideals in historical perspective. Commun Rev 1(4):1–20
Stevens M, Vitos M, Altenbuchler J, Conquest G, Lewis J, Haklay M (2014) Taking participatory citizen science to the extremes, pervasive computing. IEEE CS 13(2):20–29
Svensson J (2014) Political participation on social media platforms in Sweden today: connective individualism, expressive issue-engagement and disciplined updating. Int J Media Cult Politics 10(3):347–354
Taleb NN (2007) The black swan. The impact of the highly improbable. Random House, New York
Thiel S-K (2016) A review of introducing game elements to e-particpation. In: Edelmann N, Parycek P (eds) CeDEM 16. Proceedings of the 6th international conference for e-democracy and open government, IEEE computer society no. P5845, 3-9
Ulbricht L (2016) Big data: big power shifts? Internet Policy Rev 6(1):1–8
Van Dijk JAGM (2009) One Europe, digitally divided. In: Chadwick A, Howard PN (eds) The Routledge handbook of internet politics. Routeledge, New York, pp 288–304

Johann Höchtl is senior researcher at the Centre for E-Governance at Danube University Krems and holds a doctoral degree in Business Informatics. The projects he is involved in include EU-funded research projects and national grants in the domain of large-scale data governance, social media application in administration, open data and inclusive approaches of ICT application in public administration. He is former member of OASIS SET TC standardisation group, member

of OKFN Austria and member of Cooperation Open Government Data Austria, where he is heading data quality sub working group. He was advisor to the E-Georgia strategy for the public administration and advisor to Macedonia (FYROM) to raise interoperability capabilities among federal ministries.

Judith Schossböck is a research fellow at the Centre for E-Governance at Danube University Krems, Austria. Among her research interests are online participation and activism, open government and open access, digital literacy, the sociopolitical effects of ICTs and occasionally cyber utopia or dystopia. She was involved in a study on the internet skills of the 14 years old youth in Austria, the development of a youth participation platform on which four European countries cooperated and a project researching electronic identification in online participation. In 2016, she won a scholarship from the Research Grants Council of Hong Kong (HK PhD Fellowship Award)

Thomas J. Lampoltshammer holds a doctoral degree in Applied Geoinformatics in addition to his Master's degrees in the fields of Information and Communication Technology, Embedded and Intelligent Systems, as well as in Adult Education. He currently works as a Senior Scientist (Post Doc) at the Department for E-Governance and Administration at the Danube University Krems/Austria. Prior to his current position, he has worked as a Researcher and Lecturer in Applied Informatics at the School of Information Technology and Systems Management at the Salzburg University of Applied Sciences Salzburg/Austria. His research experience covers national and EU-funded projects in ICT-related topics, such as Geoinformatics, Semantics, Social Media, Legal Informatics, and E-Health. He is member of the ICA Commission on Cognitive Issues in Geographic Information Visualization and acts as reviewer for several SCI-indexed journals.

Peter Parycek is full professor for eGovernance and head of the department for eGovernance and Administration at the Danube University Krems. He holds a doctoral degree in legal sciences (University Salzburg) and a master's degree in telematics management (Danube University Krems). As head of the department he is responsible for coordinating the eGovernance research groupe, development and coordination of academic programmes and for the management of national and international cooperations with public and private partners. He conducts research at the intersection of legal science, technology and political science. From 2006 until 2011, he was chairman of the Austrian working group e-democracy and e-participation of the Federal Chancellery. From 2010 until 2011, he contributed to the conceptualization of an E-Government-Act for the Principality of Liechtenstein. He has founded the International Conference for e-Democracy and Open Government (CeDEM) and is co-initiator of the open access journal JeDEM

Governance Failure in Light of Government 3.0: Foundations for Building Next Generation eGovernment Maturity Models

Morten Meyerhoff Nielsen

Abstract Demographic, economic and other challenges is putting the public sector and service deliver under increasing pressure. ICT as an enabler of increased efficiency, effectiveness and transformation has long been recognized as part of the solution. National experiences show that the potential of ICT has not been fully realized, especially not in relation to Government 3.0 (Gov3.0). Existing public administration, information systems management and eGovernment literature and individual studies all point to the role of governance and cross-organisational cooperation in successfully introducing eServices and citizens actual use of them.

With a specific focus on eGovernment and eGovernance maturity and stage models, the literature attempt to unearth the underlying reasons why countries with similar infrastructures and eService availability experience very different levels of online interaction with the public sector, and in particular whether existing stage models address governance and cooperation.

Unfortunately, the review highlight a number of gaps including: Focus on outcomes and actual use is missing; most lack a real understanding of core government service concepts; decision-making should not be considered an eGovernment maturity level; front-office service provision and back-office integration is mixed-up; none addresses governance directly; most models are merely restructure or adjust existing ones, and none address Gov3.0 as such.

Introduction

With demographic, economic and even climatic changes, the public sector and service delivery will to face change in the coming years. In this regard the potential of Information Communication Technology (ICT) as an enabler of public sector

M. Meyerhoff Nielsen (✉)
Tallinn University of Technology, Ragnar Nurkse Department of Innovation and Governance, Akadeemia tee 3, 12618 Tallinn, Estonia
e-mail: morten.nielsen@ttu.ee; https://www.ttu.ee/nurkse

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_4

efficiency, effectiveness, modernization and transformation as long been recognized by academia, international organisations, governments and public administrations alike.

Gov3.0 is loosely defined as the capture next generation infrastructure, organizational structures, process and services required for the ICT-enabled transformation of the public sector (Janssen et al. 2009). Through openness, sharing, increased communication and cooperation the public sector, citizens, businesses and non-governmental stakeholders, the aim is for government to be more service-oriented, competent, and transparent, to proactively provide personalized and customized public services and generate new jobs in a creative manner by opening and sharing government-owned data to the public and encouraging communication and collaboration between government departments (Charalabidis 2015; Ministry of Interior Korea 2016).

As technology change, so do the skills, rules and regulations, costs, organisational models, service types and delivery channels required to transform government functions and public service delivery in light of Gov3.0 (Pollitt 2014; Frissen et al. 2007). Various case studies and international benchmarks show that individual authorities and governments have had vastly different degrees of success in utilizing the benefit of ICT in public administration, especially in light of rapid technological change. Still the failure of public administrations to successfully the full potential of ICT is not fully understood. This chapter will emphasis the need for strong governance and cross-governmental models of cooperation in order to harness ICT efficiently and effectively to transform public sector, service delivery and relationship between the public sector, business and citizens (EC 2012; OECD 2014; UNDESA 2014; Christine Leitner et al. 2003; Millard et al. 2007; Huijboom et al. 2009a).

Governance and cooperation has long been the focus of academic discourse, including: Public administration, in particular ICT enabled public sector reform (Brown and Magill 1994; Heeks 2005; Bannister and Connolly 2011; Pollitt and Bouckaert 2011; Cordella and Bonina 2012); information systems (IS) management (Brown and Magill 1994; Brown and Grant 2005; Klischewski and Scholl 2008; Ross et al. 2006; Weill 2004; Poeppelbuss et al. 2011), and; electronic government and governance research (i.e. eGovernment and eGovernance) (Heeks and Bailur 2007; Millard et al. 2008; Huijboom et al. 2009b). Several authors have highlighted failures to address specific issues including merely digitizing existing processes (Bannister 2001; Traunmüller and Wimmer 2003; de Bri and Bannister 2010), only addressing technology and supply (Janssen et al. 2012; Lips 2012; Meyerhoff Nielsen 2015), and ignoring the outcome and impact of ICT use (Cordella and Bonina 2012; Bannister 2007; Andersen and Henriksen 2006). The aim of this chapter is to identify and review the existing literature to assess the degree to which governance and cooperation is addressed – elements which are essential if public authorities are to realise the potential of ICT and Gov3.0.

First public administration, IS management and eGovernment literature will be explored. The aim is to identify the most relevant stream for a literature review (section "Background"). The literature review methodology (section "Methodology") and its findings are presented and discussed (sections "Stage and Governance Models" and "Review of Existing Stage Models"). The article concludes by recommending potential further research (sections "Conclusion" and "References").

Background

Research related to IT and technology use in public administration has progressed, and consequently the focus has shifted over time. Researchers such as Bannister (2007), Brown and Grant (2005), Heeks and Bailur (2007), Scholl (2009), Yildiz (2007), and ongoing research by Jukić et al. (2015), illustrate the changing focus of academic discourse. Initially the focus was on measuring and evaluating the maturity of ICT in public administration (from 1999/2000), followed by analysis of environmental and precondition issues (e.g. awareness, infrastructure, digital divide, etc.). The focus shifted to the evaluation of the availability of eGovernment services (i.e. supply, maturity level, etc.). Subsequently the research focus has moved to the actual use eGovernment solutions (i.e. demand usage, the gap between interest and use, the factors that affect the use, etc.) and the evaluation of eGovernment impacts (i.e. effectiveness, efficiency, equity, etc.). Of late, the innovative use of ICT in "SMART city" and decision making (e.g. eParticipation and eDemocracy) has been in vogue.

The term 'electronic government' was first coined in 1993 by the US National Performance Review, while the abbreviated form 'eGovernment' became prominent around 1997 (Heeks and Bailur 2007). That said, ICT has played a role in public sector service delivery since the middle of the twentieth century – as exemplified by Gammon's 1954 review article on the automatic handling of paper work in the public sector (Gammon 1954). In this chapter, eGovernment is defined as "the use of ICT and its application by government for the provision of information and public services to the people" (UNDESA 2014).

The definition of eGovernment stands in contrast to electronic governance (i.e. eGovernance), which encompass all processes of governing, whether undertaken by a government, market forces, a network (e.g. family, tribe, professional), formal or informal organization, a geographical territory or whether through laws, norms, power or language (UNDESA 2014). In other words, governance refers to what the 'governing bodies' responsible for eGovernment do to ensure success.

Governance and cooperation in relation to public sector service delivery matters for a number of reasons. An early estimate indicate that top performing companies generate up to 40% greater return than their competitors for the same investment in ICT (Weill 2004).

ICT Enabled Reform in Public Administration

ICT use in public administration is in the literature seen in two ways: As a tool to rationalize existing process or as an instrument to rethink the public sector, re-engineer processes and organisations (Cordella and Bonina 2012).

ICT as a tool to increase public sector performance and efficiency is closely associated the New Public Management (NPM) literature (Cordella and Bonina 2012; Cordella 2007; Demmke 2006). NPM brings the private sector corporate way of thinking to public administration, thus shifting the focus from effectiveness to efficiency through a new management culture and a focus on measurable results, often cost savings (Pollitt and Bouckaert 2011; Cordella and Bonina 2012; Self 2000).

The expectations of ICT enabled NPM reforms has nonetheless be questioned due to the complexity of organisational change and the political ramifications (Cordella and Bonina 2012; Peters and Pierre 1998; Iribarren et al. 2008). Authors like Bannister highlight the ability of ICT to transform the public sector, creating a Joined-up Government (JUG) where inter-governmental collaboration and coordination is supported by technology (Bannister 2001; de Bri and Bannister 2010).

In contrast to NPM, JUG (also known as collaborative public management or Gov 2.0), aim to reintegrate the public sector often fragmented by NPM reform (Cordella and Bonina 2012; Huijboom et al. 2009b; Christensen and Lægreid 2007; O'Leary et al. 2006). Lips' definition of Public Administration 2.0 (Lips 2012) goes as far as dropping the "e" in order to accommodate the complex and dynamic none-technical and contextual aspects of public administration reform.

What classical public administration literature seem to lack, is the merger NPM and JUG, i.e. the role governance in the introduction of ICT in public administrations in combination with measuring maturity levels and ICT take-up.

IS Management

Like the definitions of 'public administrative reform' and 'eGovernment', IS management and computer science literature offer a host of definitions and semantic variations (Brown and Grant 2005). A simple one states that, "IT governance represents the framework for decision rights and accountabilities to encourage a desirable behavior in the use of IT" (Weill 2004). This definition is in line with the chapters earlier definition of governance, i.e. what the 'governing bodies' responsible for eGovernment do to ensure success.

Two parallel streams of research emerge as dominant in the IT governance literature. One focus on forms of IT governance, the second on IT governance contingency analysis. IT governance forms is summarized by Brown and Grant (2005) in an attempt to define the various structural forms that governance models may take. Moving from a debate on the merits of centralized vs. decentralized design, researchers have explored less rigid alternatives. These in turn are modelled on the operational realities of public sector organisations including vertical and horizontal integration, centralized, federal, decentralized organizational forms of government.

In contrast, IT governance contingency analysis unanimously agree that no universal best practice IT governance structure exist (Brown and Magill 1994; Brown and Grant 2005). Research therefore explore the basic structural options available, and attempt to unearth the logical and best options for different types of organisations. Similarly research focus on the contingencies which influence the adoption of a particular IT governance model, the role of actors, organisational maturity, size, structure, time frames, psychological climate, extra-organisational situations, resources, rank and location of responsible executives and steering committees, risk adversity, degree of centralisation etc. (Brown and Grant 2005).

For over 40 years, a recurring subtopic in this literature has been staged maturity models: models that morphed into capability maturity models (CMM) for assessing software development processes in the 1980s and, since 2002, the integration of product and service development, management, and acquisition (Poeppelbuss et al. 2011; Röglinger et al. 2012). While IT governance models, such as the US Federal Enterprise Architecture (Peters and Pierre 1998) and Chilean CMMI-inspired eGovernment maturity model and toolkit (Iribarren et al. 2008), address political and legal dimensions, most focus on business processes in single organisations, not the cross-organisational, national, or international ones of PA and eGovernment (Pöppelbuß and Röglinger 2011).What the IT governance literature lack, is the political and legal dimensions found in the public administration and eGovernment literature.

eGovernment and eGovernance

Two avenues of thinking dominates the eGovernment literature when it comes to ICT use in public sector. Both are similar to the public administration literature and sees technology as a tool to increase efficiency of existing processes, or as a way to radically transform the way government function (Cordella and Bonina 2012). This is mirror by authors like Lips (2012), Millard et al. (2007), Huijboom et al. (2009b), Traunmüller and Wimmer (2003) who see the role of ICT in public administration as changing over time. That is from eGovernment 1.0 where technology is seen as driving change in public administration and governance, to eGovernment 2.0 and 3.0 directly (Cordella and Bonina 2012; Cordella 2007; Demmke 2006). ICT is explicitly seen as an enabler of transformational change of government processes and its external relationships – including for SMART City concepts, transparency and democracy decision making (Huijboom et al. 2009b; Edelmann et al. 2008).

A stream within the eGovernment literature has since 1999 focused on the so-called stage and maturity models for use of ICT in public administration. Models have focused on mapping capabilities, maturity and progressive. Layne and Lee

(2001), West (2004), Moon (2002), Heeks (2015), Andersen and Henriksen (2006), Traunmüller and Wimmer (2003), Klievink and Janssen (2009) etc., have all argued in favour of the usefulness of stage models to guide policymakers and to stimulate the developments of capabilities needed by organisations to migrate from one stage to another – albeit from different perspectives.

A gap in the stage models and eGovernment literature is a clear link between the role governance and cooperation play in the successful implementation and subsequent use of ICT and eServices solutions. Similarly, most models merely focus on supply and technology, and less on outcomes or results.

Other Streams of Discourse

In addition to the academic discourse, relevant analysis and data is published by international organisations, including the European Union (EU), OECD (Organisation for Economic Co-operation and Development) and United Nations (UN). The 2014 EU digital scoreboard (EC 2014) and the UN eGovernment Survey (UNDESA 2014) highlight the rapid rise in Internet use (e.g. 72% in the EU) and the provision of high-speed broadband (e.g. 62% in the EU) over time. The EU, OECD and UN has traditionally focused on the availability of Internet and eServices, key technical enablers such as, data registries and unique identifiers and electronic identification (eID) (EC 2014). In their latest reports, the focus has shifted and now highlights effectiveness (OECD 2014), accountability (UNDESA 2014), and transparency and user-centricity (EC 2014) as critical enablers of eGovernment. Still, the mere introduction of technology do not guarantee success or additional value creation. The challenge of increasing the use of the digital service delivery channels and to increase public-sector efficiency and effectiveness persist. This is exemplified Japan (among others) where ICT infrastructure is well established, but actual use and efficiency gains have been limited or stagnant, due in part to fragmented organisational and project-governance structures (Meyerhoff Nielsen 2014, 2016a; Meyerhoff Nielsen and Igari 2012; Meyerhoff Nielsen and Mika 2014).

Research Stream and Potential Gaps

The technology and supply-side focus of most evaluations (incl. benchmarks, indexes and rankings) fail to provide an explanation for the discrepancies between the availability (i.e. supply) and the use (i.e. demand) of online public services (Meyerhoff Nielsen 2014; Meyerhoff Nielsen and Igari 2012). Wimmer (Traunmüller and Wimmer 2003), Leitner et al. (Christine Leitner et al. 2003), Huijboom et al. (Frissen et al. 2007; Huijboom et al. 2009b), Millard et al. (Millard et al. 2007; Millard 2013) and Bannister (de Bri and Bannister 2010) all highlight a lack of a holistic approach, while Brown (Brown and Magill 1994) recommend an merger of the classical IT governance streams of thinking.

To illustrate the importance of governance models and outcomes is the discrepancy between Denmark and Japan online address changes (via the Internet). In Demark close to 80% of address changes are made online, while this is a scant 0.0002% in Japan (Meyerhoff Nielsen and Igari 2012; Igari 2014). Statistical analysis also fails to shed light on the underlying reasons why Danes use the Internet to interact with public administration (85%) more often than their Dutch and Swedish counterparts (79% and 78%, respectively) – although similar numbers of households in Denmark, the Netherlands, and Sweden pay for having access to the Internet (all in the 90+ percentile), and why their citizens have similar patterns of Internet use (also in the 90+ percentile) and private sector services such as online banking (all, 82%) (EC 2014; Meyerhoff Nielsen 2014, 2016b; Eurostat 2016).

In light of these challenges, the OECD on 15 July 2014 adopted a number of recommendations for public sector digitisation and eGovernment strategies (OECD 2014). The recommendations address the strategic direction of eGovernment, implementation, governance, and cooperation models. The OECD's recommendations are anchored in the realisation that, in order to successfully introduce ICT infrastructure and online services for improved public-sector efficiency and effectiveness, more than just a technological and supply-oriented approach is required (OECD 2014; O'Leary et al. 2006).

These practical examples hint also at potential limitations in current research. This chapter will therefore review the existing literature in an attempt to unearth the underlying reasons why countries with similar infrastructures and eService availability experience very different levels of online interaction with the public sector, and in particular whether existing stage models address governance and cooperation (sometimes known as maturity models).

Based on the initial exploration of current literature (above), an appropriate theoretical framework to assess and map the degree to which governance and cooperation models ensure the successful supply and use of online eServices, is found in the eGovernment stage model literature, and therefore be the focus of this chapters literature review.

Methodology

Framing the Literature Review

To address the two potential gaps identified in current eGovernment and governance research (in section "Background"), this chapter sets out two questions:

1. Does the literature address the degree to which, and in what way, governance and cooperation models ensure success supply and use (i.e. demand) of online citizen services?

2. Does the literature identify the success factors and are they mapped and developed into a universal governance model for successful digitisation of public sector service delivery (i.e. supply) and eService take-up (i.e. demand) by citizens?

To address the two research questions, a literature review is carried out. The focus of this review included the identification of existing models and their key differences (i.e. can the identified models and theories be mapped). What does current academic and practitioner debate focusing on? What is the current state-of-affairs? What are the clusters of theory, models and critique? What is the real life applicability of the theories and models?

Classic Literature Review

The literature review follow a classical pattern for systematic information retrieval as outlined by e.g. Roberts (1977) and the Walsh and Downe (2005) qualitative meta-synthesis procedure. The seven-step Walsh and Downe model is adapted to include 'berrypicking' (Bates 1989). The adapted methodology consists of the following six steps: Frame the exercise; Locate relevant studies; Decide what to include and a degree of 'berrypicking'; Appraise studies; Compare and contrast, and finally; Conclude.

Locating Relevant Studies, Models and Concepts

Primary and secondary key word searches were used. Primary key words were: eGovernment and stage, or model, or level, or tier, or development. Secondary key works included: eGovernment and/or maturity, governance, cooperation models, technology maturity, transformation, benchmarks, indexes. Other secondary key words were: Use, take-up, benefits, impact, output, efficiency, effectiveness, return of investment, eGovernment Readiness Index, eGovernment Benchmark.

To ensure that relevant literature and arguments were identified, Web of Science managed by Thomson Reuters, Scopus managed by Elsevier and EGRL - E-Government Reference Library (version 11.5) managed by the University of Washington, Information School online libraries were selected based on their relevance, scope and size to the literature review. Each of the reference libraries were searched and cross-referenced to ensure as complete and up-to-date picture of the academic discourse and the state-of-affairs as possible.

To ensure the quality of the literature review, the reference libraries was complimented with online research for number of secondary sources including key topic journals i.e.: GIQ – Government Information Quarterly by Elsevier, MIS Quarterly – Management Information Systems Quarterly MIS Quarterly by the Management Information Systems Research Center at the Carlson School of Management, University of Minnesota, and Information Polity by published by IOS Press.

Other complimentary sources are non-academic reports related to stage- and maturity models, benchmarks and rankings. Key publishers were the United Nations for the UN eGovernment Readiness Index, relevant surveys and country studies, the European Commission for the EU eGovernment benchmarking, studies, factsheets and good practices.

Deciding What to Include

To frame and define the parameters of the literature review, a publication had to be published in English, in the proceedings of an academic conference or in an academic journal (preferably GIQ, MISQ or Information Polity) or a recognized international body (mainly UN, EU or OECD), been subject to peer review (exception possible if published by the UN, EU or OECD), a minimum seven pages (or approx. 3700 words) in length including references, after 1 January 1995.

Where appropriate a second stage of screening, or 'berrypicking' as outlined by Bates (EC 2014), is applied. The robustness of the theoretic models identified, secondary sources and key words is of particular relevance in this regard.

Appraise Studies

As eGovernment is maturing as a distinct field of study, and Gov3.0 is only just emerging as a concept, it is important to weed out low quality studies and models in the appraisal stage of the literature review. Studies and models which highlight the same points are identified based on their relevance to the research frame and questions, the models and studies robustness and contribution to the literature. Depending on the finding the rigor of the theoretical foundation on which the model is founded is applied with various degree, i.e. 'berrypicking' (Bates 1989).

Models are compared and contracted in a mapping exercise (in section "Stage and Governance Models") to identify homogeneity or heterogeneity between the various models, their strengths and weaknesses. The purpose is to identify potential areas of future research in the in the area of stage, cooperation and governance models for successful introduction and use of eServices.

Stage and Governance Models

In light of the potential research gaps identified in section "Background", an appropriate theoretical framework to assess and map the degree to which governance and cooperation models ensure the successful supply and use of online eServices, may be found in the eGovernment stage models literature and the IT governance models, developed in the field of IS management and computer science. This section therefore outlines the characteristics and focus of number of key eGovernment stage and maturity models.

Stage Models Identified and Described

Layne and Lee refer to the experiences of eGovernment as chaotic and unmanageable, arguing for the division of development into distinguishable stages (Layne and Lee 2001). To this effect eGovernment research has largely focused on stage, or maturity, models.

Multiple stage models has been suggested by researchers, consultants, national authorities and international organisations. In this context academics differentiate between three types of stage-models (Fath-Allah et al. 2014; Persson and Goldkuhl 2005):

- Governmental models: Models developed by governments, consultants and academics to help authorities identify and improve their level of maturity (generally using predefined models and toolkits).
- Holistic approach models: Models designed to assist authorities (generally predefined models, toolkits and indicators) in project implementation and to determine if the project will be successful or not.
- Evolutionary eGovernment maturity models: Models which focus on sequential evolutionary steps, for instance from immature to mature eGovernment with improved quality (often from an academic perspective).

The primary focus of this review is on governmental and evolutionary stage models, since the holistic maturity model approach focuses on project implementation and organisational capabilities, and particularly relevant in relation to IS management and CMM literature (Ross et al. 2006; Poeppelbuss et al. 2011; Persson and Goldkuhl 2005).

Using the methodology outlined in section "Methodology", 42 stage models are identified. The following subsections clusters the various models based on their respective characteristics.

ANAO – Australian National Audit Office's (ANAO 1999) 1999, four-stage maturity model was introduced to categorize and evaluate process to guide agencies in their decision as to what services could and should provide. The model is national in character and takes an abductive-deductive approach to eGovernment maturity. The model is developed based on experiences in Australia. The levels of maturity are: Publishing and information; Interaction; Transaction of secure information (incl. login), and; Sharing information with other agencies (incl. business and citizens).

Gartner Group (Baum and Di Maio 2000) published a four state model in 2000. It is one of the earliest eGovernment maturity models not emerging out of a national context. The Gartner model focus is on supply and technology with a degree of

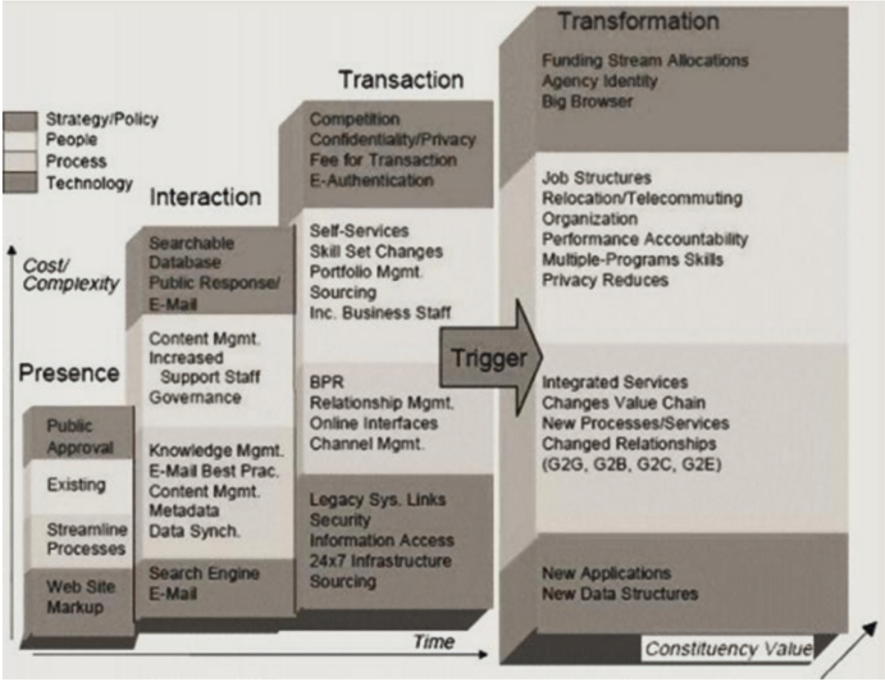


Fig. 1 Gartner four-stage model (Baum and Di Maio 2000)

integration. The model is developed by a consultancy and takes a deductive approach to eGovernment maturity. The stages of maturity are (see Fig. 1): Information incl. information, websites with static content; Interaction such as e-mails and downloadable forms; Transaction incl. integrated websites with transaction (i.e. eService), and; Transformation, i.e. seamlessly integrated websites (i.e. a degree of vertical and horizontal integration).

SAFAD (Swedish Agency for Administrative Development / Statskontoret) (Statskontoret 2000) in 2000 published a four-stage maturity model inspired by the Australian National Audit Office model and Swedish experiences. It was introduced to categorise and evaluate process to guide agencies in their decision as to what services could and should provide. The model is national in character and takes an abductive-deductive approach to eGovernment maturity. The stages of maturity are (see Fig. 2): Websites i.e. packages of information, Interactive websites, Web and communication that is information plus entry and retrival of personal information, and Website and network functions.

Deloitte Research (Deloitte and Touche 2001)¨in 2001 proposed a model focusing on supply, technology and organizational integration. It adds a dimension of engagement and co-creation (indirectly by none-governmental stakeholders). The model is developed by a consultancy and takes a deductive approach to eGovernment maturity. The model has been applied to Australia, Canada, New Zealand, UK

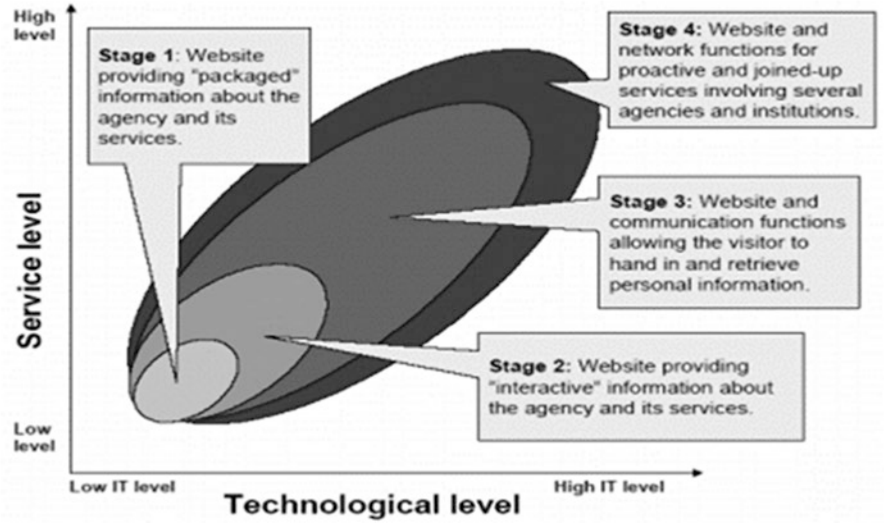


Fig. 2 SAFAD four-stage maturity model (Statskontoret 2000)

and USA. The maturity levels are: Information publishing/dissemination: Websites with static information;

"Official" two-way transaction: electronic identity management (eID) and eServices; Multi-purpose portals: portals (i.e. a degree of vertical and horizontal integration); Portal personalization: basic personalization and life-events; Clustering of common services (i.e. increased personalization and life-event, increase integration), and; Fully integration and enterprise transaction: Life-events, full personalization, user-centric and engagement in service choice and delivery.

Hiller and Bélanger's (2001) 2001, five-stage maturity models focus on supply, technology and organisational integration and some aspects of participation in a democratic sense. It is also one of the most sited models to date. It is a scientific model, with an inductive approach to eGovernment maturity. The maturity levels are: Web presence incl. technological leap-frogging, websites with static information); Interaction such as simple interaction, e-mail and downloadable forms; Transaction i.e. eServices; Transformation/integration incl. back office automation and digitization of processes, aspects of vertical and horizontal integration, and; Participation covering transparency, release of data.

Howard (2001), in 2011, propose a simple three-stage maturity model. It is a scientific model, with an inductive approach to eGovernment maturity and present it as a classical curve consisting of technical sophistication and benefits. The maturity levels are (see Fig. 3): Publish (i.e. static information); Interact (i.e. information increasingly updated, downloadable forms etc.), and; Transact (i.e. eServices).

Layne and Lee's (2001) 2001 maturity model is the most cited to date. The focus is on technology, supply and organizational integration. It is a scientific model, which takes an abductive approach to eGovernment maturity. The model is devel-

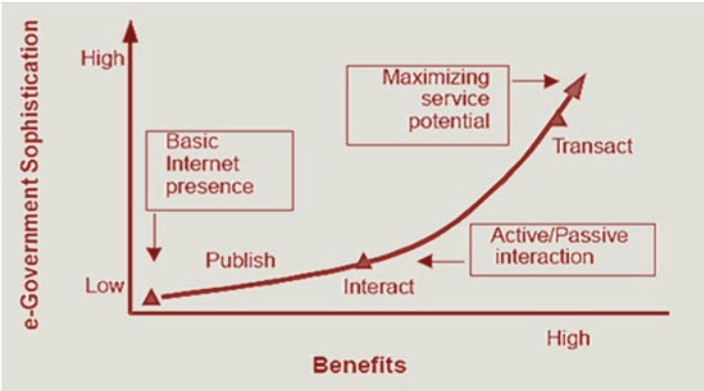


Fig. 3 Howard's three-stage eGovernment maturity curve (Howard 2001)

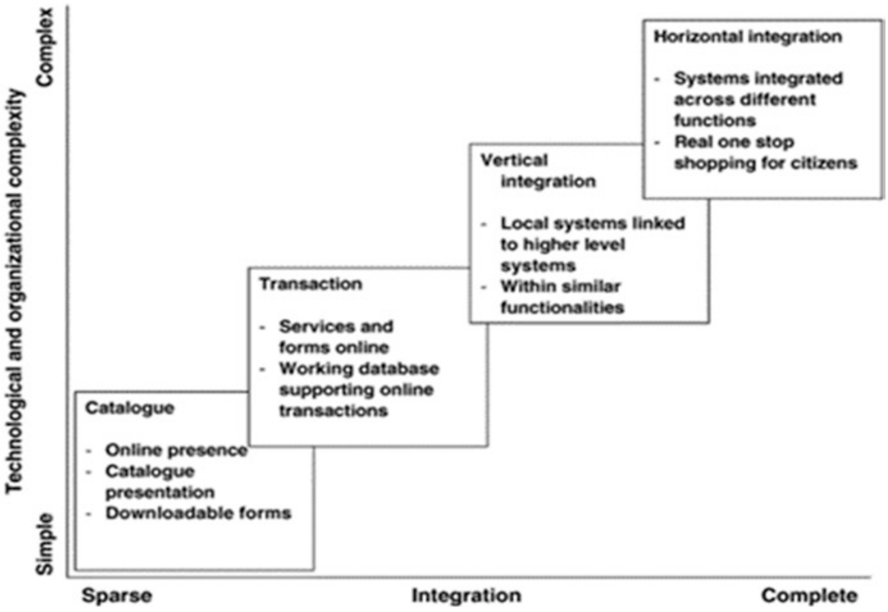


Fig. 4 Layne and Lee model four-stage maturity model (Layne and Lee 2001)

oped based on observations in the USA and earlier models. The four-stages of maturity are defined as (see Fig. 4): Catalogue i.e. online presence (i.e. websites with static information and downloadable forms); Transactional incl. service and forms (i.e. eServices); Vertical integration, that is local system integration, and; Horizontal integration i.e. integration across function (i.e. life-events and personalisation).

United Nation's (UNDESA 2014, 2008, 2010, 2012; Ronaghan 2002) is best known for its biannual UN eGovernment Readiness Index. The model has been in use since 2001 when the first Index was first published. It covers pre-conditions such as supply, technology and integration. The original focused has been on the five-stages of maturity. The UN publishes the bi-annual eGovernment Readiness Index, but has in the last few years refocused the models to include additional aspects of engagement and transparency (e.g. the UN eParticipation Index). The model is “international” in character and takes an abductive-deductive approach to eGovernment maturity. The model consists of a biannual ranking of 193 countries. The model has a pre-condition stage, which focus on at network preparedness, access to PCs, the Internet and literacy and digital competences (i.e. TII Index). The maturity levels are (see Fig. 5): Emerging presence such as basic websites with static information; Enhanced presence e.g. emerging portals (i.e. a degree of vertical and horizontal integration), interactivity, and customer services (i.e. eServices); Interactive such as two-way interactivity (i.e. eServices and communication), searchable intranet; Transactional i.e. eServices, and; Seamless incl. sully net-worked government (i.e. horizontal and vertical integration).

Wescott’s (2001) 2001 model consist of six stages. It is a scientific model, with an abductive approach to eGovenment maturity. It has been developed based on

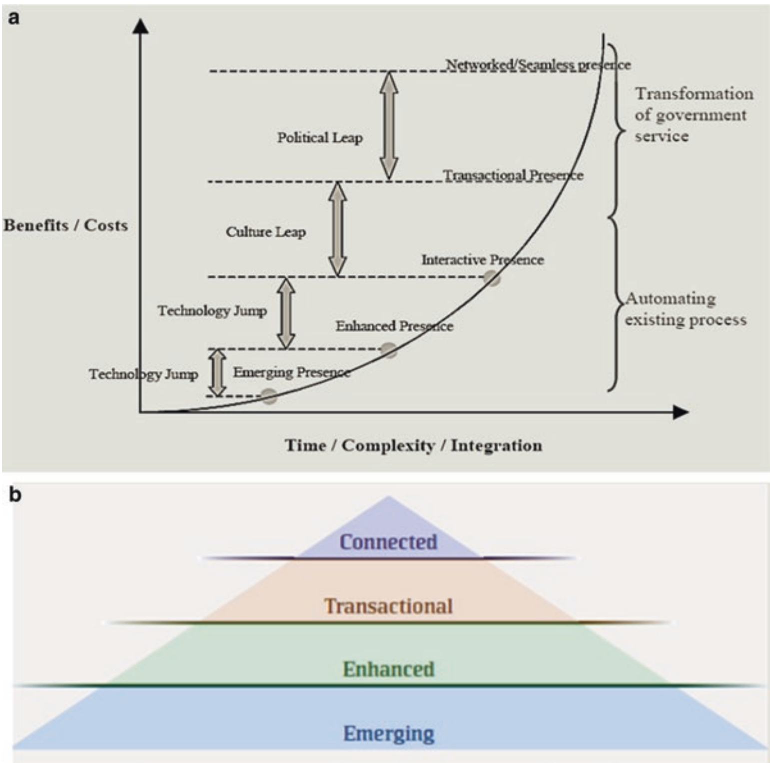


Fig. 5 (**a**) The original four-stage UN model, 2002 (Ronaghan 2002). (**b**) The updated version of the UN model, 2012 (UNDESA 2012)

observations in the Asia-Pacific. The maturity levels are: Setting up an email system and internal network e.g. feature e-mail systems to improve information sharing, coordination and feedback; Enabling inter-organisational and public access to information e.g. information is department centric, shared between organisations and can be accessed by the public over the Internet; Two-way communication such as basic eServices and citizens can make suggestions using emails or ask questions in forums and receive answers. Exchange of value e.g. eService features applications such as tax assessments and license renewals. At this stage, the citizen can make secure payments online; Digital democracy incl. focus is on empowering the civil society (e.g. increasing awareness of government corruption) and allowing citizens to vote and express their opinions and feedback, and; Joined-up government incl. vertical and horizontal integration allowing for citizens to execute services without knowing which government agency is responsible for.

Chandler and Emanuel (2002) in 2002 proposed a four-stage model. It is a scientific model, with an indicative approach to eGovernment maturity. The maturity levels are: Information i.e. online information about government services and policies; Interaction such as basic level of interaction between governments and citizens such as email systems; Transaction i.e. features eServices, and; Integration e.g. features integrated services across various departments and agencies.

European Union (2012) has since 2002 used a eGovernment benchmark model similar to the UN. The focus is on supply, technology and integration and initially included five-stages of maturity. The European Commission publishes its eGovernment benchmark yearly, but has since 2010 started including additional biannual focus areas, and has moved from benchmarking services to life-events, user engagement, access to personalized data and user-rating – through mystery shoppers and surveys. The model is "international" in character and takes an abductive-deductive approach to eGovernment maturity. The model is developed with inspiration from the SAFAD model (Statskontoret 2000) and experiences in the EU+ member states. The model forms the basis of the EU's annual eGovernment Benchmarks and Surveys. A pre-condition stage looking at PC and Internet accessibility as well as digital literacy compliments its five stages (see Fig. 6): Emerging presence i.e. basic websites with static information; Enhanced presence e.g. emerging portals (i.e. a degree of vertical and horizontal integration), interactivity, and customer services (i.e. eServices); Interactive, that is two-way interactivity (i.e. eServices and communication), searchable intranet; Transactional i.e. eServices, and; Seamless such as fully networked government (i.e. horizontal and vertical integration).

Hodgkingson (2002), in 2002, present a two phased, five-stage model, focusing learning cycles and an s-shaped curve for learning (see Fig. 7). The model focus the rate of technology diffusion in government, service impact and technical aspects such as interoperability before data exchange and vertical and horizontal integration is possible. It is inspired by diffusion of innovation (DOI) and innovation diffusion theory (IDT), technology acceptance (TAM) and IS management models. The stages are: Government online i.e. initiation of idea generation, analysis and pilot implementation and contagion such as wider adoption of technology and benefits of ICT, business needs, decentralization of strategy and resources; eGovernment i.e.

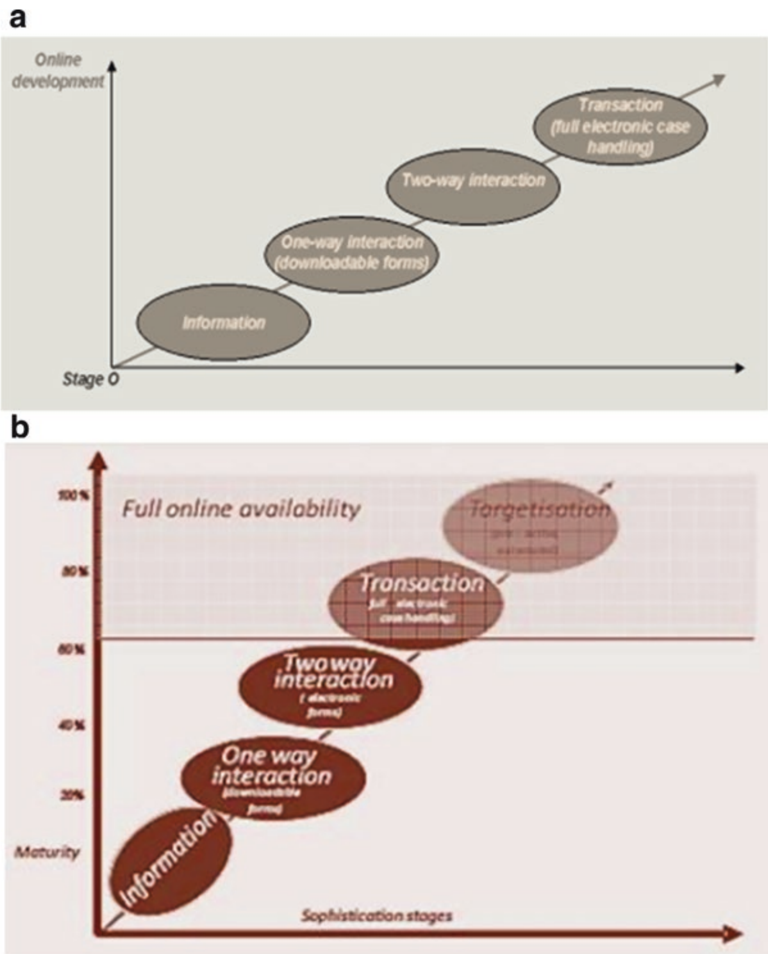


Fig. 6 (**a**) The original four-stage EU model, 2002. (**b**) The updated five-stage EU model, 2009 (EC 2012)

control (i.e. re-focus on cost, efficiency and quality, re-centalisation of some strategies and control), interoperability, and data management.

Moon's (2002) 2002 five-stage model by M.J. Moon focus on supply, technology and organisational integration and some aspects of participation in a democratic sense. It is very similar to the 2001 model proposed by Hiller and Belanger (2001). It is a scientific model, with an abductive approach to eGovernment maturity. It was developed based on observations and data from 2000 US municipality websites. The maturity levels are: Web presence i.e. technological leap-frogging, websites with static information); Interaction such as simple interaction, e-mail and downloadable forms; Transaction i.e. eServices; Transformation/integration such as back office automation and digitization of processes with aspects of vertical and horizontal integration, and; Participation for transparency and release of data.

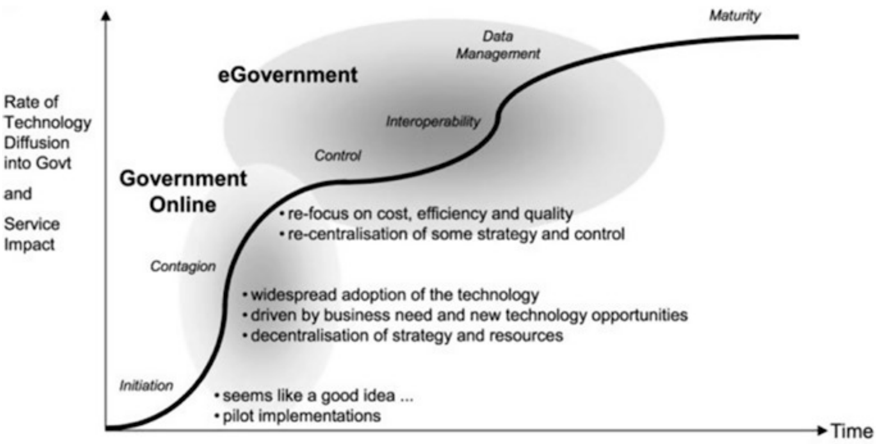


Fig. 7 Hodgkingson's five-stage maturity model and learning curve (Hodgkinson 2002)

Netchaeva's (2002) 2002 five-stage model for eGovernment and eDemocracy does not name the individual maturity levels. It is a scientific model, with an inductive approach to eGovernment maturity, and focus on the following aspects: Scattered information e.g. websites with department information; e-mails and FAQ; Other online services such as features forums and opinion surveys; eGovernment portal incl. eServices such as license renewals and payment of fines, portals and one-stop-shops, and; Possible democracy e.g. citizens can vote, contribute in online discussions and make comments on policy and legislation proposals.

UKNAO – UK National Audit Office (NAO 2002) in 2002 presented a report to the House of Commons, in which a five-state maturity model was introduced. The model is "national" in character and takes an abductive-deductive approach to eGovernment maturity. The model is developed based on experiences in UK. The maturity levels are: Basic site with limited information available online, mainly information about authorities; Electronic publishing incl. increasing number of website and more content; ePublishing e.g. use of personalization options and customizable search tools, some forms can be submitted online and others can be downloaded and increasing use of e-mails and the timely responses, alerts about new content is an offered; Transactional incl. secure eService transactions, and; Joined-up eGovernance: featuring one-stop-shops and joined-up governments through vertical and horizontal integration.

World Bank (Toasaki 2003; InfoDev, C.f.D.a.T. 2002) published a three-stage model in 2002. The model is "international" in character and takes a deductive approach to eGovernment maturity. The model is developed as part of the World Bank's Center for Democracy and Technology eGovernment handbook for developing countries. The maturity levels are (see Fig. 8): Publish online information such as rules, regulations, documents and forms; Interact, with users providing feedback and submit comments on legislative or policy proposals, and; Transact, i.e. secure eService transactions.

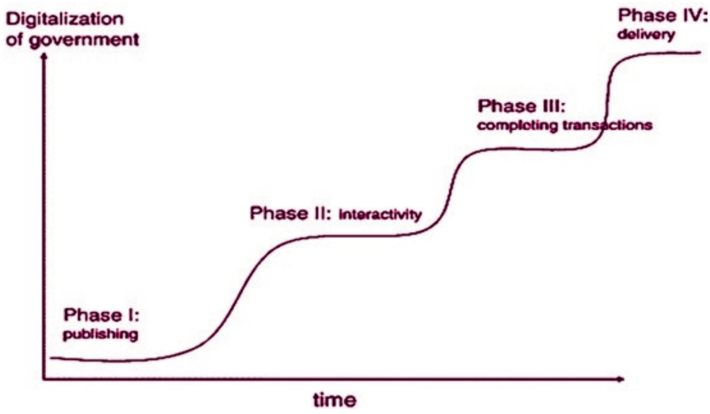


Fig. 8 World Bank four-stage maturity model (Toasaki 2003)

Accenture (Rohleder and Jupp 2003) in 2003 published a five-stage model. The model is developed by a consultancy and takes a deductive approach to eGovernment maturity. The model has been applied to Australia, Belgium, Brazil, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Italy, Japan, Malaysia, Mexico, the Netherlands, Norway, Portugal, Singapore, South Africa, Spain, the UK and USA. Based on the model Accenture publish an annual eGovernment Ranking of selected countries. The model consisting of the following maturity levels: Online presence with information published online; Basic capability i.e. security and certification is developed and the online presence is broadened; Service availability with eServices increasingly available on portal(s) and features of cross agency cooperation and services increasingly designed to meet customer needs; Mature delivery with eServices clustered with clear ownership and authority – CIO (Chief Information Officer) or central agency the involvement of customer in the process of eGovernment and the services are marketed; Service transformation i.e. improved customer service delivery is the objective and multi-channel integration is common.

Koh and Prybutok (2003) in 2003 presented a three-element model (see Fig. 9). The model is scientific and takes a inductive approach to eGovernment maturity. The model focus on internal and external factors and three stakeholder groups i.e. employees in public authorities, suppliers (i.e. IT vendors or IT departments) and customers (i.e. citizens and businesses). Visualised as circles of there are overlaps between the three elements thus providing a degree of granularity with a degree of inspiration from the IS management and computer science literature. The elements are: Informational i.e. online information; Transactional i.e. online transactions, and; Operational i.e. operational, vertical and horizontal integration.

Reddick's (2004) 2004, two-stage model, is one of the most simple maturity models identified. It is a scientific model, with an abductive approach to eGovernment maturity. The model is developed based on observations in the USA, The

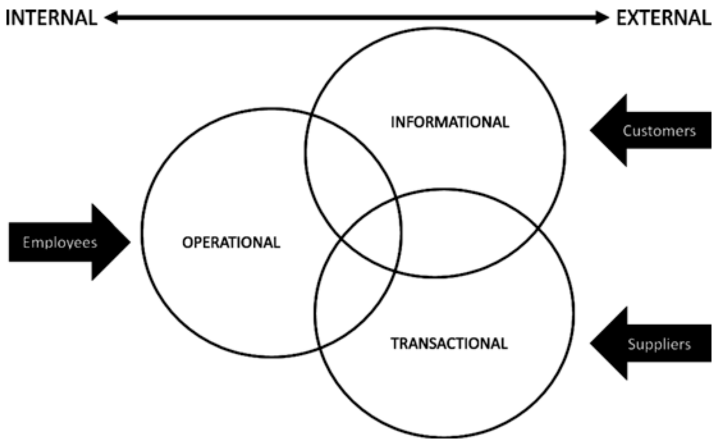


Fig. 9 Koh and Prybotok's three-stage and users of internet maturity model (Koh and Prybutok 2003)

maturity levels are: Cataloguing online information about the government and its activities, and; Transactions incl. eServices and one-stop-shops.

Waseda (Obi 2014, 2012, 2015) first published the Waseda model and its annual benchmarks for selected countries in 2004. The model is "international" in character and takes an abductive-deductive approach to eGovernment maturity. The model is used for an annual eGovernment ranking list for an increasing number of countries. The model differs somewhat from other stage models as it does not define distinct levels of maturity. It covers managerial and organisational aspects also seen in CMM/CMMI models and the IS management literature. The focus is on qualitative and quantitative indicators including: Network preparedness and infrastructure; Management optimization and efficiency; Online presence of information, services, national portals and websites; Governance incl. cooperation and promotion; eParticipation and digital inclusion; Open government, and; Cyber security. The indicators can be grouped into four-stages, that is: Networked preparedness and infrastructure; Online services; Management optimization, and; eParticipation.

West (2004) first published the four-stages model in 2004. It is a scientific model, with an abductive-deductive approach to eGovernment maturity. The model is developed based on observations and data from 1813 and 1680 US municipality websites model in 2000 and 2001. The West Index on US municipalities and a number of countries is based on the model. The maturity levels are: Bill-board i.e. websites as billboards mainly used for posting information; Partial-service-delivery with the ability to search for data via search engines with some eServices available; Portals containing all information and eServices (i.e. a one-stop-shop), and; Interactive democracy incl. ortals offers personal and proactive online service, utilise push technology and feedback forms.

Windley's (2002) 2002, four-stage model. It is a scientific model, which takes a deductive approach to eGovernment maturity. It is developed based on observations from the US Utah.gov site and consists of the following maturity levels: Simple website with static pages with downloadable forms; Online government featuring interaction mechanisms such as e-mails, online forms, help and FAQs; Integrated government incl. end-to-end eService transactions, but also emerging internal integration as information is shared between departments, and; Transformed government: Customer centric eServices organized according to user needs and segmented according to population groups and life events. Vertical and horizontal integration is also a feature.

Davison et al. (2005) in 2005 presents a four-element model combining the insights of the strategy and maturity alignment models form the IS management and computer science literature (see Fig. 10). The model focus on internal and external factors in both the government (i.e. the public sector in general) and eGovernment domain (i.e. ICT within the public sector). Rather than looking at the supply-side issues related to digitization of service delivery and ICT enabled reform Davison et al. focus on the key elements enabling the successful use of ICT. The models cover eGovernment services (i.e. information and transaction), processes (i.e. vertical and horizontal integration) and transformation within the four elements of: Government strategy with choices pertaining to positioning of government and business strategies; Government infrastructure and processes incl. choices pertaining to internal arrangements and configurations supporting authorities chosen position including public sector culture; eGovernment strategy incl. choices pertaining to IT scope, systemic capabilities and IT governance, and; eGovernment infrastructure and processes e.g. internal arrangements and configurations determining data, applications and technology infrastructure used to deliver eGovernment services.

Siau and Long's (2005) 2005 five-stage maturity models focus on supply, technology and organisational integration and some aspects of participation in a democratic sense. It is a scientific model, with an inductive approach to eGovernment maturity. It differs from the Moon (2002), Hiller and Belanger (2001) models by including engagement and political decision making to the fifth stage in the form of

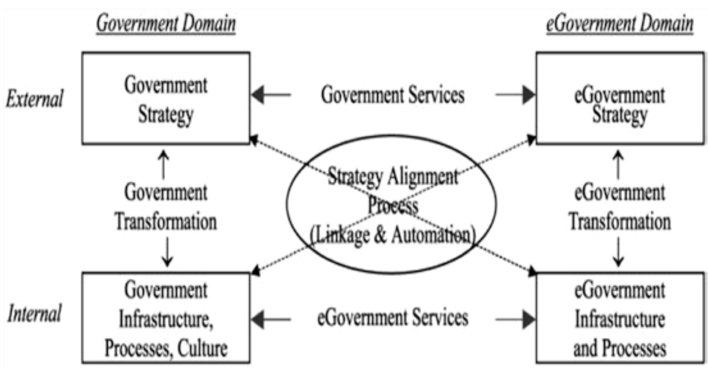


Fig. 10 Davison's et al. four stage strategy and maturity model (Davison et al. 2005)

a “eDemocracy stage”. The maturity levels are: Web presence incl. technological leap-frogging, websites with static information); Interaction e.g. simple interaction, e-mail and downloadable forms; Transaction i.e. eServices; Transformation/integration such as back office automation and digitization of processes and aspects of vertical and horizontal integration, and; eDemocracy incl. engagement, political decision making, transparency, release of data.

Persson and Goldkuhl (2005) in 2005 evaluates a number of existing models and propose a two-stage model from a computer science perspective. The maturity levels are: Integration of services with a focus on public services, directed services, concentrated services and portals, and; Integration in services incl. elements such as the integration of services and agencies, transparency in processes of independent processes, database access in information gathering, information or decision provision requirements and joint information services.

Andersen and Henriksen's (2006) 2006 Public Sector Process Rebuilding Model (PPR) builds on Layne and Lee four-stage maturity model (Layne and Lee 2001). It is a scientific model, with an abductive-deductive approach to eGovernment maturity. It is developed based on observations and data from 110 central government sites in Denmark. The PPR model focus on supply, organizational integration, processes and differs from other models by emphasising user-centricity rather than technological aspects. Four-stages of maturity, of which the first two stages comprise the four-stages proposed in the Layne and Lee model (see Fig. 11): Cultivation e.g. websites with static information, downloadable forms, vertical and horizontal integration; Extension such as eServices, basic personalization and life-events and a focus on data ownership; Maturity of eServices, none-Internet interphases,

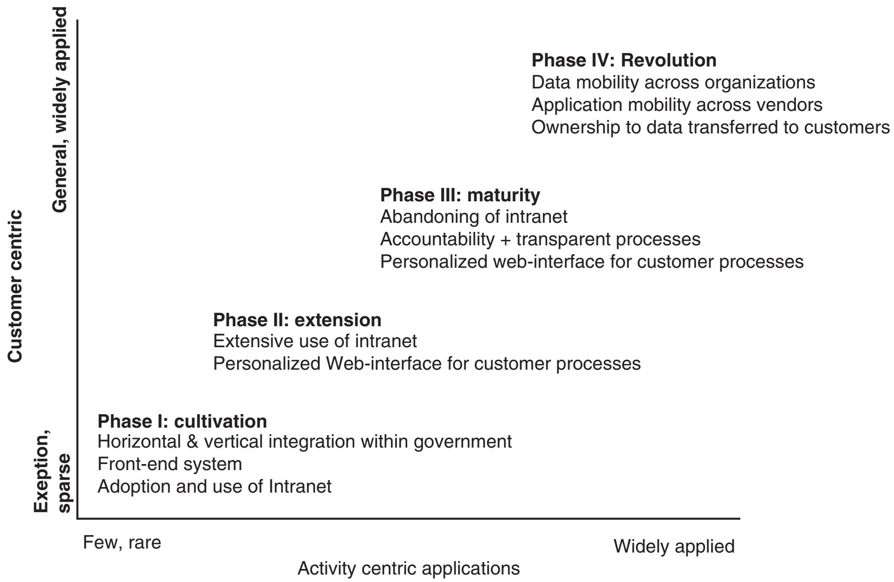


Fig. 11 Andersen and Henriksen PPR model (Andersen and Henriksen 2006)

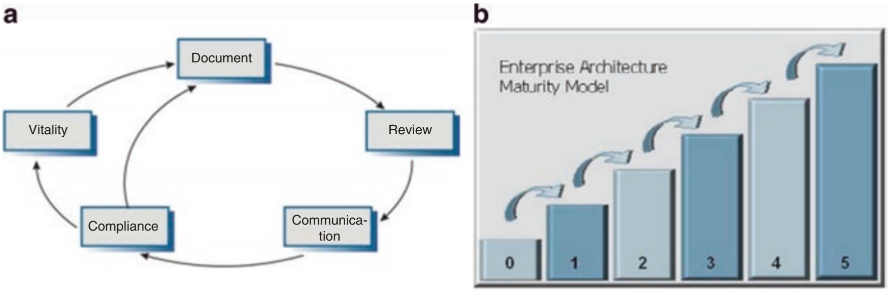


Fig. 12 (**a**) eGOV-MM's three dimension and interrelated elements (NASCIO, N.A.o.S.C.I.O. 2006). (**b**) eGOV-MM's domain level and key domain areas (NASCIO, N.A.o.S.C.I.O. 2006)

increased personalization, user-centricity and outcome based organisations with economics of scale being sought, data ownership more fluid, mobility of data and open data based infrastructure; Revolution i.e. seamless organizational structures, fully personal and outcome based service delivery, with data ownership and focus fully transferred to the end-user.

National Association of State Chief Information Officers' (NASCIO) (NASCIO, N.A.o.S.C.I.O. 2006) 2006 Enterprise Architecture Maturity Model and toolkit, is not a eGoverment matority model par say, but it is exemplifies a lot of the IS management CMM/CMMI model thinking which has inspired many future models. The model and toolkit is national in nature, takes an inductive-deductive approach to eGovernment, and is developed in corporation with CIO's in the USA. The aim of the model is to introduce a cyclic process and approach to IT development in single organisations. Based on documentation, review, compliance, communication, and vitality elements framework and procedures must be reviewed and updated to properly reflect environmental changes (see Fig. 12). The model has six-levels of maturity and each consist of a number of eight categories of factors. The stages are: Level 0 No programme; Level 1 Informal program; Level 2 Repeatable program; Level 3 Well-defined program; Level 4 Managed program, and; Level 5 Continuously improving vital program. The categories are: Administration i.e. governance roles and responsibilities; Planning incl. EA program road map and implementation plan; Framework e.g. processes and templates used for EA; Blueprint i.e. a collection of the actual standards and specifications; Communication such as education and distribution of EA and Blueprint detail; Compliance ensuring adherence to published standards, processes and other EA elements, and the processes to document and track variances from those standards; Integration of touch-points of management processes to the EA, and; Involvement and support of the EA Program throughout the organisation.

Cisco (2007), the IT and consultancy firm, in 2007 published a three-stages. It is a scientific model, with an abductive approach to eGovernment maturity. The maturity levels are: Information interaction featuring departmental websites, legislative posting, public notices, online forms, webcasting and personalized portals; Transaction efficiency i.e. eServices and portals including electronic payments like online taxes and eProcurement, and; Transformation citizen centric, i.e. consolidated and shared administrative services at this stage are across various government jurisdictions.

Almazan and Gil-Garcia's (Almazan and Gil-Garcia 2008; Luna et al. 2013) six-stage model published in 2008 (presence, information, interaction, transaction, integration and participation). It was updated in 2013 by merging the initial two stages information based stages (i.e. presence and information) and adjusting the remaining four stages. The 2013 model consists of five-stages and 172 indicators, which aim to highlight the performance and efficiency of portals by including supply and actual use in relation to the online population – thus, indirectly including preconditions (Luna et al. 2013). It is a scientific model, with an abductive approach to eGovernment maturity. It has been developed based on observations and data from 32 Mexican state portals and includes ranking (in 2013). The 2013 levels of maturity are: Information Online information, static or updated; Interaction e.g. downloadable forms, communicate with the government via e-mail and forums; Transaction such as secure eService transactions and payment options via portals; Integration incl. one-stop-shops/portals, vertical and horizontal integration, and; Political participation offering users voting and participation in opinion polls, surveys and public forums.

Chan et al. (2008) in 2008 proposed a model focusing on supply, technology and organizational integration. It adds none-governmental stakeholders to the mix. It is a scientific model, with an abductive approach to eGovernment maturity. The model is developed based on observations and data from regional government in China. The five-stages of maturity are: Publish websites with static information; Interact i.e. downloadable forms; Transact though eServices; Integrate though vertical and horizontal integration of service providing agencies, and; Tri-party integration i.e. integration of public, private and stakeholder organisations.

Iribarren et al. (2008) proposed an IT focused eGovernment Maturity Model (eGov-MM) based on four domain levels, in 2008. It is a multi-dimensional model and assessment tool in the form of a capability maturity framework to ensure continued measurement and control. It is a national model developed for the Chilean government and borrows from experiences in the UK, US, Australia, Canada, Sweden, South Korea and others. It distinguish between maturity and capabilities and is inspired by the IS management's US CMMI and EA models (NASCIO, N.A.o.S.C.I.O. 2006), ISO/IEC 15504 in Europe and supports Wimmers holistic view (Traunmüller and Wimmer 2003; Iribarren et al. 2008). The domain levels on effectiveness, efficiency, confidentiality, integrity, availability, compliance, manageability on one axis and IT resources like applications, data, infrastructure and facilities on the other (see Fig. 13). The four domain levels are: eStrategy; IT governance; Process management; People and organisation capabilities.

Shahkooh et al. (2008) in 2008 proposed a five-stage model. It is a scientific model, which takes an abductive approach to eGovernment maturity, proposing the following maturity levels: Online presence i.e. online information; Interaction with citizens interacting with governments through e-mail to officials and downloading forms; Transaction though secure eService transactions like payments and tax fill-

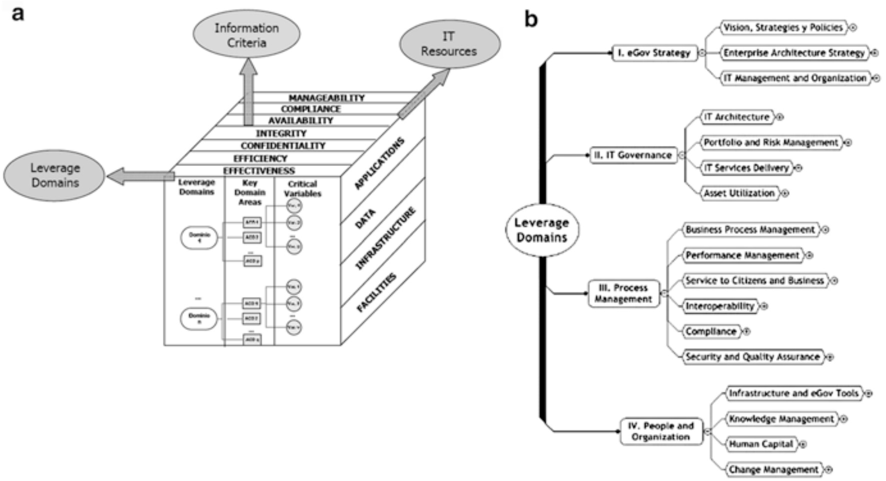


Fig. 13 (**a**) eGOV-MM's three dimension and interrelated elements (Iribarren et al. 2008). (**b**) eGOV-MM's domain level and key domain areas (Iribarren et al. 2008)

ing; Fully integrated and transformed eGovernment with services organized as a single point of contact such as portals, and; Digital democracy featuring online voting, public forums and opinion surveys.

Kim and Grant (2010) in 2010 published a five-stage model. It is a scientific model, with an inductive approach to eGovernment maturity with the following maturity levels: Web presence featuring simple and limited information online; Interaction focus on search engines and downloadable forms; Transaction incl. online transactions with the possibility of electronic payments; Integration i.e. horizontal and vertical integration and performance measurements using statistical techniques, and; Continuous improvement featuring political activities and a focus on continuous improvements and performance.

Kalambokis et al. (2011) focus on data in their 2011 Open Government Data (OGD) Stage Model. Like Andersen and Henriksen (2006) focus on value creation in light of organisational and technical complexity (see Fig. 14). Other sources includes Deloitte and Touche (2001), EU (2012), Layne and Lee (2001), Siau and Long (2005) and West (2004). It is a scientific model, with an inductive approach to eGovernment maturity and open data use – and indirectly on eServices. The maturity levels presented are: Aggregation of government data; Integration of government data; Integration of government data and non-government formal data; Integration of government data with non-government formal and social data.

Shareef et al. (2011) in 2011 present the eGovernment Adoption Model (GAM) (see Fig. 15) focus on five overaching categories, 11 sub-categories and 73 factors which influences citizens adoption of eGovermment. It focus on attitudes, digital literacy, assurance, adherence and adaptability to use. It is a scientific model with an inductive approach to eGovernment. It is based technology adoption model (TAM), diffusion of innovation (DOI) and planned behavior theory (TPB). Previous models have been considered, and empirical work has been carried out in Canada. The five

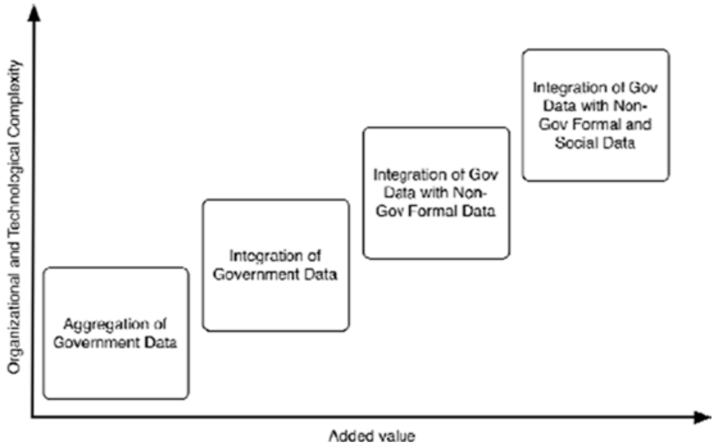


Fig. 14 OGD Maturity Model (Kalampokis et al. 2011)

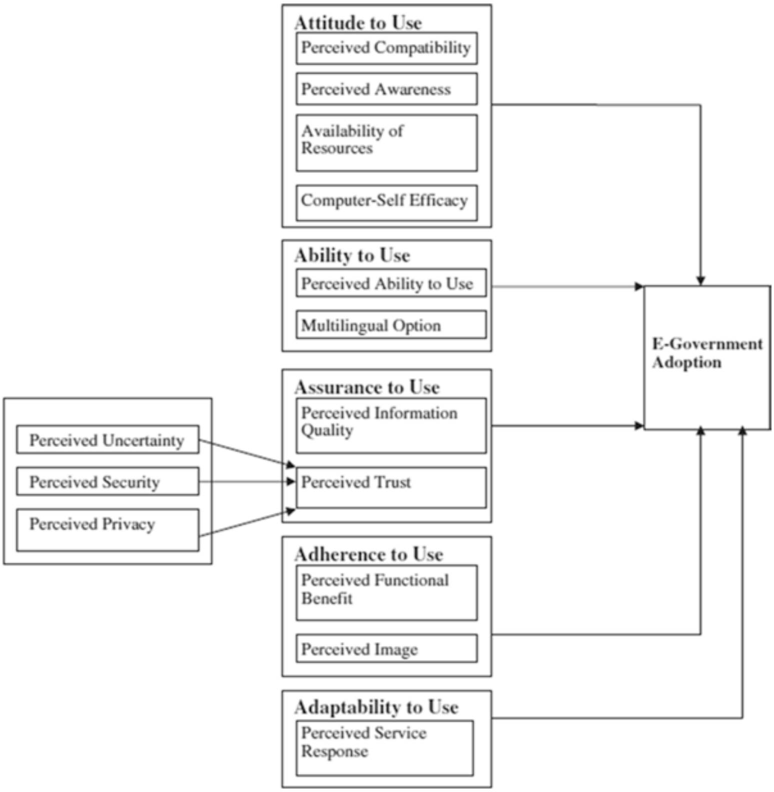


Fig. 15 GAM dimensions (Shareef et al. 2011)

categories of factors influencing citizen take-up of eGovernment solutions at various stages of maturity are: Attitude to use i.e. received compatibility, perceived awareness, availability of resources, computer-self efficancy; Ability to use i.e. perceived ability to use, multilingual option; Assurance to use that is the perceived information quality and trust; Adherance to use i.e. perceived functional benefits, perceived image, and; Adaptability to use that is the perceived service response.

Alhomod and Shafi (2012) in 2012 propose a redefined four-stage model, based on their evaluation of 25 existing models. It is a scientific model, with an abductive approach to eGovernment maturity. The maturity levels are: Presence on the web with portals merely providing information; Interaction between the citizen and the government i.e. downloadable and e-mail forms made available for use; Complete transaction over the web that is secure eService transactions and two-way communication, and; Integration of services i.e. horizontal and vertical integration between authorities to share information and data.

Lee and Kwak (2012) in 2012 suggest a five-stage model with a focus on engagement and data exchange. It is a scientific model, which takes an abductive approach to eGovernment maturity. The model is developed based on observations and data from the US health sector and propose the following maturity levels: Initial conditions not to be confused with "pre-conditions" (e.g. UN, EC and Waseda models) the focus is on one-way static interaction from authorities to citizens; Data transparency with limited use of Web2.0 and social media. Objective is to get public feedback on the usefulness and data quality; Open participation with increasing use of Web 2.0 and social media tools to increase transparency and engagement, and includes eVoting and ePetitioning; Open collaboration incl. interagency collaboration by sharing data and public input and public contests are organised and data is analyzed for obtaining new insights and improving decision-making; Ubiquitous engagement with data easily accessible via mobile devices and data being vertically and horizontally integrated and data analytics is used for decision making processes for authorities continuous improvement of performance.

Dias and Gomes (2014) in their 2014 evaluation of local eGovernment maturity in Portugal propose an adjusted model based on Layne and Lee (2001) and the EU benchmarking models (EC 2012). It is a scientific model, which takes an inductive approach to eGovernment maturity. The model is developed based on observations and data from 239 local authorities in Portugal in 1999, 2007, 2010 and 2013. The proposed model consists of three parallel dimensions each consisting of four stages: Information incl. generic information (i.e. presence), downloadable forms (i.e. interaction), search functionality (i.e. interaction) and parameterize search (i.e. interaction); Service incl. information (i.e. one-way), authentication of user (i.e. two-way), eService transaction (i.e. two-way) and authentication and eService transaction (i.e. transaction); Participation e.g. features (i.e. two-way), authentication and features (i.e. two-way), participative process (i.e. transaction) and advanced participative process (i.e. transaction).

Janowski's (2015) four-stage Digital Government Evaluation Model from 2015, is a scientific model, which takes an inductive approach to eGovernment maturity. It has many of the same features as earlier models but attempt to provide it as a practical tool. It is developed based on observations in developed and emerging

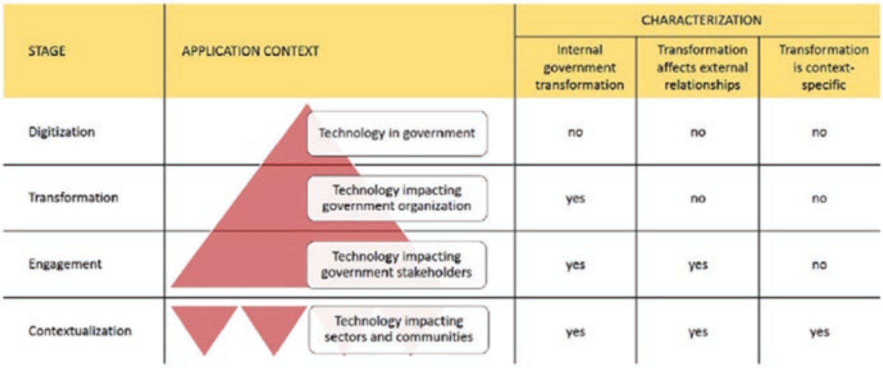


Fig. 16 Digital Government Evolution Model (Janowski 2015)

economies around the world. Rather than mere levels of maturity it propose four-stages of complexity depending on three binary variables: (1) whether digitisation adds to internal work and structures of government without affecting them; (2) transforms internal processes and structures; whether the transformation is internal with, or without affecting the end-users; (3) whether the transformation is depending on a particular application context. The four levels of maturity are (see Fig. 16): Digitisation or technology in government (i.e. precence); Transformation being eGovernment (i.e. transaction and transformation); Engagement or eGovernance (i.e. eParticipation/eDemocracy), and; Contextualisation i.e. policy-driven eGovernance.

Heeks' (2015) Manchester eGovernment Maturity Model from 2015, adapt the Layne and Lee (2001) be less linear in it process, differentiate between the front- and back-office and less "US-centric". It is a scientific model, which takes an inductive approach to eGovernment maturity. The model is developed based on observations in developed and emerging economies around the world. The result is two parallel dimensions consisting of three and four elements respectively, thus forming a matrix (see Fig. 17). The stages are: Sophistication of digitised interaction (i.e. front-office) incl. informed/one-way interaction, interact/two-way interaction and transaction/complete service; Extent of process change (i.e. back-office) incl. digitisation (simple automation), improvement (process integration), redesign (e.g. proactive transaction) and transformation (fundamental change e.g. process elimination).

Stage Models by Origin and Type

The literature review has identified 42 different stage-models. Looking closer at their description, in section "Stage Models Identified and Described", their origin can be traced to either national authorities such as national auditors, or international

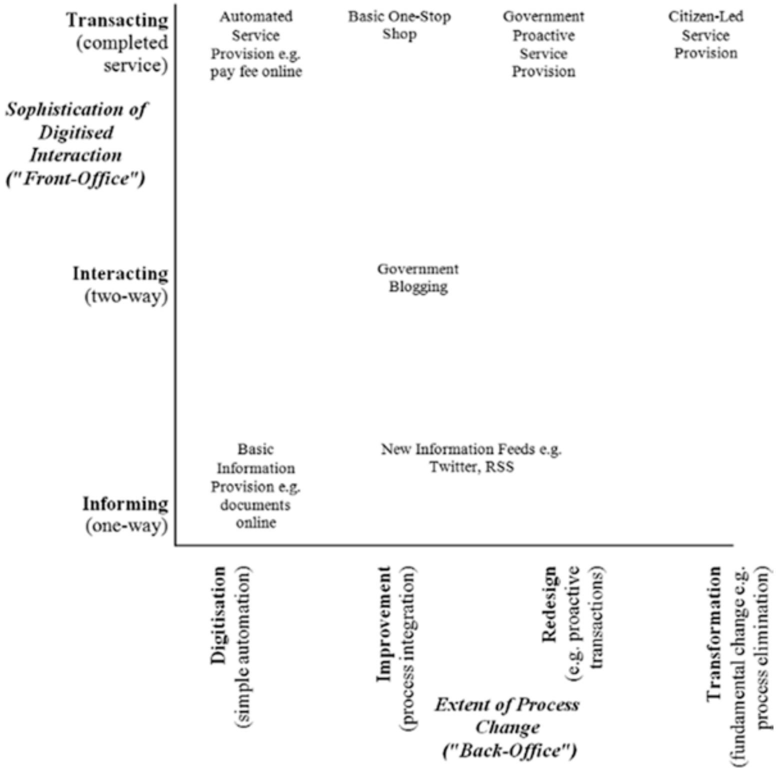


Fig. 17 Manchester eGovernment Maturity Model Metaphores (Heeks 2015)

organisations like the EU or UN, consultancy firms like Deloitte and CISCO or academia. Table 1 present the number of models identified for each of these four categories.

The first model was published by the Australian National Auditing Office in 1999 (ANAO 1999). The latest models are published by Heeks and Janowski in 2015 (Heeks 2015; Janowski 2015). Using the year of publication, the timeline (see Fig. 18) highlight a number of developments.

The first models to emerge are from national authorities, international organizations and consultancies. National models from Australian ANAO (ANAO 1999) to the UK equivalent were published in 1999–2001. International organisations followed with the UN (UNDESA 2014) in 2001 and the EU (EC 2012) and World Bank in 2002 (Toasaki 2003; Alhomod and Shafi 2012). The Deloitte (Deloitte and Touche 2001) through to the Accenture model (Rohleder and Jupp 2003) were published in 2000–2003. The first scientific models were published by (in alphabetical order) in 2001 by Hiller and Belanger (2001), Howard (2001), Layne and Lee (2001) and Silcock (2001), followed by Wescott (2001), Chandler and Emanuel (2002), Moon (2002) and Netchaeva (2002) in 2002. The most recent models includes Dias and Gomas (2014) in 2014 and Janowski (2015) and Heeks (2015) in 2015.

Table 1 Stage models by origin (incl. names of model)

Type of model	Number of models	Name of model
National	5	ANAO (1999), SAFAD (2000), UKNAO (2002), NASCIO (2006), Iribarren et al. (2008).
International	3	UN (2014, 2008, 2010, 2012), EU (EC 2014; European Commission and D.R.a.I. 2013), WB (Toasaki 2003).
Consultant	4	Deloitte (Deloitte and Touche 2001), Gartner (Baum and Di Maio 2000), Accenture (Rohleder and Jupp 2003), Cisco (Cisco 2007).
Scientific	30	Hiller and Belanger (2001), Howard (2001), Layne and Lee (2001), Silcock (2001), Wescott (2001), Chandler and Emanuel (2002), Hogdgkinson (2002), Moon (2002), Netchaeva (2002), Koh and Prybutok (2003), Reddick (2004), Waseda (Obi 2012, 2014, 2015), West (2004), Windley (2002), Davison et al. (2005) Persson and Goldkuhl (2005), Siau and Long (2005), Andersen and Henriksen (2006), Chan et al. (2008), Shahkooh et al. (2008), Almazan and Gil-Garcia (2008),Luna et al. (2013), Kleivink and Janssen (2009), Kim and Grant (2010), Kalampokis et al.(2011), Shareef et al. (2011), Alhomod and Shafi (2012), Lee and Kwak (2012), Dias and Gomes (2014), Heeks (2015), Janowski (2015).

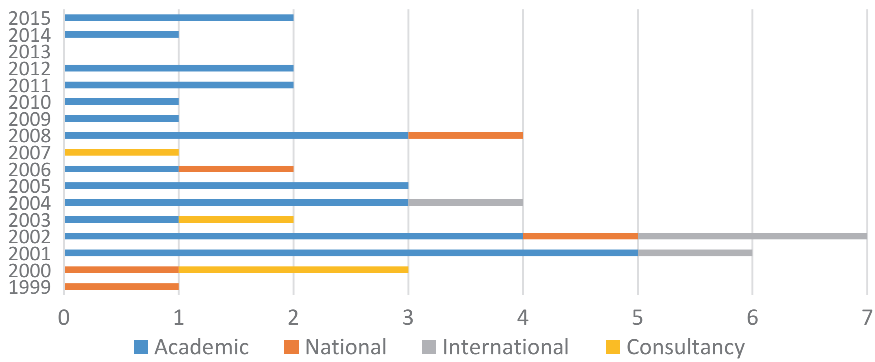


Fig. 18 Stage-models published over time

What is also clear from the literature review is that stage models were of particular interest in 2000–2004 when 23 of the 42 identified models were published (i.e. 54.8%) – including all models originating in international organisations and consultancies.

As presented in Table 2, 22 (i.e. 52.4%) of the identified models are based on practical experiences and case studies with 15 (i.e. 35.7%) being based largely on observations of ICT use in a single country and at a single level of government (e.g. local, regional, or central) public administration. Seven (i.e. 16.7%) models are based on the experiences in multiple countries, i.e. Accenture, UN, EU, Iribarren et al., Janokowski, Wescott and West. Three models (i.e. 7.1%), Windley, Chan et al. and Almazan et al., are based on regional observations in a single

Table 2 Stage-models based on practical experiences and case studies

Model	Type	Experiences/case study
ANAO	National	Australian experience.
SAFAD	National	Swedish experience and ANAO model.
UKNAO	National	UK experiences.
NASCIO	National	USA States.
Iribarren et al.	National	Chilean experience plus experiences of 22 countries. Annual ranking of Australia, Canada, South Korea, Sweden, UK, USA and others.
Accenture	Consultant	Observations in 22 countries. Annual ranking of Australia, Belgium, Brazil, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Italy, Japan, Malaysia, Mexico, the Netherlands, Norway, Portugal, Singapore, South Africa, Spain, the UK and USA.
UN	International	Observations in 193 countries.
EU	International	Observations in 28 EU plus associated member states. Based on SAFAD model. Annual ranking of the countries.
Layne and Lee	Scientific	Observations in the US.
Moon	Scientific	Case study of 2000 US municipalities.
Reddick	Scientific	Observations in US municipalities.
Wescott	Scientific	Observations in Asian-Pacific countries.
Waseda	International	Observations in multiple countries.
West	Scientific	Case studies of from 1813 and 1680 US municipalities in 2000 and 2001 plus observations in multiple countries e.g. in 2006.
Windley	Scientific	Case study of US Utah.gov.
Andersen and Henriksen	Scientific	Case study of 110 Danish stage sites and Layne and Lee model.
Shareef et al.	Scientific	Case study in Canada.
Chan et al.	Scientific	Case study of selected Chinese regional portals.
Almazan et al.	Scientific	Case study of 32 Mexican state portals.
Dias and Gomes	Scientific	Case studies of 239 Portuguese municipalities in 1999, 2007, 2010 and 2013.
Lee and Kwak	Scientific	Observations in US health sector.
Janowski	Scientific	Observations in multiple developing countries.

country, whereas Moon, Reddick and Dias & Gomes (i.e. 7.1%) are based on case studies in municipalities.

The most cited model is hard to asses as the original source of national, international and consultant models are often not citied or referenced appropriately in the literature, is neither publically available, not included in scientific databases, nor available on sites such as research gate and Google scholar. Using Google scholar (accessed on 15 April 2016) the most frequently cited models are all scientific: Layne and Lee's 2001 model (Layne and Lee 2001) with 2031 citations, Moon's 2002 model (Moon 2002) with 1550 citations, Hiller and Belanger's 2001 model (Hiller and Belanger 2001) citied 952, and Andersen and Henriksen's 2006 model

(Andersen and Henriksen 2006) model being cited 453 times. The most cited model not published by academics are Gartner's (Baum and Di Maio 2000) 2000 model with 302 citations.

Maturity Levels in Stage-Models

Analysing the 42 models, 11 different stages are identified: From pre-conditions to transformation (or morphing) and eDemocracy. As illustrated in Fig. 19 (at the end of the chapter), the models and their respective complexity and maturity levels (or stages) varies from simple models such as Reddick's (2004) two-stage model presenting information online and transactional eServices, and the World Bank's (Toasaki 2003) three-stage model, which adds user-engagement to Reddick's version. More complex models includes Dias and Gomes' three-dimensional, 12-stage model (Dias and Gomes 2014), Waseda's four-stages with seven cross cutting themes (Obi 2015), Iribarren et al. with five-stages and 172 indicators, or the UN model with its four-stages and over 200 indicators for its eGovernment Readiness Index (UNDESA 2008). It is particularly interested that models like Dias and Gomes, Heeks and Waseda borrow heavily from the CMM / CMMI models with their multi-dimensional approach.

Two clusters of development are identified in literature (and visualized in Fig. 19). The first cluster appear in the period 1999–2004 and consists of 23 models (i.e. 54.8%). Three of five models published by national authorities, all three international organisations and the four consultancy models are from this period. All models (except Waseda) in this cluster includes maturity stages for publication of static information online, transactional services (i.e. eServices), aspects of back-office integration and a degree of public sector reform. Only the UN, EU and Waseda address pre-conditions such as the availability of internet access, digital literacy and internet use. Similarly, only Gartner, Silcock and Accenture included ICT enabled transformation (or morphing) of public administration. Hiller and Belanger, Wescott, Moon and Netchaeva by contract, address user engagement, participation and decision making (i.e. eParticipation and eDemocracy) to some degree.

A second cluster of emerge from 2005 (but over a longer period) and consist of 19 models (i.e. 45.2%). Three trends emerge within the second cluster. First, all build on the ideas from the 1999–2004 cluster, and includes the presentation of static information online (except Iribarren et al. and Kleivink and Janssen), eServices transactions (except Iribarren et al. and Kleivink amd Janssen), back-office integration and a degree of ICT enabled public sector reform. Second, public sector reform becomes more prominent and is included in 14 models (i.e. 14/19, compared to 4/23). Lastly, eParticipation and eDemocracy is also included in more models. In addition to the 12 models (i.e. 12/19, compared to 7/23) addressing user engagement and decision making published from 2005, the period also see the UN and EU extending their models in order to address these aspects (EC 2012; UNDESA 2012).

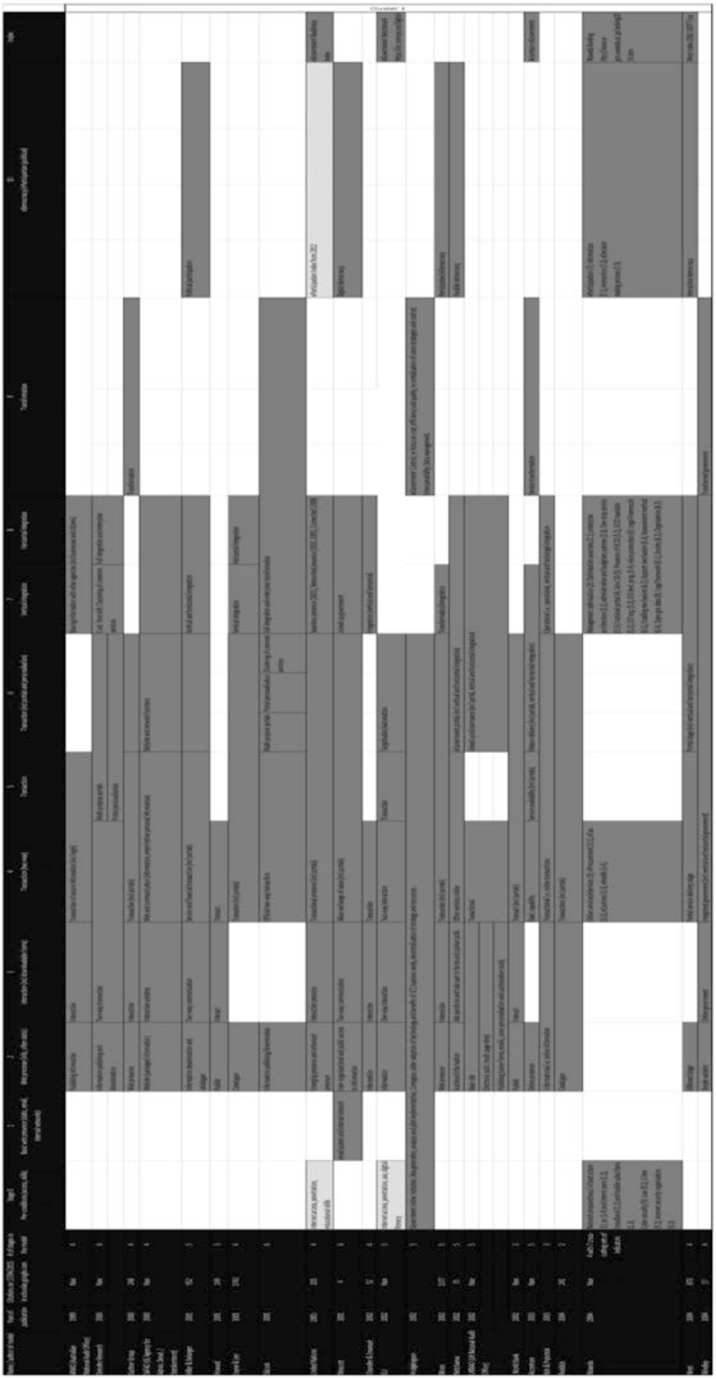


Fig. 19 (**a**) Identified stage models mapped in accordance with their different maturity levels. (**b**) Identified stage models mapped in accordance with their different maturity levels

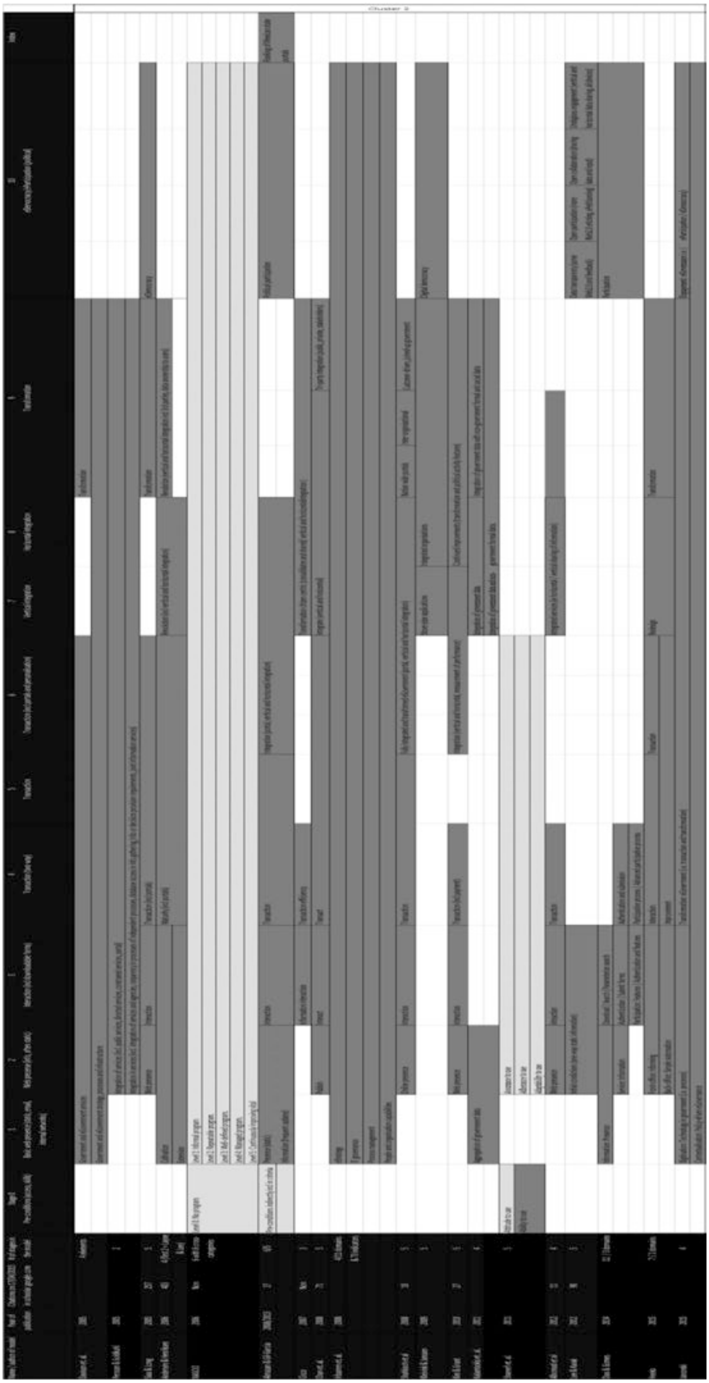


Fig. 19 (continued)

The vast majority of the 42 models use different semantics and metaphors, similarly many models and individual stages overlap (Meyerhoff Nielsen 2016a; b; Alhomod and Shafi 2012; Lee 2010). This means that some general categories exist. In fact, commonalities between national, international and consultancy models, are also shared with many of the scientific models, and is visualized in Fig. 19 (Lee 2010).

Overarching Characteristics and Meta Stages

As the various models are based on different perspectives and use different definition and metaphors, they can be difficult to understand and summarise. To alleviate this difficulty, the 11 meta stages presented in Fig. 19 are distilled further using Lee's qualitative meta-synthesis framework (Lee 2010).

Using a detailed qualitative meta-synthesis procedure Lee use 12 stage-models to develop a new semantic framework consisting of five general metaphors namely: Presenting, Assimilating, Reforming, Morphing, eGovernance. The Lee's five metaphors are defined and described in Table 3 below.

Table 3 Metaphors: their definitions, related stages, and themes (Lee 2010)

Metaphors	Description	Stages/concepts	
		Citizens and services	Operation and technology
Presenting	Presenting information in the information space	Information	
Assimilation	Assimilates (or replicates) processes and service in the information space with the ones in the real world	Interaction	Integration
Reforming	Reform the processes and services in the real world to match the information space requirements, fitting for efficiency	Transaction	Streamlining
Morphing	Change the shape and scope of processes and services in the information space as well as the ones in the real world, fitting for effectiveness	Participation	Transforming
eGovernance	Processes and services in both worlds are synchronously managed, reflecting citizen-involved changes with reconfigurable processes and services	Involvement	Process management

From the analysis of the 42 models, identified in the literature review, it becomes clear that the 11 overarching stages identified represents six specific meta stage characteristics. With respect to Lee's framework, an initial 'pre-condition' stage is missing. A pre-condition stage is therefore added to Lee's framework for the purpose of this article (bringing the number of stages to six) (Meyerhoff Nielsen 2016a).

The 42 models and their respective overarching stages are, in Fig. 20, mapped in accordance with the six meta characteristic described in Table 3. The models are presented chronological and in alphabetical order within said year.

Review of Existing Stage Models

The stage and meta characteristic mapping in Fig. 20 highlight a number of interesting aspects. Table 4 below summaries the number of models, which address each of the six meta stages. The main differences in the models unearth relates to ICT enabled morphing (i.e. transformation) of public administrations and eParticipation and eDemocracy (i.e. user engagement and decision-making).

Preconditions

Models, like the UN (UNDESA 2014), EU (EC 2012), Waseda (Obi 2015) and Iribarren et al. (Iribarren et al. 2008) which include preconditions generally focus on the availability of key enabling factors such as digital literacy, Internet availability and use, electronic identifiers (eID), availability of a basket of electronic services, accessing public sector information, downloadable forms and transactional eServices in aggregated terms. The aim is to enrich analysis and monitor the availability of key enablers. Unfortunately, none of the models addresses the actual use of key enablers like eID's.

While Lee's framework include management and governance issues in the final maturity level (Lee 2010), it may be argued – in line with the IT governance literature (Brown and Magill 1994; Brown and Grant 2005) (see section "Background"), recommendations by the OECD (OECD 2014) and authors like Iribarren, NASCIO and Janowski (Iribarren et al. 2008; NASCIO, N.A.o.S.C.I.O. 2006; Janowski 2015) – that governance structures and cross-governmental cooperation are preconditions for successful ICT implementation and take-up. For instance, is the eGovernment Strategy legally binding for one or all levels of government, what mechanisms govern decision-making, legal changes and coordination processes, benefit realization etc. While most would agree on the objective of IT governance, the Waseda, NASCIO, Iribarren et al., Shareef et al. and Janowski models are the only one, which address it directly (e.g. governance, cooperation and promotion structures, management optimization, policy driven eGovernment) (Iribarren et al. 2008; Meyerhoff Nielsen 2016a; Obi 2015; NASCIO, N.A.o.S.C.I.O. 2006; Shareef et al. 2011; Janowski 2015; Lee 2010).

Name / author of model	Year of publication	# of stages in the model	Pre-conditions (0)	Presenting (1+2+3 / Lee presenting)	Transaction (4+5 / Lee assimilation, transaction)	Reforming /User-centric (6+7+8 / Lee Reforming)	Morphing / Personal (9 / Lee Morphing)	eDemocracy (10 / Lee eGovernance)	Ranking/ benchmark/ index/ evaluation	
ANAO (Australian National Audit Office)	1999	4		2+3	4+5	6+7				CLUSTER 1
Deloitte Research	2000	6		2+3	4+5	7+8				
Gartner Group	2000	4		2+3	4+5	6+7+8	9			
SAFAD (Swe Agency for Admin. Dev. / Statskontoret)	2000	4		2+3	4+5	6+7+8				
Hiller & Belanger	2001	5		2+3	4+5	6+7+8		10		
Howard	2001	3		2+3	4					
Leyne & Lee	2001	4		2	4+5	6+7+8				
Silcock	2001	6		2	4+5	6+7+8	9			
United Nations	2001-	4	0	2+3	4+5	6+7+8		(10)	x	
Wescott	2001	6		1+2+3	4+5	6+7+8		10		
Chandler & Emanuel	2002	4		2+3	4	7+8				
EU	2002		(0)	2+3	4+5	6		(10)	x	
Hodginson	2002	5	(0)	1+2+3	4+5		9			
Moon	2002	5		2+3	4+5	6+7+8		10		
Netchaeva	2002	5		2+3	4+5	6+7+8		10		
UKNAO (UK Natonal Audit Office)	2002	5		2+3	4	6+7+8				
World Bank	2002	3		2+3	4+5	6				
Accenture	2003	5		2	4+5	6+7	9		x	
Koh & Prybotok	2003	3		2+3	4+5+6	7+8				
Reddick	2004	2		2+3	4+5	6				
Waseda	2004-		0		4	7+8		10	x	
West	2004	4		2	4+5	6+7+8		10	x	
Windley	2004	4		2+3	4+5	6+7+8	9			
Davison et. al.	2005	4		1+2+3	4+5	6+7+8				CLUSTER 2
Siau & Long	2005	5		2+3	4+5	6	9	10		
Persson & Goldkuhl	2005	2		1+2+3	4+5	6+7+8	9	10		
Andersen & Henriksen	2006	4		(1)+2+3	4+5	6+7+8	9	(10)		
NASCIO	2006	6	0	1+2+3	4+5	6+7+8	9	10		
Cisco	2007	3		3	4	7+8	9			
Almazan & Gil-Garcia	2008	6		1+2+3	4+5	6+7+8		10	x	
Chan et. al.	2008	5		2+3	4+5	6+7+8	9			
Iribarren et. al.	2008	4					9			
Shahkooh et al	2008	5		2+3	4+5	6+7+8		10		
Kleivink & Janssen	2009	5				6+7+8	9			
Kim & Grant	2010	5		2+3	4	6+7+8	9	(10)		
Kalambokis et. al.	2011	4		1+2		7+8	9	10		
Shareef et. al.	2011	5	0	1+2	3+4+5					
Alhomod et al	2012	4		2+3	4	8				
Lee & Kwak	2012	5		2+3			(9)	10		
Dias & Gomes	2014	12 / 3 domains		1+2+3	4+5			(10)	x	
Heeks	2015	7 / 2 domains		2+3	4+5	6+7+8	9			
Janowski	2015	4		1+2+3	4+5	6+7+8	9	10		

Fig. 20 Identified stage models mapped in accordance with Lee's qualitative meta-synthesis framework (Adapted by author to incl. pre-conditions) (Lee 2010)

Table 4 Metaphores: their definitions, related stages, and themes

Pre-conditions: 6/42 (i.e. 14.3%)	United Nations, EU, Waseda, NASCIO, Iribarren et al., Shareef et al.
Presenting: 39/42 (i.e. 92.9%)	ANAO, Deloitte, Gartner, SAFAD, Hiller and Belanger, Howard, Layne and Lee, Silcock, UN, Wescott, Chandler and Emanuel, EU, Moon, Netchaeva, UKNAO, World Bank, Accenture, Reddick, West, Windley, Siau and Long, Persson and Goldkuhl, Andersen and Henriksen, NASCIO, Cisco, Almazan and Gil-Gaarcia, Chan et al., Shahkooh et al., Kim and Grant, Kalambokis et al., Shareef et al., Alhomod et al., Lee and Kwak, Dias and Gomes, Heeks, Janowski (except Waseda, Iribarren et al., Klievink and Janssen).
Assimilation: 38/42 (i.e. 90.5%)	ANAO, Deloitte, Gartner, SAFAD, Hiller and Belanger, Howard, Layne and Lee, Silcock, UN, Wescott, Chandler and Emanuel, EU, Moon, Netchaeva, UKNAO, World Bank, Accenture, Reddick, Waseda, West, Windley, Siau and Long, Persson and Goldkuhl, Andersen and Henriksen, NASCIO, Cisco, Almazan and Gil-Gaarcia, Chan et al., Shahkooh et al., Kim and Grant, Shareef et al., Alhomod et al., Lee and Kwak, Dias and Gomes, Heeks, Janowski (except Iribarren et al., Klievink and Janssen, Kalambokis et al., Lee and Kwak).
Reforming: 36/42 (i.e. 85.7%)	ANAO, Deloitte, Gartner, SAFAD, Hiller and Belanger, Layne and Lee, Silcock, Hodginson, UN, Wescott, Chandler and Emanuel, EU, Moon, Netchaeva, UKNAO, World Bank, Accenture, Reddick, Waseda, West, Windley, Siau and Long, Persson and Goldkuhl, Andersen and Henriksen, NASCIO, Cisco, Almazan and Gil-Gaarcia, Chan et al., Shahkooh et al., Kleivink & Janssen, Kim and Grant, Kalambokis et al., Shareef et al., Alhomod et al., Heeks, Janowski. (Exempt Howard, Hodginson, Iribarren et al., Shareef et al., Lee and Kwak, Dias and Gomes).
Morphing: 18/42 (i.e. 42.9%)	Gartner, Silcock, Hodginson, Accenture, Windley, Siau and Long, Persson and Goldkuhl, Andersen and Henriksen, NASCIO, Cisco, Chan et al., Iribarren et al., Kleivink and Janssen, Kim and Grant, Kalambokis et al., Lee and Kwak, Heeks, Janowski.
eDemocracy: 19/42 (i.e. 45.2%)	Hiller and Belanger, UN, Chandler and Emanuel, EU, Moon, Netchaeva, Waseda, West, Siau and Long, Persson and Goldkuhl, Andersen and Henriksen, NASCIO, Almazan and Gil-Gaarcia, Shahkooh et al., Kim and Grant, Kalambokis et al., Lee and Kwak, Dias and Gomes, Janowski.

Presenting Online Information and Services

Emerging from a national context, the Australian ANAO and SAFAD models (see Fig. 2) (Persson and Goldkuhl 2005) were introduced to categorize, evaluate process and guide government organisations' decisions on what services could and should provide. Layne and Lee's (2001) 2001 maturity model streamlines the development stages online information and transactional services by merging different aspects into two categories (see Fig. 4), that is: Catalogue of static information and downloadable forms one websites and transactional aspects such as online service and forms (i.e. eServices).

Dias and Gomes (2014) adjust the Layne and Lee (2001) and the EU benchmarking models (EC 2012) in their 2014 evaluation of local eGovernment maturity in

Portugal. The proposed model consists of three parallel dimensions each consisting of four stages: (1) Information: Generic information (i.e. presence), downloadable forms (i.e. interaction), search functionality (i.e. interaction), parameterize search (i.e. interaction); (2) Service: Information (i.e. one-way), authentication of user (i.e. two-way), eService transaction (i.e. two-way), authentication and eService transaction (i.e. transaction); (3) Participation: features (i.e. two-way), authentication and features (i.e. two-way), participative process (i.e. transaction), advanced participative process (i.e. transaction).

Iribarren et al. eGOV-MM model (see Fig. 13) (Iribarren et al. 2008) takes a multi-dimensional approach including the front- and backoffice, policy, management and oranisational capacities. Criticizing the Layne and Lee's model (2001) for being too linear and too 'US-centric' Heeks' Manchester eGovernment Maturity Model differentiate between the front- and back-office (Heeks 2015). The result is two parallel dimensions which forms a matrix (see Fig. 17). One focus on the sophistication of digitised interaction (i.e. one and two-way interaction plus transaction) and the extent of process change (i.e. simple digitisation and automation, improvement process integration, redesign/reform and transformation) which is similar to Waseda (Obi 2015), IT governance and CMM/CMMI approach by NASCIO, Iribarren and others (Iribarren et al. 2008; NASCIO, N.A.o.S.C.I.O. 2006).

While these adjustments to the presentation and publication of information and eServices have evolved over time, none of the models includes actual use. This is in sharp contrast to research in public administration reform – whether it is a NPM efficiency or a JUG effectiveness approach (Bannister and Connolly 2011; Cordella and Bonina 2012; Bannister 2001; Meyerhoff Nielsen and Mika 2014). This is unfortunate as the value added of a project comes from its use, not its existence.

Vertical and Horizontal Integration (Reforming)

Layne and Lee's stage model breaks with the initial models, by including vertical and horizontal integration as two distinct, and most advanced, levels of maturity to their model (see Fig. 4) (Layne and Lee 2001). Both Deloitte (Deloitte and Touche 2001) and Gartner (Baum and Di Maio 2000) mirror this development.

Persson and Goldkuhl (2005) in 2005 evaluates a number of existing models and propose a two-stage model with a clear computer science perspective. Based on Layne and Lee (2001), their focus is on the integration of services (i.e. services, directed services, concentrated services and portals) and integration in services including horizontal and vertical integration of organisations, processes, the exchange and re-use of data - with the data focus being similar to OGD Maturity Model by Kalambokis et al. (see Fig. 14) (Kalampokis et al. 2011).

ICT Enabled Reform and Transformation (Reform and Morphing)

The review in section "Preconditions". (see Table 4, Figs. 19 and 20) identified 36 (i.e. 85.7%) models which includes ICT enabled reform of public administration as a maturity level. Of these only half (i.e. 18 models or 42.9% of all models) address ICT enabled transformation (or morphing).

The Klievink and Janssen (2009) five-stage is of particular interest. The level of customer orientation increases with every stage of the model, as does the level of flexibility and includes: Stovepipes, integrated organisations, nationwide portals, inter-organisational integration and customer-driven, joined-up government. The Klievink and Janssen model clearly reflect joint-up government (i.e. integration) and outcomes based thinking seen in public administration and eGovernment literature.

Kim and Grant (2010) propose continuous improvement as a fifth and final maturity level in their 2010 model. Featuring political activities and a focus on continuous improvements and performance it sees ICT as a tool enabling public sector innovation and reform – on par with the logic behind agile development in the IT sector. Lee and Kwak's (2012) takes a similar approach in their data based model for collaboration and ubiquitous engagement. Although data and collaboration forms the core of Lee and Kwak's model, the development stages follow a 'classical' stage-model pattern, i.e. publication, assimilation, reform and transformation and does therefore not cover Gov3.0. Janowski's (Janowski 2015) model focus on complexity of ICT enabled reform and move from a 'classical' model focus to a fourth and final contextual stage.

The IT governance and CMM/CMMI models, like Davison, Iribarren et al., NACSIO and Waseda, provides a particular interesting multi-dimensional perspective and inclusion of both human, management and organisational capacities (Iribarren et al. 2008; Davison et al. 2005; Obi 2015; NASCIO, N.A.o.S.C.I.O. 2006).

Considering the level of academic consensus of ICT as an enabler of public sector reform and transformation, the limited attention paid to actual outputs and results is surprising. Similarly, not of the models adequately address the Gov3.0 concept.

Cooperation is indirectly addressed by all the models addressing reform and transformation, but none look at the role governance play to ensure backoffice integration or the outcomes required to move from one stage to another. Here the IT governance and CMM/CMMI models, like Davison, Iribarren et al., NACSIO and Waseda, stands out with their multi-dimensional perspective and the inclusion of both human, management and organisational capacities (Iribarren et al. 2008; Davison et al. 2005; Obi 2015; NASCIO, N.A.o.S.C.I.O. 2006).

Stage Models with a Participative and Democratic Dimension (eGovernance)

The Hiller and Bélanger (2001) and Deloitte and Touche (2001) – and in 2003 the World Bank (Toasaki 2003) with respect to legislative consultations – are the first to add a dimension of engagement and co-creation (indirectly by none-governmental stakeholders) and aspects of participation in a democratic sense. The focus is non-the-less on supply, technology and organisational integration.

In contract active engagement, participation and democratic decision making are aspects of the most advanced maturity levels proposed by authors like Moon (2002) and Siau and Long (2005) while Chan et al. (2008) adds none-governmental stakeholders to the mix of their five-stage model focusing on supply, technology and organizational integration. Similarly the UN eParticipation index was introduced in 2012 (UNDESA 2012) and EU benchmark has included aspects since 2013 (EC 2012).

Lee and Kwak's (2012) five-stage model focus on engagement and data exchange between authorities (i.e. horizontal and vertical integration), transparency by increasing access to data, user-engagement and participation in decision making (i.e. eParticipation and eDemocracy), and lastly on the total transformation of the way public administration deliver services and make decisions (i.e. ubiquitous engagement).

While increased levels of transparency in the government, political and democratic processes is laudable, the latter two does not necessarily constitute a maturity level in their own right. Especially, when focusing on ICT use to improve the efficiency, effectiveness, quality and value added of public sector service delivery.

Realigning the Stage Model to Focus on Integration, User-Centricity and Outcomes

While stage models like indexes and benchmarks are helpful in mapping the supply and sophistication levels of eService offerings, they all have a technological focus. The relevance of these different models is therefore limited in terms of governance, cooperation and measuring the successful use of online offerings – and thus the value added. In contrast to other stage models, Andersen and Henriksen (2006) follow an activity- and user-centric approach to personalisation of online services in their Public Sector Process Rebuilding (PPR) model (illustrated in Fig. 11). Andersen and Henriksen extends the Layne and Lee's model (see Fig. 4) (Layne and Lee 2001) by making an online presence, horizontal and vertical integration the foundation of their PPR model (Meyerhoff Nielsen 2015, 2016a; Alhomod and Shafi 2012). Klievink and Janssen also address outcomes but anchor their model in the joint-up government research stream (Klievink and Janssen 2009). The approach is interesting as it also reflects ideas around whole-of-government approaches (Frissen et al. 2007; Huijboom et al. 2009b; Traunmüller and Wimmer 2003; Millard

2010), JUG (Bannister and Connolly 2011; de Bri and Bannister 2010) and personalisation of online service delivery (Meyerhoff Nielsen and Igari 2012; Meyerhoff Nielsen and Robert 2015).

The importance of outcomes is a key topic with the both the public administration reform (Bannister and Connolly 2011; Bannister 2001, 2007; de Bri and Bannister 2010), IT-governance and computer science (Brown and Grant 2005) and eGovernment literature (Cordella and Bonina 2012; Traunmüller and Wimmer 2003; Scholl 2009; Janowski 2015). Seven models are complimented with various benchmarks, indexes and rankings (EC 2012; UNDESA 2014; West 2004; Rohleder and Jupp 2003; Obi 2014; Almazan and Gil-Garcia 2008; Luna et al. 2013; Dias and Gomes 2014) but several researchers have questions the value of their due to their simplicity, their supply and technology focus (Lips 2012; Meyerhoff Nielsen 2015, 2016a; Bannister 2007; Heeks 2006, 2015; Rorissa et al. 2011). Andersen and Henriksen are the first researchers, which have taken an outcomes based approach but do not include take-up, qualitative or quantitative indicators. The Waseda (Obi 2015) model differs somewhat from other stage models as it does not define distinct levels of maturity. The focus is on qualitative and quantitative indicators including network preparedness and infrastructure, management optimisation and efficiency etc. Unfortunately, it does not directly address the actual use of eServices, but rather pre-conditions like internet and mobile subscriptions.

Conclusion

The review of the 42 stage-models identified, their respective maturity levels and meta charateristics show that aspects of Gov3.0 aspects such as ICT enabled integration, transformation, sharing of data and increased participation a number of weaknesses persists.

First, all models, with the exemption of the PPR (Andersen and Henriksen 2006), Howard (2001) and Klievink and Janssen (2009) models, have a technology and supply orientated, i.e. no focus on outcomes or actual use (Meyerhoff Nielsen 2016a, b; Alhomod and Shafi 2012; Lee 2010). This is unfortunate as the tangible benefits of any ICT solution and eServices in particularly can only be realized through the actual and effective use of supplied eServices by citizens (OECD 2014; UNDESA 2014; Meyerhoff Nielsen 2016a; Meyerhoff Nielsen and Mika 2014; Meyerhoff and Kelly 2011).

Second, most of the models have no real understanding of core government service concepts. For instance individual service elements – that is information, transaction capability, personal data – are not separate maturity levels but rather elements in a given service request and subsequent delivery. Similarly downloadable forms are merely a type of static information and does not warrant a separate maturity level (Meyerhoff Nielsen 2016a, b). This is particular surprising considering that 22 models (i.e. 52.4%) are partially based on observations, experiences and case studies in one or more countries (see Table 2).

Third, decision-making, as illustrated by the eParticipation and eDemocracy stages, should not be considered an eGovernment maturity level. Dias and Gomes (2014) makes this argument indirectly, when defining engagement, petition and voting solutions as types of public services. That is, public services which consist of information, transaction capability and some form of data, e.g. information about an election, and internet voting solution allowing for vote casting, plus data such as unique ID numbers, name and address for authorizing a vote. Thus the eParticipation and eDemocracy stage(s) should be seen as an indication of democratic maturity and degree of transparency in a country not as eGovernment maturity levels (Meyerhoff Nielsen 2014, 2016a; Dias and Gomes 2014).

Fourth, front-office service provision and back-office integration are mixed-up in a number of models. For instance, one-stop-shop portals does not constitute a form of transaction, but is rather an indicator of degree to which authorities cooperate and integration in the provision of services via a portal (Meyerhoff Nielsen 2015, 2016a). Heeks attempt to address this by proposing a two dimensional matrix model distinguishing between the front- and the back-office (Heeks 2015). Unfortunately, Heeks does not account for governance or take-up.

Fifth, none of the identified models addresses governance directly. Some, like the Davison et al. (2005), Iribarren et al. (2008), Janowski (2015), Kalambokis et al. (2011), Shareef et al. (2011) and Waseda (Obi 2015) models, highlight management and coordination issues such as the existence of chief information officers. Cooperation on the other hand is indirectly addresses in most models. This is manifested in terms of vertical and horizontal integration, and the existence of one-stop-shops, the sharing of information and data between different authorities and levels of government – even private and third party stakeholders (Lee and Kwak 2012; Chen and Mingins 2011).

Sixth, as illustrated by Figs. 19 and 20 most models merely restructure or adjust existing ones. Key exemptions are the IT governance models like NASCIO (NASCIO, N.A.o.S.C.I.O. 2006) and Iribarren et al. (2008), Andersen and Hendriksen's PPR model (Andersen and Henriksen 2006), Hodgkingson's focus on learning curves (Hodgkinson 2002), Davison's four elements (Davison et al. 2005), Shareef's (Shareef et al. 2011) dimensions, Waseda's approach (Obi 2015) and Janowski's (2015) approach, all of which builds on existing models while attempting to address outcomes and governance issues.

Acknowledgement This chapter is a result of the project "SmartEGOV: Harnessing EGOV for Smart Governance (Foundations, methods, Tools)/NORTE-01-0145-FEDER-000037", supported by Norte Portugal Regional Operational Programme (NORTE 2020), under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund (EFDR). It work was also supported in part by funding from Tallinn University of Technology, Project B42; OGI – Open Government Intelligence project in the EU Horizon 2020 framework program, grant agreement 693849.

References

Alhomod SM, Shafi MM (2012) Best practices in e-government: a review of some innovative models proposed in different countries. Int J Electri Comput Sci 12(2):1–6

Almazan RS, Gil-Garcia JR (2008) e-Government portals in Mexico. Electron Gov Concepts Methodol Tools Appl 6:1726–1736

ANAO (1999) Electronic service delivery, including internet use by Commonwealth government agencies. ANAO, Australian National Auditing Office, Canberra, p 87

Andersen KV, Henriksen HZ (2006) E-government maturity models: Extension of the Layne and Lee model. Gov Inf Q 23(2):236–248

Bannister F (2001) Dismantling the silos: extracting new value from IT investments in public administration. Inf Syst J 11(1):65–84

Bannister F (2007) The curse of the benchmark: an assessment of the validity and value of e-government comparisons. Int Rev Adm Sci 73(2):171–188

Bannister F, Connolly R (2011) Transformation and public sector values, in tGov 11. Brunel University, London

Bates MJ (1989) The design of browsing and berrypicking techniques for the online search interface. Online Review 13(5):407–424

Baum C, Di Maio A. (2000) Gartner's four phases of e-government model. In: Gartner Group

Brown AE, Grant GG (2005) Framing the frameworks: a review of IT governance research. Commun Assoc Inf Syst 15(1):38

Brown CV, Magill SL (1994) Alignment of the IS functions with the enterprise: toward a model of antecedents. MIS Q:371–403

Chan CM, Lau YM, Pan SL (2008) E-government implementation: a macro analysis of Singapore's e-government initiatives. Gov Inf Q 25(2):239–255

Chandler S, Emanuels S (2002) Transformation not automation. In: Proceedings of 2nd European conference on E-government. Management Center Europe, Brusseles

Charalabidis Y (2015) What is government 3.0? In: Charalabidis Y (ed) Governance and transformation. Yannis Charalabidis, Athens

Chen JYY, Mingins C (2011) A three-dimensional model for e-government development with cases in China's regional e-government practice and experience. In: ICMeCG, 2011 fifth international conference on management of e-commerce and e-government. The Institute of Electrical and Electronics Engineers Inc., Wuhan

Christensen T, Lægreid P (2007) The whole-of-government approach to public sector reform. Public Adm Rev 67(6):1059–1066

Christine Leitner, J.-M.E., François Heinderyckx, Klaus Lenk, Morten Meyerhoff Nielsen, Roland Traunmüller (2003) eGovernment in Europe: the state of affairs. p 66

Cisco IBSG (2007) e-Government Best Practices learning from success, avoiding the pitfalls. Cisco IBSG

Cordella A (2007) E-government: towards the e-bureaucratic form? J Inf Technol 22(3):265–274

Cordella A, Bonina CM (2012) A public value perspective for ICT enabled public sector reforms: a theoretical reflection. Gov Inf Q 29(4):512–520

Davison RM, Wagner C, Ma LC (2005) From government to e-government: a transition model. Inf Technol People 18(3):280–299

de Bri F, Bannister F (2010) Whole-of-government: the continuing problem of eliminating silos. Proceedings of the 10th European conference on eGovernment. National Centre for Taxation Studies and University of Limerick, Ireland, pp 122–133

Deloitte and Touche (2001) The citizen as customer. In: CMS management. Deloitte and Touche, p 58

Demmke C (2006) Governmental, organisational and individual performance. Performance myths, performance "hype" and real performance. EIPAScope 2006(*1*):*4–11*

Dias GP, Gomes H (2014) Evolution of local e-government maturity in Portugal. In: Information systems and technologies (CISTI), 2014 9th Iberian conference on. 2014. IEEE

EC (2012) E.C., Public services online ‘Digital by default or by De-tour?’ Assessing user centric eGovernment performance in Euorpe – eGovernment Benchmark 2012. European Commission, Brussels

EC (2014) E.C., Delivering the European advantage? ‘How European governments can and should benefit from innovative public services’. European Commission DG Communications Networks, Content & Technology, Brussels

Edelmann N, Krimmer R, Parycek P (2008) Engaging youth through deliberative e-participation: a case study. Int J Electron Gov 1(4):385–399

European Commission, D.R.a.I (2013) Powering European public sector innovation: towards a new architecture. D.R.a. Innovation, Editor. European Commission, DG Research and Innovation, Brussels, pp 1–64

Eurostat (2016) Information society household survey [cited 28 March 2016]; Available from: http://ec.europa.eu/eurostat/web/information-society/data/database

Fath-Allah A et al (2014) eGovernment maturity models: a comparative study. Int J Software Eng Appl 5(3):72–91

Frissen V et al (2007) The future of eGovernment: an exploration of ICT-driven models of eGovernment for the EU in 2020. D. Osimo, D. Zinnbauer and A. Bianchi, Joint Research Centre

Gammon H (1954) The automatic handling of office paper work. Public Adm Rev 14(1):63–73

Heeks R (2005) Implementing and managing eGovernment: an international text. Sage, Los Angeles

Heeks R (2006) Understanding and measuring eGovernment: international benchmarking studies. UNDESA workshop “E-participation and e-government: understanding the present and creating the future”. Budapest, Hungary, pp 27–28

Heeks R (2015) A better eGovernment maturity model. In: iGovernment Briefing. Manchester, University of Manchester

Heeks R, Bailur S (2007) Analyzing e-government research: Perspectives, philosophies, theories, methods, and practice. Gov Inf Q 24(2):243–265

Hiller JS, Belanger F (2001) Privacy strategies for electronic government. E-government 200:162–198

Hodgkinson S (2002) Managing an e-government transformation program. Working Towards Whole-of-Government Online Conference, Canberra

Howard M (2001) E-government across the globe: how will “e” change government? Gov Finan Rev 17(4):6–9

Huijboom N, van der Broek T, Frissen V, Kool L, Kotterink B, Meyerhoff Nielsen M, Millard J (2009a) Public services 2.0: key areas in the public sector impact of social computing. p 134

Huijboom N et al (2009b) Public Services 2.0: the impact of social computing on public services, in Institute for Prospective Technological Studies, Joint Research Centre, European Commission. Office for Official Publications of the European Communities, Luxembourg

Igari N (2014) How to successfully promote ICT usage: a comparative analysis of Denmark and Japan. Telematics Inform 31(1):115–125

InfoDev, C.f.D.a.T (2002) The e-government handbook for developing countries. World Bank, Washington, DC, pp 1–41

Iribarren M et al (2008) Capability maturity framework for eGovernment: a multi-dimensional model and assessing tool. In: Electronic government. Springer, pp 136–147

Janowski T (2015) Digital government evolution: from transformation to contextualization. Gov Inf Q 32(3):221–236

Janssen M, Chun SA, Gil-Garcia JR (2009) Building the next generation of digital government infrastructures. Gov Inf Q 26(2):233–237

Janssen M, Charalabidis Y, Zuiderwijk A (2012) Benefits, adoption barriers and myths of open data and open government. Inf Syst Manag 29(4):258–268

Jukić TT, Ljupčo N, Nameslaki A (2015) Investigation of e-government research field: what has been done and how to proceed? NISPAcee J Public Admin Policy 23

Kalampokis E, Tambouris E, Tarabanis K (2011) Open government data: a stage model. In: Electronic government. Springer, pp 235–246

Kim D-Y, Grant G (2010) E-government maturity model using the capability maturity model integration. J Syst Inf Technol 12(3):230–244
Klievink B, Janssen M (2009) Realizing joined-up government—dynamic capabilities and stage models for transformation. Gov Inf Q 26(2):275–284
Klischewski R, Scholl HJ (2008) Information quality as capstone in negotiating e-government integration, interoperation and information sharing. Electron Gov Int J 5(2):203–225
Koh CE, Prybutok VR (2003) The three ring model development of an instrument for measuring dimensions of E-government functions. J Comput Inf Syst 43(3):34
Layne K, Lee J (2001) Developing fully functional E-government: a four stage model. Gov Inf Q 18(2):122–136
Lee J (2010) 10 year retrospect on stage models of e-Government: a qualitative meta-synthesis. Gov Inf Q 27(3):220–230
Lee G, Kwak YH (2012) An open government maturity model for social media-based public engagement. Gov Inf Q 29(4):492–503
Lips M (2012) E-government is dead: long live public administration 2.0. Inf Polity 17(3):239–250
Luna DE et al (2013) Improving the performance assessment of government web portals: a proposal using data envelopment analysis (DEA). Inf Polity 18(2):169–187
Meyerhoff M, Kelly A (2011) Scandinavia 2.0: efficiency, cooperation and innovations to alleviate the economic crisis. Eur J ePract 11:19–38
Meyerhoff Nielsen M (2014) Identifying eGovernment success factors: an analysis of selected national governance models and their experiences in digitising service delivery. Proceedings of the 2014 conference on Electronic Governance and Open Society: challenges in Eurasia, 2014, pp 19–25
Meyerhoff Nielsen M (2015) Supply and use of citizen eServices: an analysis of selected national experiences in relation to existing governance and cooperation models. NISPAcee J Public Admin Policy 23
Meyerhoff Nielsen M (2016a) The role of governance, cooperation, and eService use in current eGovernment stage models. Hawaii
Meyerhoff Nielsen M (2016b) eGovernance and stage models: Analysis of identified models and selected Eurasian experiences in digitizing citizen service delivery. Int J Electron Gov Res x(x):2016
Meyerhoff Nielsen M, Igari N (2012) Speaking Danish in Japan. CeDEM 12 conference for E-Democracy and Open Government 3–4 May 2012 Danube-University Krems, 2012, p 137
Meyerhoff Nielsen M, Mika Y (2014) An analysis of the Danish approach to eGovernment benefit realisation. Internet Technologies and Society 2014 conference proceedings, 2014, pp 47–58
Meyerhoff Nielsen M, Robert K (2015) Reuse of data for personal and proactive service: an opportunity not yet utilised. In: CeDEM 15 conference for e-democracy and open government 20–22 May 2015, Danube-University Krems, Austria. Krems an der Donau: Donau-Universität Krems; eJournal of eDemocracy and Open Government
Millard J (2010) Government 1.5 – is the bottle half full or half empty? Eur J ePract (9):35–48
Millard J (2013) ICT-enabled public sector innovation: trends and prospects. In: Proceedings of the 7th international conference on theory and practice of electronic governance. ACM
Millard J, Luca C, Galasso G, Riedl R, Neuroni AC, Walser K, Sami Hamida A, Huijboom N, Meyerhoff Nielsen M, Leitner C, Fehlmann RS (2007) European eGovernment 2005–2007: Taking stock of good practice and progress towards implementation of the i2010 eGovernment Action Plan. p 80
Millard J et al (2008) Social computing: trends in public services and policies. JRC-IPTS
Ministry of Interior Korea (2016) Government 3.0. Ministry of Interior Korea, Seoul
Moon MJ (2002) The evolution of e-government among municipalities: rhetoric or reality? Public Adm Rev 62(4):424–433
NAO (2002) N.A.O., Government on the Web II. UK National Audit Office, London
NASCIO, N.A.o.S.C.I.O. (2006) Enterprise Architecture Maturity Model (EAMM), version 3.1. National Association of State Chief Information Officers, Lexington

Netchaeva I (2002) e-government and e-democracy a comparison of opportunities in the North and South. Int Commun Gaz 64(5):467–477
O'Leary R, Gerard C, Bingham LB (2006) Introduction to the symposium on collaborative public management. Public Adm Rev 66(s1):6–9
Obi T (2012) WASEDA – IAC Internationl e-Government Index. Waseda University and IAC International Agency of CIO, Tokyo
Obi T (2014) WASEDA – IAC internationl e-government index. Waseda University and IAC International Agency of CIO, Tokyo
Obi T (2015) WASEDA – IAC Internationl e-Government Index. Waseda University and IAC International Agency of CIO, Tokyo
OECD (2014) Recommendation of the Council on Digital Government Strategies 15 July 2014 – C(2014)88. OECD, Paris
Persson A, Goldkuhl, G (2005) Stage-models for public e-services-investigating conceptual foundations. 2nd Scandinavian Workshop on e-Government, Copenhagen
Peters BG, Pierre J (1998) Governance without government? Rethinking public administration. J Public Adm Res Theory 8(2):223–243
Poeppelbuss J et al (2011) Maturity models in information systems research: literature search and analysis. Commun Assoc Inf Syst 29(27):505–532
Pollitt C (2014) Future trends in European public administration and management: an outside-in perspective. COCOPS Coordination for Cohesion in the Public Sector of the Future
Pollitt C, Bouckaert G (2011) Public management reform: a comparative analysis-new public management, governance, and the Neo-Weberian state. Oxford University Press, Oxford
Pöppelbuß J, Röglinger M (2011) What makes a useful maturity model? A framework of general design principles for maturity models and its demonstration in business process management. ECIS
Reddick CG (2004) A two-stage model of e-government growth: theories and empirical evidence for US cities. Gov Inf Q 21(1):51–64
Roberts SE (1977) Theories and Models in Information Retrieval. J Doc 33(2):126–148
Röglinger M, Pöppelbuß J, Becker J (2012) Maturity models in business process management. Bus Process Manag J 18(2):328–346
Rohleder SJ, Jupp V (2003) e-Government leadership: engaging the customer. Accenture, Arlington, pp 1–94
Ronaghan SA (2002) Benchmarking e-government: a global perspective: assessing the progress of the UN member states United Nations Division for Public Economics and Public Administration
Rorissa A, Demissie D, Pardo T (2011) Benchmarking e-Government: a comparison of frameworks for computing e-Government index and ranking. Gov Inf Q 28(3):354–362
Ross JW, Weill P, Robertson D (2006) Enterprise architecture as strategy: creating a foundation for business execution. Harvard Business Press, Boston
Scholl HJJ (2009) Profiling the EG research community and its core. In: Electronic government. Springer, Berlin/Heidelberg, pp 1–12
Self P (2000) Rolling back the state. Economic dogma & political choice. St Martin's Press, New York
Shahkooh KA, Saghafi F, Abdollahi A (2008) A proposed model for e-Government maturity. In: Information and communication technologies: from theory to applications, 2008. ICTTA 2008. 3rd international conference on. 2008. IEEE
Shareef MA et al (2011) e-Government Adoption Model (GAM): differing service maturity levels. Gov Inf Q 28(1):17–35
Siau K, Long Y (2005) Synthesizing e-government stage models-a meta-synthesis based on meta-ethnography approach. Ind Manag Data Syst 105(4):443–458
Silcock R (2001) What is e-government. Parliam Aff 54(1):88–101
Statskontoret (2000) 24-timmmarsmyndighet: Förslag til kriterier för statlige elektronisk förvaltning i medborgarnas tjänst. Statskontoret, Stockholm, pp 1–80
Toasaki Y (2003) e-Government from a user's perspective. World Bank, Taipei

Traunmüller R, Wimmer MA (2003) E-government at a decisive moment: sketching a roadmap to excellence. In: Electronic government. Springer, Berlin/Heidelberg, pp 1–14
UNDESA (2008) E-Government Survey 2008: From e-government to connected government. United Nations, New York
UNDESA (2010) E-Government Survey 2010: Leveraging e-government at a time of financial and economic crisis. United Nations, New York
UNDESA (2012) E-Government Survey 2012: E-Government for the people. New York
UNDESA (2014) E-Government Survey 2014: E-Government for the future we want. United Nations, New York
Walsh D, Downe S (2005) Meta-synthesis method for qualitative research: a literature review. J Adv Nurs 50(2):204–211
Weill P (2004) Don't just lead, govern: how top-performing firms govern IT. MIS Q Exec 3(1):1–17
Wescott CG (2001) E-Government in the Asia-pacific region. Asian J Political Sci 9(2):1–24
West DM (2004) E-government and the transformation of service delivery and citizen attitudes. Public Adm Rev 64(1):15–27
Windley PJ (2002) eGovernment maturity [Online]. USA: Windleys' Technolometria. Available: http://www.windley.com/docs/eGovernment% 20Maturity.pdf
Yildiz M (2007) E-government research: reviewing the literature, limitations, and ways forward. Gov Inf Q 24(3):646–665

Morten Meyerhoff Nielsen Researcher at Tallinn University of Technology, Ragnar Nurkse School of Innovation and Governance (www.ttu.ee/nurkse), in Estonia and an academic fellow at the United Nation University, Operating Unit for Policy-Driven Electronic Governance (https://egov.unu.edu), in Portugal. He currently work on: eGovernment strategy development and evaluation (Albania, Faroe Islands); performance management and benefit realisation (Albania, UNU-EGOV); reuse of public sector information (Horizon 2020); Interoperability (Macedonia); ICT enabled administrative burden reduction and public service delivery (UNU-EGOV); research and teach on eGovernment, eService usability, social media use and stakeholder engagement, governance and intergovernmental cooperation models (www.msm.nl and www.ttu.ee); ICEGOV 2017 (www.icegov.org). Morten is the author and co-author of various publications, reviewer and track chair for multiple conferences and academic journals, regularly run executive training courses and present at various conferences.

Techniques for Reuse in Business Process Modeling in Public Administration

Wassim Derguech, Edward Curry, and Sami Bhiri

Abstract As part of the Smart Cities movement, public administrations are constantly in need to create new and innovative public services. Innovative services can be derived from exiting best practices. Reuse is a key enabler for cost effective customization of their processes for delivering effective and timely services. The literature exhibits a wide variety of techniques that can be applied. This paper conducts an analysis of major reuse-oriented process modeling techniques with respect to available means of maintainability, user support, compression rate gained when storing process models as well as traceability of modeling decisions. Furthermore, we empirically evaluated the technique of configuration-based process modeling to validate its applicability in modeling municipal processes.

Introduction

Processes in public administrations have distinguishing characteristics from private organizations such as the significant diversity of administrative services (Karow et al. 2008). For example, processes in municipalities include more than 1000 services and workflows (Karow et al. 2008). This diversity is driven by multiple factors such as directives, federal and state laws. Furthermore, public organizations such as municipalities have the authority to customize their processes independently. This adds a significant number of entries in public administrations' portfolios of processes.

Another characteristic of public administrations is the transparency in delivering and using open data for enhancing public services (Zillner et al. 2016). As part of the Smart Cities movement (Curry et al. 2016), government agencies in cities like Helsinki, Manchester, Amsterdam, Barcelona, and Chicago are using big and open data from open sensor data, public sector processes, and citizen generated social

W. Derguech (✉) • E. Curry
Insight Centre for Data Analytics, National University of Ireland, Galway, Ireland
e-mail: wassim.derguech@insight-centre.org; edward.curry@insight-centre.org

S. Bhiri
ISIMM, University of Monastir, Monastir, Tunisia
e-mail: sami.bhiri@gmail.com

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_5

data to enhance the dynamic design of new and innovative public services (Chouikh et al. 2016; Ojo et al. 2015).

While public administrations are constantly required to deliver improved and efficient public services, they are facing various challenges such as cost reductions, change management in organizational work concepts, political pressures, etc. (Karow et al. 2008). Consequently, public administrations have to redesign their processes and resource allocations to meet cost and time requirements. Reusing and customizing existing proven practices is an important pillar for driving innovative services in a cost-effective and rapid manner.

Reuse in process modeling has been proven to be effective using techniques that vary from establishing a common repository of processes (Beeri et al. 2008a; Lu and Sadiq 2007; Rosa et al. 2011; Vulcu et al. 2011) to creating reference process models that can be tailored to each organization needs (Baran et al. 2013; Derguech et al. 2010; Rosemann and van der Aalst 2007; Sadiq et al. 2001). However, choosing the right technique to apply within an organization requires a proper analysis of available tools for maintainability, user support and alignment with the organizations' strategies regarding transparency and traceability (Karow et al. 2008).

The aim of this paper is to analyze major reuse-oriented process modeling techniques with respect to a set of requirements that are identified in section "Methodology". The outcome of the analysis can serve as a guideline for choosing which technique to apply in certain organizations. The analyzed approaches are classified in two families: techniques using repositories of process models in section "Business Process Models Repository" and techniques using reference process models in section "Reference Business Process Modelling". Before concluding the chapter in section "Conclusion", we conduct an evaluation of one of the techniques that uses reference process models, in section "Configurable Models for Municipalities", to assess its applicability in modeling municipal processes.

Methodology

In this section, we define the methodology that we use in conducting the analysis of the state of the art related to the topic of reuse in business process modelling. Our analysis starts by classifying research contributions with respect to the categories shown in Fig. 1. That is: sections "Business Process Models Repository" and "Reference Business Process Modelling" respectively outline contributions in two main categories of reuse-oriented business process modelling techniques: (i) using *Business Process Repositories* and (ii) using *Reference Business Process Models.*

The first category is investigated in section "Business Process Models Repository" by considering various implementations of business process repositories that permit either to discover an entire business process model or to discover business process building blocks that can be used later for composition.

The second category is investigated in section "Reference Business Process Modelling" by considering three implementations of reference process models

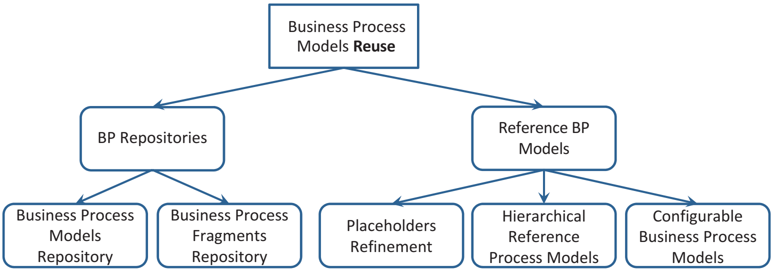


Fig. 1 Classification of reuse-oriented business process modelling approaches

either by refining placeholders, using hierarchical reference models or customising configurable models.

The analysis of these contribution is done with respect to the following requirements:

- *Requirement 1: Compression Rate* – Managing multiple variants of the same business process should consider common elements and avoid redundancy, especially in large business process repositories (La Rosa et al. 2009). This results in a reduced size for input process elements with a high compression rate if there is a high similarity between the variants (Gottschalk et al. 2008). This requirement was elicited from: La Rosa et al. (2009), Assy et al. (2015) and Derguech and Bhiri (2011).
- *Requirement 2: Maintainability* – In order to adopt a process modeling solution, maintainability tools should be provided (Derguech and Bhiri 2011). In our analysis, this requirement answers the following question: What mechanisms does the proposed approach support for maintainability? This requirement was elicited from: Gottschalk et al. (2008), La Rosa et al. (2009), Assy et al. (2015) and Derguech and Bhiri (2011).
- *Requirement 3: User Support* – This requirement is aligned with the *ease-of-use* of the proposed approach by answering the following question: How does the current approach help end-users that have little or no modelling experience? An approach is easy to use if it provides and facilitates access to the required modelling tools. This requirement was elicited from: La Rosa et al. (2009), Vulcu et al. (2011) and Derguech and Bhiri (2011).
- *Requirement 4: Traceability* – In public administration, decision making is based on the principles of transparency and traceability (Karow et al. 2008). It is crucial for a process modeling solution to trace the origin of process elements that are taken into account in the management of public administration processes (Karow et al. 2008). This requirement was elicited from: Karow et al. (2008), La Rosa et al. (2009) and Derguech and Bhiri (2011).

These requirements constitute guidelines for adopting reuse-oriented process modelling approaches in public administrations. Each of the reviewed approaches in section "Business Process Models Repository" and "Reference Business Process Modelling" will be assessed against these requirements. One of the reviewed solutions will be evaluated using real municipal processes in section "Configurable Models for Municipalities".

Business Process Models Repository

In the first part of the analysis, we study related work in the area of business process model discovery. The discovery operation consists of querying a business process repository in order to find a relevant business process model satisfying particular needs. In this section, we investigate various implementations of process repositories.

The Process Variant Repository

Description The Process Variant Repository (Lu and Sadiq 2006, 2007; Lu et al. 2009a) or PRV for short, defines a repository of both business process models and associated "*preferred work practices*". A preferred work practice is a process variant that is captured from the process execution logs and is suitable for a particular situation. Each process model is stored with its historical information about the execution instances in order to achieve new operational goals in similar situations. For example, we can refer to the registration of a newborn child of parents from either the local or a foreign country. Here the process will be the same with some changes in the required documents.

PVR provides a support for querying business process models and their variants where a query is a partial or complete description of a process variant. On the basis of similarity metrics, the authors measure the equivalence and subsume relations between the process query and the stored processes using reduction techniques in graphs. The results are then ranked based on these similarity values.

Analysis With respect to the identified requirements, the key points of analysis are as follows:

– *Requirement 1: Compression Rate*: not fulfilled. The PVR focus is on providing a discovery mechanism while ignoring any challenges related to managing common process parts. Business process variants are stored individually without performing any compression.
– *Requirement 2: Maintainability*: not discussed.
– *Requirement 3: User Support*: not fulfilled. Querying the repository requires expert knowledge for creating queries.
– *Requirement 4: Traceability*: partially fulfilled. In essence, the use of process repositories guarantees traces of all process variants. However, traces of user queries are not logged in this work.

BP-Suite

Description BP-Suite is a tool-set for querying BPEL-based business process repositories. It consists of three query subsystems: (1) BP-QL (Beeri et al. 2008a) is used to query business process specifications (which is the system related to this work); (2) BPMon (Beeri et al. 2008b) is used for monitoring process instances at run-time and (3) BP-Ex (Balan et al. 2010) allows for querying business process execution logs.

The focus of BP-QL is to use XQuery (Walmsley 2007) to discover business processes given a structural pattern. Entries of the repository (i.e., business processes) are described using AXML, an abstraction of BPEL. The proposed language represents business processes as graphs, i.e., with nodes and links between them. Since the BPEL specification is also XML-based, an obvious question is why not query it directly? The answer to this question, according to the authors (Beeri et al. 2006), is ease of use. Indeed, the BPEL format is complex and extremely inconvenient for querying.

Analysis With respect to the identified requirements, the key points of analysis are as follows:

– *Requirement 1: Compression Rate*: not fulfilled. The BP-Suite focus is more on providing a user friendly discovery mechanism while ignoring any challenges related to maintainability and particularly to managing common process parts. Business process variants are stored individually without performing any compression.
– *Requirement 2: Maintainability*: not discussed.
– *Requirement 3: User Support*: partially fulfilled. The authors claim that their query building mechanism is user friendly as it is similar to those used by commercial vendors for the design of BPEL processes. However, it is important to notice that "*BPEL more closely resembles a programming language than a modeling language*" (van der Aalst et al. 2005) which requires some learning. This makes the proposed approach helpful for reducing the learning curve of non-experts.
– *Requirement 4: Traceability*: partially fulfilled.

Semantic Business Process Repositories

Description In this section, we review four repositories of business process models that use semantics.

First, the Semantic Business Process Repository, or SBPR (Ma et al. 2007), describes business processes using ontologies such as: process, organizational and business function (i.e., business capability) ontologies. They use relational databases to store these descriptions. A reasoner such as Integrated Rule Inference

System – IRIS[1] is integrated with the semantic business process repository to reason over the business processes described using ontologies.

Second, while the framework for querying business process models proposed by Markovic et al. (2008) uses ontologies for describing business process models, Sakr and Awad (Sakr and Awad 2010) use ontologies only in the query matching process and tackle the problem of applying different terminologies when modelling processes. The former (Markovic et al. 2008) uses Web Service Modeling Ontology (WSMO) for describing functional and non-functional related properties and a process algebra, pi-calculus, for the structural properties of a business process model. They use Web Service Modeling Language (WSML) logical expressions as a query language and ontological reasoning for query answering. Whereas the latter (Sakr and Awad 2010) relies mainly on activity labels for describing functional properties and uses BPMN-Q (Awad and Sakr 2012) for querying business process models with an underlying classical database management system.

Last, the *oryx* (Decker et al. 2008) extension for semantically-enabled business process discovery (Vulcu et al. 2011) proposes the use of ontologies for modelling and storing business process models. The authors propose an ontology for describing graph-based and block-based business processes while capturing their functional (i.e., Input, Output, Precondition and Effect) and non-functional properties at multiple levels of abstraction.

Analysis With respect to the identified requirements, the key points of analysis are as follows:

- *Requirement 1: Compression Rate*: not fulfilled. The reviewed solutions investigate the use of ontologies for storing and querying business process models. They use graphical querying mechanisms for supporting users to avoid learning a complex querying language. However, none of them deals with how to efficiently store process variants: compression is out of scope.
- *Requirement 2: Maintainability*: fulfilled. Standard CRUD operations and version management were investigated (Ma et al. 2007; Sakr and Awad 2010).
- *Requirement 3: User Support*: partially fulfilled. Although an extensive work has been put towards creating graphical query mechanisms, users still need to manually define some difficult parameters such as Input, Output, Precondition and Effect.
- *Requirement 4: Traceability*: fulfilled. In essence, the use of process repositories guarantees traces of all process variants. Furthermore, version control adds another traceability dimension for verifying the evolution of changes in the process models.

APROMORE

Description APROMORE (Advanced PROcess MOdel REpository) (La Rosa et al. 2011) is a recently proposed process models repository supporting multiple modelling languages including EPC, BPMN, Protos, WF-Nets, YAWL, and

[1] http://www.iris-reasoner.org/

WS-BPEL. It manages company specific process models, reference models and process patterns. The strength of this repository is that it builds on a large set of existing contributions in terms of approaches and techniques which have been adapted and incorporated as evaluation, comparison, management and presentation functionalities.

APROMORE is open to integrate multiple contributions related to the management and maintainability of business process repositories. Examples of such contributions include the detection of clones (Dumas et al. 2013; Uba et al. 2011) and errors (Mendling et al. 2008) in the repository.

Analysis With respect to the identified requirements, the key points of analysis are as follows:

– *Requirement 1: Compression Rate*: fulfilled. In order to overcome the problem of resource efficiency and propose a suitable compression of the stored business process variants, APROMORE proposes the integration of merging and individualisation features which relate to the area of configurable process models (Rosemann and van der Aalst 2007).
– *Requirement 2: Maintainability*: fulfilled. The fact that APROMRE is open to integrate business process modelling contributions, it makes most maintainability issues resolved.
– *Requirement 3: User Support*: not discussed.
– *Requirement 4: Traceability*: partially fulfilled.

Business Process Models Repositories: Summary and Discussion

The reviewed business process models repositories (summarized in Table 1) share in essence the same objective: discovering a business process model by querying a repository and selecting the most suitable one. As depicted in Fig. 2, this technique involves a process variant repository and two kinds of stakeholders: (i) a process modeller and (ii) a business expert. The process modeller is responsible for regularly updating the process variant repository. The business expert has to query this repository in order to find a particular business process variant. Learning a customized query language for retrieving a suitable business process model is far from being user-friendly. This motivated current approaches to propose graphical querying languages and interfaces for end-users (*Requirement 3: User Support*).

For *Requirement 1: Compression Rate*: This requirement is needed in order to avoid duplication of common process parts and ensure consistency (i.e, every change of a process model has to be propagated in all similar models) and correct (i.e., without clones and errors). As these solutions do not consider managing common process parts as single elements, additional maintainability effort (*Requirement*

Table 1 Comparative analysis of approaches using process models repositories

Approach	Compression rate	Maintainability	User support	Traceability
The process variant repository (Lu and Sadiq 2006, 2007; Lu et al. 2009a)	Not fulfilled	Not discussed	Require experts knowledge for writing queries	Partially fulfilled
BP-suite (Beeri et al. 2008a, b)	Not fulfilled	Not discussed	Effort to providing a query language that is easy to use are investigated (Beeri et al. 2006) aiming to reduce the learning curve of non-experts	Partially fulfilled
Semantic business process repositories (Ma et al. 2007; Markovic et al. 2008; Sakr and Awad 2010; Vulcu et al. 2011)	Not fulfilled	Standard CRUD operations and version management in (Ma et al. 2007; Sakr and Awad 2010)	Using graphical querying mechanisms for avoiding learning a complex querying language	Partially fulfilled
APROMORE (La Rosa et al. 2011)	Not discussed	Detection of clones (Dumas et al. 2013; Uba et al. 2011) and errors (Mendling et al. 2008)	Not discussed	Partially fulfilled

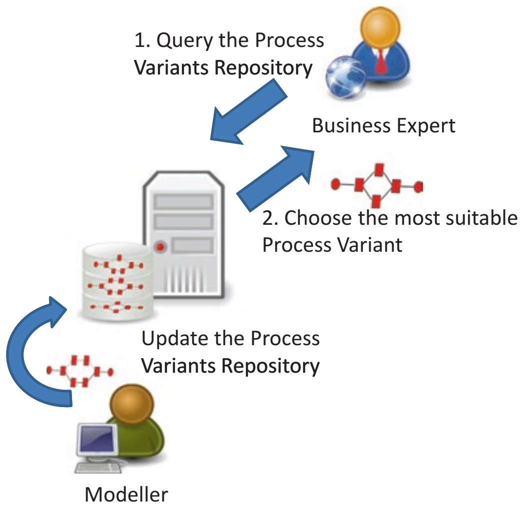


Fig. 2 A process variants repository for reusing business process models

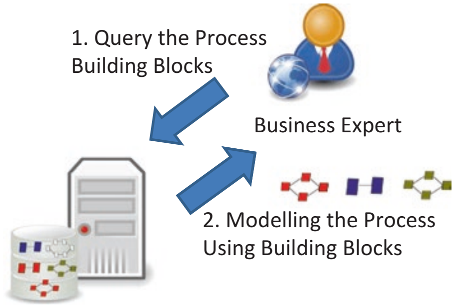


Fig. 3 Using process building blocks for modelling business processes

2: Maintainability) for ensuring a clean repository, maintainability operations such as the detection of clones (Dumas et al. 2013; Uba et al. 2011) and errors (Mendling et al. 2008) are required.

With respect to *Requirement 4: Traceability*, in essence the use of process repositories guarantees traces of all process variants. However, traces of user queries are not logged in these works. Nevertheless, version management has been proposed as a solution for keeping track of on changes to process models (Ma et al. 2007; Sakr and Awad 2010).

A key point of this analysis is: Even though it is well recognized that process variants share some commonalities, this has not been taken into account in these approaches. In fact, each process variant is stored as a standalone entity. Consequently, this method suffers from resource redundancy because it does not consider common parts of process models which are duplicated in each entry of the repository. This can be resolved by storing business process building blocks instead of entire models. These building blocks can be later retrieved and aggregated in order to construct a business process model (Mancioppi et al. 2011; Schumm et al. 2012). As depicted in Fig. 3, the business expert will have to, first, query the building blocks he needs and then aggregate them in order to derive his entire business process model. Modelling business process models from building blocks still requires some skills in modelling but this can be reduced using dynamic composition (Sirbu et al. 2011).

Reference Business Process Modelling

In this part of the analysis, we study three implementations of reference business process modelling techniques. A reference process model is a generic model that can be tailored to specific needs and adapted to various situations. Stakeholders benefit from these models by avoiding the need to create a model from scratch and use the reference model as a starting point. The main challenge with such solutions is that a reference model has to be properly managed in order to help derive a proper process variant.

Placeholders Refinement: Late Modelling

Description Creating a model with a *placeholder*, or a *pocket of flexibility*, as introduced by Sadiq et al. (2001), provides the means for creating flexible business process models. The idea is to create a partially completed business process model with placeholders that require late modelling. The late modelling allows business processes to be tailored either to a process model during the modelling phase or to individual instances at runtime (Weber et al. 2009).

During the late modelling users can refine the placeholders using their own modelling skills. They can be assisted either with a set of activities and/or constraints as it has been highlighted by Sadiq et al. (2001). The authors also distinguish three options for implementing late modelling:

– *Option 1: Reference Process Model.* Placeholders may be defined without any constraints or predefined activities.
– *Option 2: Reference Process Model + Set of Activities.* Placeholders may be defined using the predefined set of activities without any constraints.
– *Option 3: Reference Process Model + Set of Activities + Set of Constraints.* Placeholders may be defined from the predefined set of activities under the given set of constraints.

Sadiq et al. (2005) propose an implementation of option 3 for late modelling. Figure 4 illustrates the proposed approach. This example defines a set of activities and constraints that are needed to define the placeholder (i.e., task B) of the process model. At runtime, the placeholder/pocket of flexibility is defined for a given process instance based on tacit knowledge.

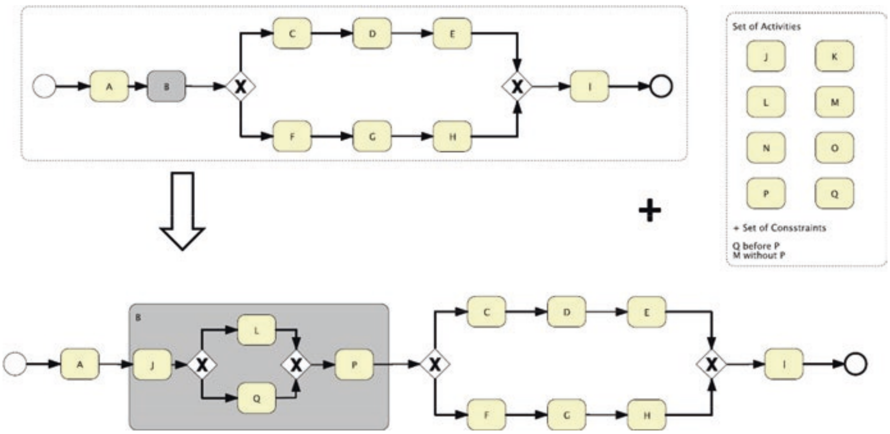


Fig. 4 Using placeholders for managing business process variants (Adapted from Weber et al. 2009)

Analysis With respect to the identified requirements, the key points of analysis are as follows:

- *Requirement 1: Compression Rate*: fulfilled. In essence, the use of a reference model guarantees that duplicate process elements are merged, ensuring a high compression rate.
- *Requirement 2: Maintainability*: fulfilled. Maintainability, has been tackled from a technical perspective. Indeed, the literature proposes various algorithms for checking the satisfiability of the constraints (Lu et al. 2009b; Pesic et al. 2010) used with the predefined set of activities.
- *Requirement 3: User Support*: partially fulfilled. Even though it has been noticed that there is a need to help users create sound and correct models (van der Aalst et al. 2009), we could not find any contribution that creates and updates such reference process models. However, during the customisation phase, users can be assisted either with a set of activities and/or constraints as it has been highlighted by Sadiq et al. (2001).
- *Requirement 4: Traceability*: not discussed.

Hierarchical Reference Process Models

Description In most cases, business process models tend to be very large and are difficult to manage by end-users. Reducing the complexity of large models can be achieved by representing them at different levels of detail. The general idea is to reduce the complexity of business processes and reveal to the end-user a partial model by applying abstraction techniques. This fosters the reuse of similar process fragments as well as reducing inconsistency. In this context, some researchers tried to manage reference process models at various levels of abstraction while explicitly capturing variation points. The object of this section is to review the proposed approaches that study such models, i.e., hierarchical reference process models.

Razavian and Khosravi (2008), propose a variability modelling method which is specifically designed for the component and connector view of UML 2. The authors introduce multiple mechanisms for modelling variation points depending on the variable element (component, connector or interface). Variation points are presented at various levels of abstraction by having optional or alternative architectural elements. An example is shown in Fig. 5 where the top level component "UI Manager" can be further refined to one of the two associated variants: "JavaScript UI Manager" and "HTML UI Manager". Each element is annotated by specific stereotypes: the variation point is marked by << *alt vp* >> and its lower level sub processes express all details related to higher level activities and variabilities residing in them and they are annotated by << *variant* >>.

Baran et al. (2013) investigated the use of hierarchical reference business process models using BPMN. Such models are created in a two-step operation. First, the proposed algorithm transforms the input BPMN models into two-level hierarchy.

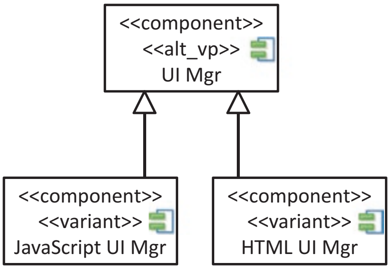


Fig. 5 "UI Manager" variation point using hierarchical representation (Razavian and Khosravi 2008)

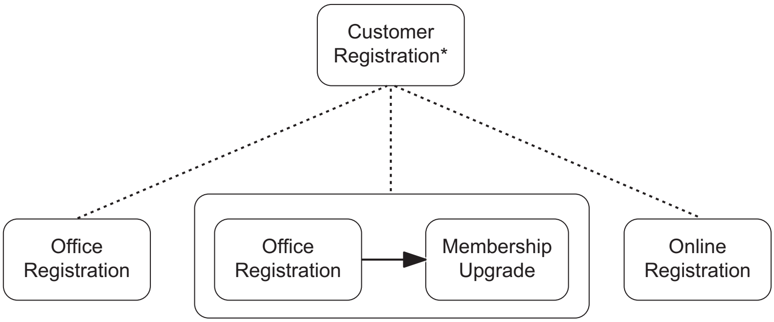


Fig. 6 A hierarchical indexing structure for modelling one variation point of a process for registering a customer to an insurance contract (Derguech and Bhiri 2010)

The authors use a very simple abstraction technique that takes as input a BPMN model and the set of interlinked high-level and low-level tasks and delivers the corresponding hierarchical model. Second, the BPMN models are merged into a single one that requires additional transformations to become well formed.

In previous works, we explored the use of hierarchical reference process models (Derguech and Bhiri 2010; Derguech et al. 2010) by proposing the use of an indexing structure for representing process models at different levels of abstractions as depicted in Fig. 6 We used the concept of abstract tasks for capturing variation points, it is marked with a "*" at the end of the task label (see "Customer Registration*" on Fig. 6). An abstract task can be refined/concreted by selecting one of its concrete alternatives which are associated to it via dotted lines. In addition to this customised notation, we proposed an algorithm for updating the reference model by inserting a new node (either a task or sub-process). The work looked promising, however, it has not been implemented or further investigated.

Analysis With respect to the identified requirements, the key points of analysis are as follows:

– *Requirement 1: Compression Rate*: fulfilled. In essence, the use of a reference model in general, and hierarchical model in particular, guarantees that duplicate process elements are merged, ensuring a high compression rate.

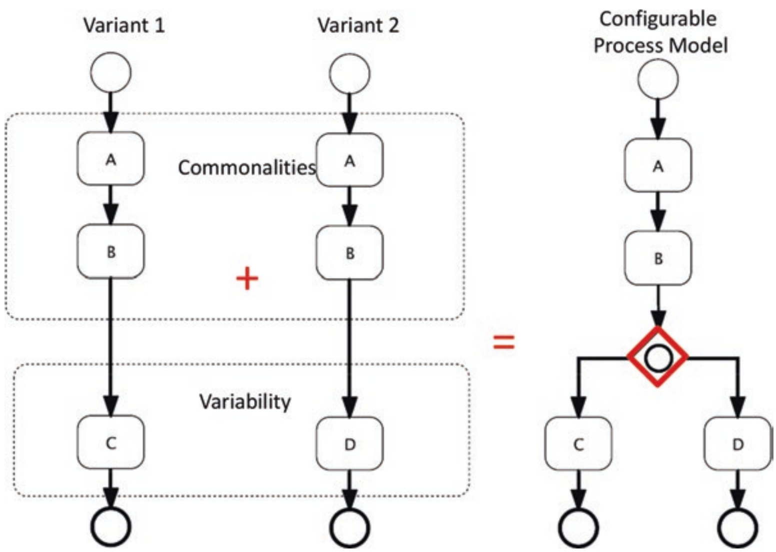


Fig. 7 Configurable business process model (Adapted from La Rosa 2009)

– *Requirement 2: Maintainability*: partially fulfilled. Algorithms and proposal of maintainability solutions are discussed but have not been implemented and further investigated.
– *Requirement 3: User Support*: partially fulfilled. We assume this requirement is partially fulfilled as an automation support to reduce manual efforts to create those models has been proposed but needs further investigation.
– *Requirement 4: Traceability*: not discussed.

Configurable Business Process Models

Description A configurable business process model (Rosemann and van der Aalst 2007) is the result of merging process variants into a single model. This model can be tailored to the analysts' needs by enabling or disabling different branches of the configurable model. Figure 7 depicts, in the left-hand side, two variants of the same business process. These two variants reflect two common tasks (i.e., Task A and B), however after this, each variant ends with a different task (i.e., C or D). This difference introduces the choice between the task C or D that represents a variability depending on various indicators, e.g., cost, quality of service, user preference, etc.

The right-hand side of the Fig. 7 shows the configurable process model which is a merger between the two process variants. The variation point is represented by a configurable gateway: an inclusive split gateway marked with a thick red border. Unlike a "normal" BPMN gateway, it does not represent a choice or a parallel split, instead, it represents a design choice that needs to be made by an analyst to adapt the configurable process model to a particular requirement. In this example, the configurable gateway captures the fact that one needs to choose whether to select one path (i.e., task C) or the other (i.e., task D), or possibly both.

In this case, the modelling phase consists of enabling or disabling different branches of the configurable process model. This allows customization of the configurable process model by choosing the right variant. However, the main weakness of this solution is that it does not allow the business users to understand the relationship each variant has with the business domain. There are two important challenges for adopting these models: (1) automation support for creating a configurable model and (2) assisting end-users during the configuration. Multiple contributions providing algorithms for automatically creating configurable process models either by merging a set of input variants or mining process logs have been investigated (Assy et al. 2015; Derguech and Bhiri 2011; La Rosa et al. 2013).

La Rosa recognises the need to make the configuration phase user-friendly and proposes a questionnaire-driven configuration (La Rosa 2009; La Rosa et al. 2009). The proposed approach is sketched in Fig. 8. A process modeller has to define the configurable process model and meet with the domain expert in order to define domain constraints (i.e., business capabilities) and their mapping to the model. The configuration is then performed via an interactive questionnaire. The domain expert's answers are then mapped to the configurable model in order to "individualize" it in a process model.

Analysis With respect to the identified requirements, the key points of analysis are as follows:

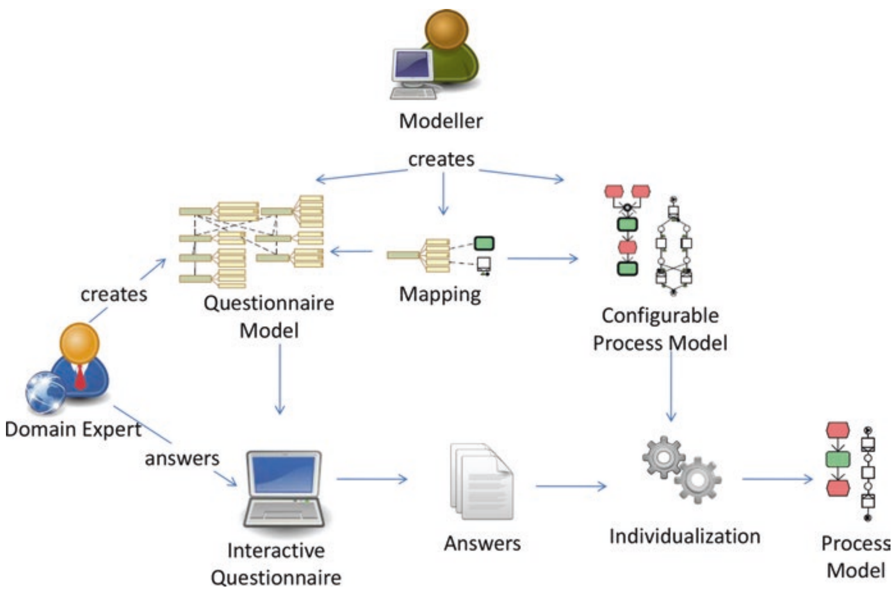


Fig. 8 Questionnaire-driven approach for configurable business process modelling (La Rosa 2009)

– *Requirement 1: Compression Rate*: fulfilled. In essence, the use of a reference model in general, and configurable process model in particular, guarantees that duplicate process elements are merged, ensuring a high compression rate.
– *Requirement 2: Maintainability*: fulfilled. Automatically creating configurable models has been the subject of extensive research.
– *Requirement 3: User Support*: fulfilled. User friendly configurations have been considered for these models.
– *Requirement 4: Traceability*: fulfilled. Several contributions for automatically creating a configurable business process model from a set of process variants keeping track on the origin of process elements are proposed in the literature (Assy et al. 2015; Derguech and Bhiri 2011; La Rosa et al. 2013).

Reference Business Process Modelling: Summary and Discussion

This section analysed reuse in the context of reference process modelling. The results of the analysis are summarised in Table 2 that clearly shows the use of such models fulfills already the first requirement of compression rate.

For maintainability, the approaches considered in this analysis exhibit a heterogeneous set of methods for maintainability and more specifically in automatically creating such process models (Derguech and Bhiri 2011; Gerth et al. 2009, 2010; Gerth and Luckey 2012; Kuster et al. 2008a; b; La Rosa et al. 2013).

For user support, customizing a reference model is difficult and has been extensively discussed in the literature. Even though La Rosa (2009) proposes a prevalent solution to this problem, it still suffer for a major shortcoming: the need for an extensive manual matching between the model and the domain constrains.

Traceability has been covered by covered by La Rosa et al. (2013) and Derguech and Bhiri (2011) as it was considered as part of their requirements when merging business process variants for creating configurable process models.

From our analysis, we found that configurable business process models are the most mature contributions with respect to the considered requirements. The use of configurable models in public administration is assessed in section "Configurable Models for Municipalities".

Configurable Models for Municipalities

In this section, we implemented an existing business process models merging algorithm (Derguech and Bhiri 2011) for creating configurable business process models. The algorithm has been implemented as an extension of EPCTools (Nicolas

Table 2 Comparative analysis of approaches reference process models

Approach	Compression rate	Maintainability	User support	Traceability
Placeholders refinement: late modelling (Sadiq et al. 2001, 2005)	Fulfilled	Checking the satisfiability of the constraints (Lu et al. 2009b; Pesic et al. 2010)	Users require modelling expertise to model placeholders; they can be assisted to create sound and correct models	Not discussed
Hierarchical reference process models (Baran et al. 2013; Derguech and Bhiri 2010; Derguech et al. 2010; Razavian and Khosravi 2008)	Fulfilled	Maintaining an indexing structure for such models has been investigated (Derguech and Bhiri 2010; Derguech et al. 2010) but requires further research	Abstract nodes in the models reduce their complexity. The configuration phase is complex (Razavian and Khosravi 2008)	Not discussed
Configurable business process models (Rosemann and van der Aalst 2007)	Fulfilled	Solutions for automatically creating configurable process models have been proposed (Assy et al. 2015; Derguech and Bhiri 2011; La Rosa et al. 2013).	Questionnaire-driven configuration phase is proposed but requires intensive manual work beforehand (La Rosa 2009; La Rosa et al. 2009).	Fulfilled: Annotations of process elements with their origins

and Ekkart 2006) for covering *Requirement 2: Maintainability*, section "Tool Support" reports on this extension. This tool has been used, in section "Compression Rate and Time Evaluation", to carry out further evaluations for measuring the compression rate gained by using this tool for merging a set of business process models and assess the required execution time in order to report on *Requirement 1: Compression Rate*. The tool uses annotations of process elements with the identifier of the original model in order to fulfill *Requirement 4: Traceability*. *Requirement 3: User Support* is partially fulfilled in this work, as we simply provide the user with the required tools to create the model but do not assess the user support in the configuration part, this remains as part of our future work.

Tool Support

The designed business process merging algorithm (Derguech and Bhiri 2011) has been implemented as an extension of EPCTools (Nicolas and Ekkart 2006). EPCTools is an open source initiative toward a tool for Event Driven Process Chains (EPCs) that

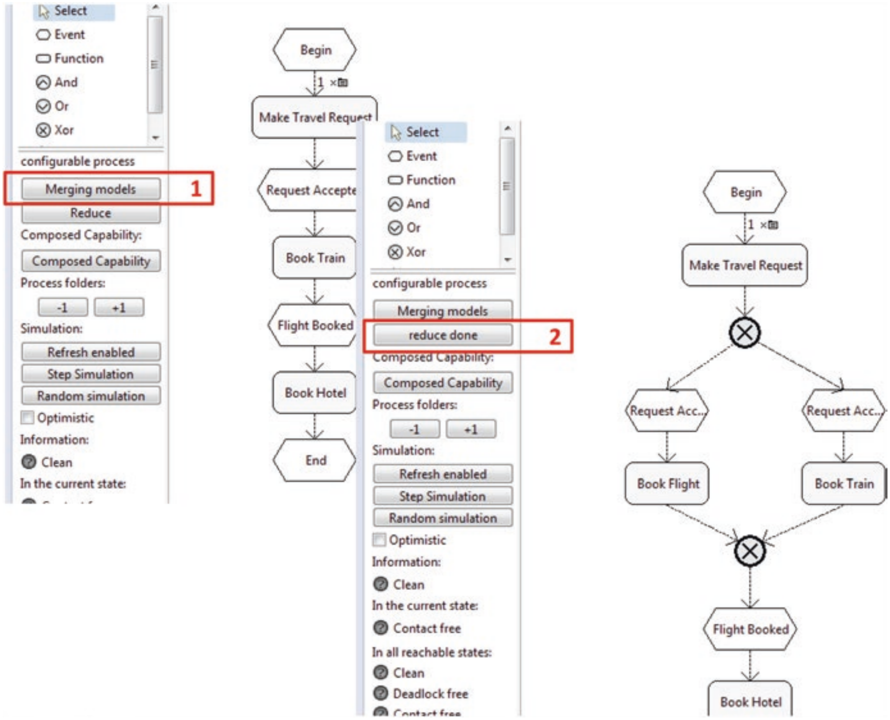


Fig. 9 Extended version of EPCTools that supports the creation of capability-annotated configurable business process models

supports the tool independent EPC interchange format EPML (Mendling and Nuttgens 2006) implemented as an Eclipse Plug-in. As shown in Fig. 9, after opening one of the two process models, the user has to click on the "Merging models" button (see 1 in Fig. 9), then a new dialog window is open, the user selects the second process model and clicks on ok, in this step the new configurable process is created. The user can optionally decide to apply a reduction step by selecting the "Reduce" button (see 2 in Fig. 9) to further reduce the generated model by applying reduction rule defined in Derguech and Bhiri (2011). The tool support is a proof of concept that has been implemented to carry out compression rate and execution time evaluations. Further evaluations regarding the user interface and how the user interacts with this tool is part of our future work. The user experience evaluation might be influenced by the modelling environment and is out of the scope of the contribution of this research.

Compression Rate and Time Evaluation

Methodology The objective of the compression rate evaluation is to highlight the benefit of merging business process variants into a single configurable business process model by avoiding duplicate process elements in process repositories.

For organisations time is important and should not be spent on manual creation of configurable models, this evaluation shows how quickly the merging algorithm delivers configurable process models.

The evaluation of compression rate and execution time has been carried out as follows:

1. A test collection of real-world municipal process models have been manually created.
2. Each of the input models have been quantified in terms of the number of process elements (i.e., events, functions and connectors).
3. Using the tool support, we have created configurable process models from the input models.
4. Each resulting configurable process model has been quantified in terms of the number of process elements.
5. Measure the compression rate by comparing the sizes of the input models and the output configurable model.
6. Measure the execution time of the merging process.

Please note that the execution of the merging steps has not been interrupted with a manual task. In this regard, all the model variants are merged at once (instead of merging each pair one by one manually). Furthermore, the reduction step has been carried out automatically after merging (no manual decision is needed regarding the reduction step).

Test Collection The process variants that we used in the experiment are those that have been used in a case study (Gottschalk et al. 2009) in which techniques for managing configurable process models were extensively tested in a real-world scenario. The process models used in this case study are four processes out of the five most executed registration processes in the civil affairs department of Dutch municipalities (Gottschalk et al. 2009):

– *P1: Acknowledging an unborn child*: This process is executed when a man wants to register that he is the father of an unborn child in case he is not married to his pregnant partner. Figure 10 shows an example of this process.
– *P2: Registering a newborn*: This process describes the steps for registering a newborn and get his birth certificate.
– *P3: Marriage*: This process describes all the steps required before getting married in a Dutch municipality.
– *P4: Decease*: This process describes the steps required by relatives to burry the deceased and get a death certificate.

The process variants considered in this evaluation are initially available in Protos.[2] Each process has five process variants. Consequently, a total of $5 \times 4 = 20$ process models were considered in this work (similar to the case study (Gottschalk et al. 2009)). We have manually translated these models into EPC and used the

[2] Protos is part of Pallas Athena's BPM toolset BPM|one.

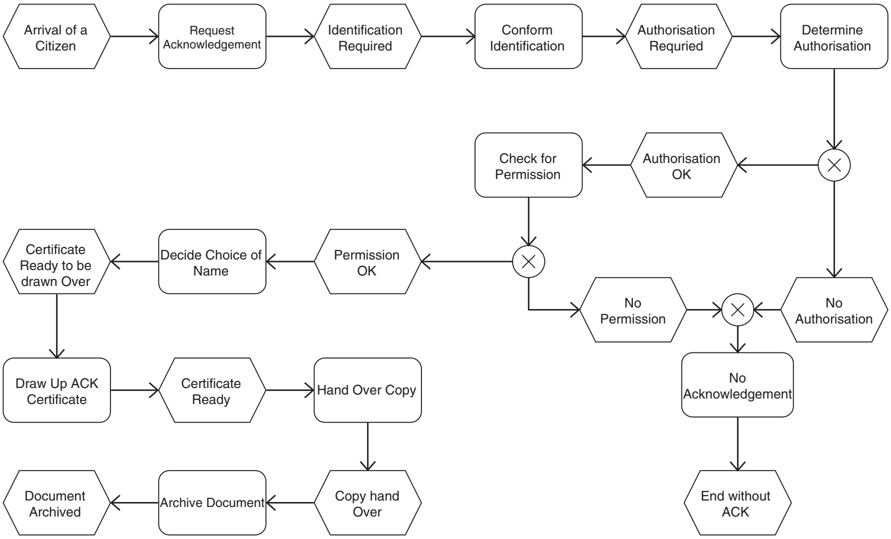


Fig. 10 Example of a process for acknowledging an unborn child

extended version of EPCTools (see section "Tool Support") for merging them in order to create configurable process models for each process.

Observations During the merging steps, two metrics were observed: process models sizes (before, and after the merging) and the execution time of the merging steps. These metrics are shown in Table 3.

Table 3 shows the size of the input and output models (size in terms of number of EPC nodes). The percentage value between parenthesis shows the compression rate gained from the creation of the configurable process models. And the last column shows the execution time in milliseconds needed for merging the input process models.

Discussion The reduction approach can gain around 50% in terms of space for storing several process variants. Besides the space gain, we can see that in a few milliseconds a set of five process variants can be automatically merged which would take much longer for a business analyst to perform the task manually.

In general, compression rates are high because most of the process models share various process elements. Indeed, all the used variants, are from various Dutch municipalities that are initially defined from a high level reference model (Gottschalk et al. 2009). Depending on the population and the available resources of each municipality, few process tasks are either skipped or replaced by other ones. This keeps most of the process functions sequentially aligned. Consequently, the merged model observe a large number of common functions and events.

Table 3 Results of merging registration processes of Dutch municipalities

Process number	Input size (Number of nodes)	Output size before reduction	Output size after reduction	Exec. time (ms)
P1	190 (29 + 56 + 52 + 29 + 24)	131 (31%)	71 (62%)	157
P2	347 (63 + 84 + 73 + 57 + 70)	276 (20%)	180 (48%)	235
P3	507 (76 + 127 + 127 + 114 + 63)	298 (41%)	214 (57%)	407
P4	355 (56 + 111 + 91 + 67 + 30)	266 (25%)	160 (54%)	282

Conclusion

As public administrations are constantly in need to create new and innovative public services, they need to face challenges related to cost reductions, reorganizations and political pressures. Reuse of their existing best practices is a key enabler for cost effective customization of their processes. The literature exhibits a wide variety of techniques that can be applied. However, in the absence of a guideline for choosing what technique to apply, this task remains difficult.

This paper, helps overcoming this issue by providing an analysis of major reuse-oriented process modeling techniques with respect to their maintainability, user support, compression rate gained when storing the models as well as traceability of modeling decisions.

The analysis shows that the use of configurable process models is a promising technique that covers all the requirements. The technique has been evaluated in this paper for assessing its applicability. However, the user support requirement has not been validated in this paper and is kept as part of our future work.

Acknowledgment The research leading to these results has received funding from Science Foundation Ireland (SFI) under Grant Number SFI/12/RC/2289. It is supported in part by the European Commission's Seventh Framework Programme from ICT grant agreement WATERNOMICS no. 619660.

References

Assy N, Chan NN, Gaaloul W (2015) An automated approach for assisting the design of configurable process models. IEEE T Services Computing 8(6):874–888

Awad A, Sakr S (2012) On efficient processing of bpmn-q queries. Comput Ind 63(9):867–881

Balan E, Milo T, Sterenzy T (2010) Bp-ex: a uniform query engine for business process execution traces. In: Proceedings of the 13th international conference on extending database technology, EDBT '10. ACM, New York, pp 713–716

Baran M, Kluza K, Nalepa GJ, Ligeza A (2013) A hierarchical approach for configuring business processes. In: Ganzha M, Maciaszek LA, Paprzycki M (eds) FedCSIS. pp 915–921

Beeri C, Eyal A, Kamenkovich S, Milo T (2006) Querying business processes. In: Dayal U, Whang KY, Lomet DB, Alonso G, Lohman GM, Kersten ML, Cha SK, Kim YK (eds) VLDB. ACM, New York, pp 343–354

Beeri C, Eyal A, Kamenkovich S, Milo T (2008a) Querying business processes with bp-ql. Inf Syst 33(6):477–507

Beeri C, Eyal A, Milo T, Pilberg A (2008b) Bp-mon: query-based monitoring of bpel business processes. SIGMOD Record 37(1):21–24

Bichler M, Hess T, Krcmar H, Lechner U, Matthes F, Picot A, Speitkamp B, Wolf P (eds) (2008) Multikonferenz Wirtschaftsinformatik, MKWI 2008, Mu¨nchen, 26.2.2008–28.2.2008, Proceedings. GITO-Verlag, Berlin

Chouikh A, Ojo A, Driss OB (2016) Exploring the affordances of social media platforms in supporting emerging public service paradigms. In: Bertot JC, Estevez E, Mellouli S (eds) Proceedings of the 9th international conference on theory and practice of electronic governance, ICEGOV 2016, Montevideo, 1–3 Mar 2016. ACM, pp 177–186

Curry E, Dustdar S, Sheng QZ, Sheth AP (2016) Smart cities – enabling services and applications. J. Internet Services and Applications 7(1):6:1–6:3. http://dx.doi.org/10.1186/s13174-016-0048-6

Decker G, Overdick H, Weske M (2008) Oryx – an open modeling platform for the bpm community. In: Dumas M, Reichert M, Shan MC (eds) Business process management, 6th international conference, BPM 2008, Milan, 2–4 Sept 2008. Proceedings, Lecture Notes in Computer Science, vol. 5240. Springer, pp 382–385

Derguech W, Bhiri S (2010) Reuse-oriented business process modelling based on a hierarchical structure. In: zur Muehlen, M, Su J (eds) Business process management workshops. Lecture Notes in Business Information Processing, vol. 66. Springer, pp 301–313

Derguech W, Bhiri S (2011) An automation support for creating configurable process models. In: Bouguettaya A, Hauswirth M, Liu L (eds) Web information system engineering – WISE 2011 – 12th international conference, Sydney, 13–14 Oct 2011. Proceedings. Lecture Notes in Computer Science, vol. 6997. Springer, pp 199–212

Derguech W, Vulcu G, Bhiri S (2010) An indexing structure for maintaining configurable process models. In: Bider I, Halpin TA, Krogstie J, Nurcan S, Proper E, Schmidt R, Ukor R (eds) BMMDS/EMMSAD. Lecture Notes in Business Information Processing, vol. 50. Springer, pp 157–168

Dumas M, Reichert M, Shan MC (eds) (2008) Business process management, 6th international conference, BPM 2008, Milan, 2–4 Sept 2008. Proceedings, Lecture Notes in Computer Science, vol. 5240. Springer

Dumas M, Garcia-Banuelos L, Rosa ML, Uba R (2013) Fast detection of exact clones in business process model repositories. Inf. Syst. 38(4):619–633

Gerth C, Luckey M (2012) Towards rich change management for business process models. Softwaretechnik-Trends 32(4):32–34

Gerth C, Küster JM, Engels G (2009) Language-independent change management of process models. In: Schurr A, Selic B (eds) Model driven engineering languages and systems, 12th international conference, MOD-ELS 2009, Denver, 4–9 Oct 2009. Proceedings. Lecture Notes in Computer Science, vol. 5795. Springer, pp 152–166

Gerth C, Luckey M, Küster JM, Engels G (2010) Detection of semantically equivalent fragments for business process model change management. In: 2010 IEEE international conference on services computing, SCC, Miami, 5–10 July 2010. IEEE Computer Society, pp 57–64

Gottschalk F, van der Aalst WMP, Jansen-Vullers MH (2008) Merging event-driven process chains. In: Meersman R, Tari Z (eds) On the move to meaningful internet systems: OTM 2008, OTM 2008 confederated international conferences, CoopIS, DOA, GADA, IS, and ODBASE 2008, Monterrey, 9–14 Nov 2008, Proceedings, Part I. Lecture Notes in Computer Science, vol. 5331. Springer, pp 418–426

Gottschalk F, Wagemakers TAC, Jansen-Vullers MH, van der Aalst WMP, Rosa ML (2009) Configurable process models: experiences from a municipality case study. In: van Eck P, Gordijn J, Wieringa R (eds) Advanced information systems engineering, 21st international conference, CAiSE 2009, Amsterdam, 8–12 June 2009. Proceedings. Lecture Notes in Computer Science, vol. 5565. Springer, pp 486–500

Karow M, Pfeiffer D, Rackers M (2008) Empirical-based construction of reference models in public administrations. In: Bichler M, Hess T, Krcmar H, Lechner U, Matthes F, Picot A, Speitkamp B, Wolf P (eds) Multikonferenz Wirtschaftsinformatik, MKWI 2008, Munchen, 26–28 Feb 2008, Proceedings. GITO-Verlag, Berlin

Kuster JM, Gerth C, Forster A, Engels G (2008a) Detecting and resolving process model differences in the absence of a change log. In: Dumas M, Reichert M, Shan MC (eds) Business process management, 6th international conference, BPM 2008, Milan, 2–4 Sept 2008. Proceedings, Lecture Notes in Computer Science, vol. 5240. Springer, pp 244–260

Kuster JM, Gerth C, Forster A, Engels G (2008b) A tool for process merging in business-driven development. In: Bellahsene Z, Woo C, Hunt E, Franch X, Coletta R (eds) Proceedings of the forum at the CAiSE'08 conference, Montpellier, 18–20 June 2008. CEUR Workshop Proceedings, vol. 344, pp 89–92. CEUR-WS.org

La Rosa M (2009) Managing variability in process-aware information systems. Ph.D. thesis, Queensland University of Technology, Brisbane

La Rosa ML, Reijers HA, van der Aalst WMP, Dijkman RM, Mendling J, Dumas M, Garcia-Banuelos L (2011) Apromore: An advanced process model repository. Expert Syst. Appl 38(6):7029–7040

La Rosa M, van der Aalst WMP, Dumas M, ter Hofstede AHM (2009) Questionnaire-based variability modeling for system configuration. Software and System Modeling 8(2):251–274

La Rosa M, Dumas M, Uba R, Dijkman R (2013) Business process model merging: an approach to business process consolidation. ACM Trans. Softw. Eng. Methodol. 22(2):11

Lu R, Sadiq S (2006) Managing process variants as an information resource. In: Proceedings of the 4th international conference on business process management. BPM'06, Springer, Berlin/Heidelberg, pp 426–431

Lu R, Sadiq SW (2007) On the discovery of preferred work practice through business process variants. In: Parent C, Schewe KD, Storey VC, Thalheim B (eds) ER. Lecture Notes in Computer Science, vol. 4801. Springer, pp 165–180

Lu R, Sadiq SW, Governatori G (2009a) On managing business processes variants. Data Knowl Eng 68(7):642–664

Lu R, Sadiq SW, Governatori G, Yang X (2009b) Defining adaptation constraints for business process variants. In: Abramowicz W (ed) BIS. Lecture Notes in Business Information Processing, vol. 21. Springer, pp 145–156

Ma Z, Wetzstein B, Anicic D, Heymans S, Leymann F (2007) Semantic business process repository. In: Hepp M, Hinkelmann K, Karagiannis D, Klein R, Stojanovic N (eds) SBPM. CEUR Workshop Proceedings, vol. 251. CEUR-WS.org

Mancioppi M, Danylevych O, Karastoyanova D, Leymann F (2011): Towards classification criteria for process fragmentation techniques. In: Daniel F, Barkaoui K, Dustdar S (eds) Business process management workshops (1). Lecture Notes in Business Information Processing, vol. 99. Springer, pp 1–12

Markovic I, Pereira AC, Stojanovic N (2008) A framework for querying in business process modelling. In: Bichler M, Hess T, Krcmar H, Lechner U, Matthes F, Picot A, Speitkamp B, Wolf P (eds) Multikonferenz Wirtschaftsinformatik, MKWI 2008, Munchen, 26–28 Feb 2008, Proceedings. GITO-Verlag, Berlin

Mendling J, Nuttgens M (2006) EPC markup language (EPML): an xml-based interchange format for event-driven process chains (EPC). Inf Syst E-Business Manage 4(3):245–263

Mendling J, Verbeek HMW, van Dongen BF, van der Aalst WMP, Neumann G (2008) Detection and prediction of errors in epcs of the sap reference model. Data Knowl Eng 64(1):312–329

Nicolas C, Ekkart K (2006) EPC tools. http://www2.cs.uni-paderborn.de/cs/kindler/research/EPCTools/

Ojo AK, Curry E, Zeleti FA (2015) A tale of open data innovations in five smart cities. In: Bui TX Jr, RHS (eds) 48th Hawaii international conference on system sciences, HICSS 2015, Kauai, 5–8 Jan 2015. IEEE Computer Society, pp 2326–2335

Pesic M, Bosnacki D, van der Aalst WMP (2010) Enacting declarative languages using ltl: avoiding errors and improving performance. In: van de Pol J, Weber M (eds) SPIN. Lecture Notes in Computer Science, vol. 6349. Springer, pp 146–161

Razavian M, Khosravi R (2008) Modeling variability in business process models using uml. In: ITNG. IEEE Computer Society, pp 82–87

Rosemann M, van der Aalst WMP (2007) A configurable reference modelling language. Inf Syst 32(1):1–23

Sadiq SW, Sadiq W, Orlowska ME (2001) Pockets of flexibility in workflow specification. In: Kunii HS, Jajodia S, Sølvberg A (eds) ER. Lecture Notes in Computer Science, vol. 2224. Springer, pp 513–526

Sadiq SW, Orlowska ME, Sadiq W (2005) Specification and validation of process constraints for flexible workflows. Inf Syst 30(5):349–378

Sakr S, Awad A (2010) A framework for querying graph-based business process models. In: Proceedings of the 19th international conference on world wide web. WWW '10, ACM, New York, pp 1297–1300

Schumm D, Dentsas D, Hahn M, Karastoyanova D, Leymann F, Sonntag M (2012) Web service composition reuse through shared process fragment libraries. In: Brambilla M, Tokuda T, Tolksdorf R (eds) ICWE. Lecture Notes in Computer Science, vol. 7387. Springer, pp 498–501

Sirbu A, Marconi A, Pistore M, Eberle H, Leymann F, Unger T (2011) Dynamic composition of pervasive process fragments. In: ICWS. IEEE Computer Society, pp 73–80

Uba R, Dumas M, Garcıa-Banuelos L, Rosa ML (2011) Clone detection in repositories of business process models. In: Rinderle-Ma S, Toumani F, Wolf K (eds) BPM. Lecture Notes in Computer Science, vol. 6896. Springer, pp 248–264

van der Aalst WMP, Pesic M, Schonenberg H (2009) Declarative workflows: balancing between flexibility and support. Computer Science – R&D 23(2):99–113

van der Aalst WMP, Dumas M, ter Hofstede AHM, Russell N, Verbeek HMWE, Wohed P Life after bpel? In: Bravetti M, Kloul L, Zavattaro G (eds) EPEW/WS-FM, Lecture Notes in Computer Science, vol 3670. Springer, New York, 2005, pp 35–50

Vulcu G, Bhiri S, Derguech W, Ibanez MJ (2011) Semantically-enabled Business process models discovery. Int J Bus Process Integr Manag 5:257–272

Walmsley P (2007) XQuery. O'Reilly Media, Inc.

Weber B, Sadiq SW, Reichert M (2009) Beyond rigidity – dynamic process lifecycle support. Computer Science – R&D 23(2):47–65

Zillner S, Becker T, Munne R, Hussain K, Rusitschka S, Lippell H, Curry E, Ojo AK (2016) Big data-driven innovation in industrial sectors. In: Cavanillas JM, Curry E, Wahlster W (eds) New horizons for a data-driven economy – a roadmap for usage and exploitation of big data in Europe, pp 169–178. Springer. http://dx.doi.org/10.1007/978-3-319-21569-3

Dr. Wassim Derguech (www.wassimderguech.org) is a postdoctoral researcher at the Insight Centre for Data Analytics at the National University of Ireland, Galway. In his research, Wassim investigated the use of semantic web and related technologies for managing services and business processes applied to the e-government domain, customs clearance procedures and Internet of Things. He also tackled the problem of decision support and data analytics in the area of energy intelligence and smart water management. He is actively involved as a program committee member and reviewer of international journals, conferences and workshops

Dr. Edward Curry (www.edwardcurry.org) is Vice President of the Big Data Value Association (www.BDVA.eu) a non-profit industry-led organisation with the objective of increasing the competitiveness of European Companies with data-driven innovation. He is a research leader at the Insight Centre for Data Analytics (www.insight-centre.org) and a funded investigator at LERO The Irish Software Research Centre (www.lero.ie). Edward has worked extensively with industry and government advising on the adoption patterns, practicalities, and benefits of new technologies. Edward has published over 120 scientific articles in journals, books, and international conferences

Dr. Sami Bhiri is an associate professor in computer science at the ISIMM: Institut Suprieur d'Informatique et Mathmatiques Monastir, at the University of Monastir, Tunisia. His research interests include service computing and business process management. Before joining ISIMM, he served as an associate professor at Telecom SudParis. Prior to that, he was the leader of the SOA unit at DERI, and adjunct lecturer at the National University of Ireland, Galway. Before joining DERI, he was a research and teaching assistant in the University of Nancy 1 and in the ECOO team of the LORIA-INRIA research laboratory from where he holds an M.S. (2001) and a Ph.D. (2005)

Capability Development in Open Data-Driven Organizations

Fatemeh Ahmadi Zeleti and Adegboyega Ojo

Abstract Open data (OD) is increasingly considered as a core resource for many organizations in the emerging data economy. Open data-driven organizations (ODDOs) like any other organizations must develop capabilities for generating value from OD, agility, and competitiveness to survive. This chapter investigates the salient factors for generating value from OD and agility in a dynamic data ecosystem by developing an operationalization of the Resource-based View Theory (RBV) and Dynamic Capability Theory (DCT) for ODDOs. As a first step towards determining the critical factors for developing value capabilities (VCs) and dynamic capabilities (DCs) in these organizations, we analyzed the information gathered from expert interviews on the saliency of the different aspects and stages of VCs and DCs in developing VCs for a down-stream organization and the agility of an up-stream organization or OD supplier in the data ecosystem. Both frameworks were enhanced based on the feedbacks received from interviewees and as a result new open data value capabilities are discovered. Our findings further suggest that critical factors for DCs differ for organizations in the upstream and downstream sectors, albeit some core elements are shared across sectors in data ecosystem.

Introduction

The increasing number of ODDOs and their centrality in the new data economy; calls for scholarly works on the competitiveness and survivability of these entities. Studies attempting to understand the required capabilities for value generation, agility and competitiveness like (Zeleti and Ojo 2014) are emerging. Specifically Zuiderwijk

F.A. Zeleti (✉)
Insight Centre for Data Analytics @NUI Galway, Insight Centre,
IDA Business Park, Lower Dangan, Galway, Ireland
e-mail: Fatemeh.Ahmadizeleti@insight-centre.org

A. Ojo
Insight Centre for Data Analytics, National University of Ireland Galway,
Lower Dangan, Galway, Ireland
e-mail: Adegboyega.Ojo@insight-centre.org

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_6

et al. (2015) examined conditions for using OD for competitiveness in companies, while Zeleti and Ojo (2014) elaborated on the different kinds of capabilities required for producing and capturing value in ODDOs and businesses. In these studies, Resource Dependency Theory and Capability Constructs were used as analytical frameworks. However, research on the how ODDOs develop the necessary capabilities for generating value and addressing agility to cope with the rapidly changing stakeholder's need, data ecosystem, and data marketplace are yet to be carried out.

In the area of firm competitiveness, the Resource-based View (RBV) and Dynamic Capability Theory (DCT) have been the two influential theoretical framework for understanding how value is generated, how agility within an organization is achieved, and how competitive advantage might be sustained over time (Eisenhardt and Martin 2000; Mata et al. 2013; den Hertog et al. 2010; Vivas López 2005; Ambastha and Momaya 2004; Augier and Teece 2007). Theories assume organizations as collections of specific physical, human and organizational resources (Wernerfelt 1984; Oliveira et al. 2002) which are "Valuable, Rare, Inimitable and Non-substitutable" (VRIN) (Daniel and Wilson 2003) that can be used to implement value-creating strategies (Griffith and Harvey 2013; Eisenhardt and Martin 2000). However, RBV has been criticized for conceptual vagueness and for its adequacy in a context characterised by unpredictable change (Eisenhardt and Martin 2000; Oliveira et al. 2002), termed high-velocity or dynamic markets (Daniel and Wilson 2003).

To creating and capturing value for open data stakeholders, ODDOs are required to employ emerging set of capabilities to catalyze positive change in the organization (van den Broek et al. 2012). This has led to the concept of 'value capabilities' (VCs). In addition, in high-velocity markets, where the competitive landscape is shifting, organizations must continually reconfigure, gain and dispose internal and external competencies and resources to meet the demands of a shifting market (Eisenhardt and Martin 2000) and maintain the source of sustained competitive advantage (Daniel and Wilson 2003). This has led to the concept of dynamic capabilities (DC) (Eisenhardt and Martin 2000; Helfat and Peteraf 2003). DCs develop systemic coherence while recognizing the unique features of each market's environment to facilitate customization of individual market strategies and adapt, integrate and reconfigure internal and external resources to match opportunities in the global marketplace (Griffith and Harvey 2013).

This chapter attempts to provide a better understanding of the important factors for developing open data value capabilities (ODVCs) and open data dynamic capabilities (ODDCs) in this category of organizations and firms by operationalizing RBV and DCT for ODDOs. This chapter attempts to the emerging literature on capabilities and specifically VCs and DCs in ODDOs some guide for both researchers and practitioners on what factors matter most in generating value from open data and enabling agility in these class of organizations or firms.

Theoretical Background

Research Concept: Types of Business Capabilities

Many organizations today wonder what exactly organizational capability means and why it is so important (Brits et al. 2007). While there are different definitions and conceptualizations for the concept of organization capability in research literature, extensive experience from practice clearly indicate that the concept represents "organization capacity to successfully perform a unique organization activity period of overtime".

Along this perspective, Brits (2006) defines capability as a "special type of a resource whose function improves the productivity of other resources". This implies that resources can represent a cluster of elements that constitute a capability. In addition, Townsend and Cairns (2003) argue that there is a considerable difference between competency and capability. Competency, as it is more regularly defined and theorized, is basically a term that covers observable current skills based on current knowledge while capability is beyond competency. Capability is a more "holistic, broad-based concept that includes the additional elements of values and self-efficacy as core components and it describes how an individual or organization applies their ability in a confident manner to problems in new and unfamiliar circumstances as well as in familiar situations" (Townsend and Cairns 2003). Townsend and Cairns (2003) identified three fundamental organization capability attributes: (1) ability (the current organization competence), (2) self-efficacy (belief in one's 'capability' to perform satisfactorily) and (3) shared appropriate values (sharing values across organization such as trust and valuing diversity).

In the study completed by Zeleti and Ojo (2014) and Bhatt and Grover (2005), three types of organization capabilities are introduced based on the well-known edicts of Resource-Based View and Dynamic Resource-Based Theory (Helfat and Peteraf 2003). The Resource-Based View naturally evolved into studying how intangible resources, such as intellectual assets, could be leveraged in order to accelerate organizational learning and competitive advantage (Oliveira et al. 2002; Bharadwaj 2000). Dynamic Resource-Based Theory simply facilitates the evolution of these capabilities over time (Helfat and Peteraf 2003). The three capability types include (1) Value capabilities, (2) Competitive capabilities and (3) Dynamic capabilities (Bhatt and Grover 2005).

Value Capability this includes capabilities that are characterized by value, heterogeneity, and imperfect mobility. Value capabilities are necessary to produce value which was promised by the organization. Value capabilities include all capabilities which assist an organization to deliver the organization value to the customers. Value capabilities are not source of competitive advantage as they only produce the promised necessary customer value. For example, IT infrastructure falls into this type of capability. IT infrastructure has been described as an important organization capability that can be an effective source of value (Bhatt and Grover 2005; Bharadwaj 2000; Zeleti and Ojo 2014).

Dynamic Capabilities this includes capabilities involved in dynamic nature of competitive environment. The concept of dynamic capability reflects the ability of the organization to renew capabilities (integrate, build, and reconfigure internal and external competences (Helfat and Peteraf 2003)) to address rapidly changing environments. Dynamic capabilities capture the ability to search, explore, acquire, assimilate, and apply knowledge about resources, opportunities, and how resources can be configured to exploit opportunities (Bhatt and Grover 2005). Dynamic capability can also facilitate branching of other capabilities as it is changing the organization capabilities. According to Brits (2006), differential performance of organisations over time is because of their capacity in the (1) accumulation, (2) deployment, (3) renewal, (4) reconfiguration of resources in response to changes in the internal and external environment, (5) Attempts to explain the process of how capabilities are created, (6) Emphasises the strategic value of higher order resources because of its dynamic nature, and (7) Renewal of core competencies and competitive advantage. For example, Research and Development capability falls into this type of capability (Helfat and Peteraf 2003).

Competitive Capability this includes capabilities that foster the organization competitive advantage and allow organizations stay competitive. These capabilities also impact the future competitive capabilities because of the dynamic and long-term effect (Bhatt and Grover 2005; Oliveira et al. 2002). For example, IT strategic choices fall into this type of capability. IT strategic choices are source of competitive advantage because they develop through years of experience by learning by doing (Oliveira et al. 2002). IT experience allows the organization the ability to integrate IT strategy and organization strategy, develop reliable and cost-effective systems for the organization and anticipate organization needs sooner than the competitors (Bhatt and Grover 2005).

There are other types of capabilities such as competitive capabilities and dynamic capabilities. In dividing capabilities, it is very important to distinguish the difference between capabilities that produce value and capabilities that are source of competitive advantage and capabilities that are dynamic. Value capabilities are effective and primary source of value while competitive and dynamic capabilities are secondary which means value capability is prerequisite and is necessary for the others to occur (Bhatt and Grover 2005; Zeleti and Ojo 2014).

Summary of the capability types and capabilities associated with each type is illustrated in Table 1. Dynamic capability and competitive capability are briefly discussed in this section. The six types of value capabilities are described in section "Value Capabilities: Theory Background".

Table 1 General business capabilities

Value capability	Innovative/Dynamic capability	Competitive capability
Individual/competences Business process Organization IT infrastructure Management/governance Technological	Process innovation Knowledge mgt. Manufacturing performance Supply chain integration	IT (Strategic choices) Manufacturing strategy Business operational (Localization/Internationalization)

Value Capability

Individual/Competences Jaques and Stamp (1995) define it as the extent and complexity of the context within which an individual can operate. For example, specific employee skills required performing a specific task.

Business Process is a collection of related, structured activities or tasks that produce a specific service or product for a particular customer or customers. For example, Standardization and harmonization process, validation and visualization process (Steiner et al. 1997; Symphony Technologies Pvt Ltd n.d.).

Organization refers to the way systems and people in the organization work together to get things done. For example collaboration mechanisms, organization-specific competencies (marketing, finance, etc.), employees motivation, efforts towards organizational goal, adaptability, and flexibility, creativity and innovation (Ambrosini and Bowman 2009).

IT Infrastructure IT infrastructure can provide an organization the ability to share information across the organization (Bhatt and Grover 2005). Another word, IT infrastructure is the technological foundation of equipment, computer, communications, data and basic systems used in common across an organization. It includes software (ERP), internal and external network resources (servers and switches) and services (software setup, help desk and computer administration) (Bhatt and Grover 2005; Bharadwaj 2000; Mithas et al. 2009; Gheysari et al. 2012; Xia and King 2002).

Technological Infrastructure *t*echnology is knowledge embedded in products and processes on doing practical things, especially producing things or data. It includes any sensor-based devices, sensing/sensor phones and smart grids (Gheysari et al. 2012; Arnold and Thuriaux 1997; Brazilian National Council for Scientific and Technological Development (BNCSTD) 2011).

Management/Governance is about controlling things (people and resources) and action of governing the organization. Different management skills or actions might be required for different stages of the value chain. For example, staffing, training programs, compensation, a quick response accepting additional data for advanced features, technical management expertise and managing risks (Ambrosini and Bowman 2009).

Dynamic Capability

Process Innovation is required to improve the processes for the production of new product or output (Verworn and Herstatt 2002).

Knowledge Management encompasses identifying and mapping intellectual assets within the organization, generating new knowledge for competitive advantage, making vast amounts of corporate information accessible, sharing of best practices, and technology (Tanriverdi 2005; Easterby-Smith and Prieto 2008).

Manufacturing Performance are characterized by the set of practices in use for the manufacturing system (Hallgren 2007).

Supply Chain Integration enables firms to share information with their chain to create supply partners information-based approaches for superior demand planning, for the staging and movement of physical products, and for streamlining voluminous and complex financial work processes (Rai et al. 2006).

Competitive Capability

IT (Strategic Choices) are the main forces for competitive advantage. IT strategies increase competitive pressure in the marketplace (Xia and King 2002).

Manufacturing Strategy are set of strategies organizations define for improvement of manufacturing processes and performance (Hallgren 2007).

Business Operational capability of the whole system (organization) to operate locally/globally (Cepeda and Vera 2007).

In addition, all the aforementioned capability types and their associated capabilities have lifecycle which indicates the potential for development of a capability over time. According to Helfat and Peteraf (2003), capability lifecycle has three stages which are (1) Founding (capability is identified and starts functioning), (2) Development (capability is developed gradually over time) and (3) Maturity (capability meets its highest level of functionality and impact) (Helfat and Peteraf 2003). Not all capabilities may reach the maturity stage due to poor development.

Moreover, all aforesaid aspects of capabilities are found in both the Resource-Based View and Dynamic Resource-Based View. That is why both are seen as essential towards identifying, managing and in the end modelling organization capabilities.

In classifying capabilities, it is important to distinguish between those that have value and those that can be a source of competitive advantage (Fig. 1). Value capability is necessary for the competitive advantage to occur but value capability alone does not lead to competitiveness of an organization. Bhatt and Grover (2005) argue that competitive capabilities are not only valuable but heterogeneously distributed and difficult to transfer. Further, Bhatt and Grover (2005) argue that competitive capability is a major source of competitive advantage of an organization. On the

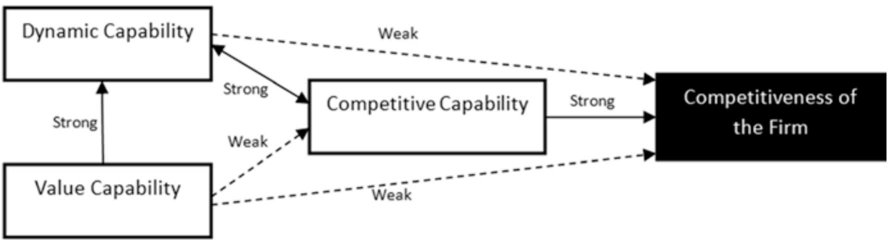


Fig. 1 Organizational capability model and competitiveness of a firm

same page, Mata et al. (2013) claim that an organization is said to have a competitive advantage when it is deploying its DCs sufficiently. For example, an organization has competitive advantage if it is formulating and implementing a strategy, which is not simultaneously implemented by many other organizations and where these other organizations face significant disadvantages in acquiring the resources necessary to implement this strategy.

Although value and competitive capabilities are important, we also need to recognize the dynamic nature of both. Organizations that are involved in such (dynamic) activities have greater absorptive capacity and can build and renew value and competitive capabilities, which could be a source of competitive advantage. For example, knowledge management which is a dynamic concept involves accumulation, sharing, and application of knowledge which could be heterogeneous across organizations, and thereby also a source of competitive advantage (Bhatt and Grover 2005).

Value Capabilities: Theory Background

Value Chain

For a better understanding of the activities through which an organization creates and develops value for shareholders, it is useful to separate the organization system into a series of value-generating activities known as the value chain (Brits et al. 2007). Value chain consists of stages of the process of creating value for stakeholders (Rayport and Sviokla 1995). Value chain as described in Rayport and Sviokla (1995) is a model to describe a series of value-adding activities and processes known as value production connecting an organization's supply side to its demand side. Moreover, value chain offers organizations a means by which they can evaluate both existing and new strategic opportunities to create customer value (Walters and Rainbird 2007).

Organizations should oversee a physical value chain but, they must also build and exploit a virtual value chain. This is possible in three stages (1) Visibility (organization can see physical operations more effectively through information), (2) Mirroring capabilities (organization substitute virtual activities for physical activities and they start building capabilities) and (3) Customer relationship (organizations can deliver value to customers in new ways based on the flow of information in the virtual value chain). The three processes (Fig. 2) show that physical value chain is linear and deliberates on physical activities while virtual value chain is nonlinear and deliberates on information space or the flow of information in an organization (Rayport and Sviokla 1995).

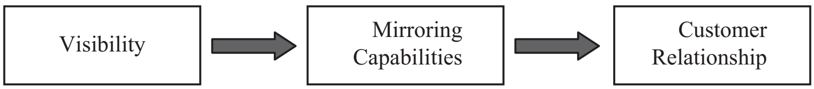


Fig. 2 Value chain adaptation process

Given the sufficiency in research in the area of the value chain, three well-known value chain frameworks are illustrated. *Porter's Value Chain* which lies on the concept of physical value chain of the organization (Bhatt and Emdad 2001; Porter 1985); *Rayport and Sviokla's Value Chain* which lies on the concept of virtual value chain of the organization (Rayport and Sviokla 1995) and the *Open Government Data Value Chain* which lies on the concept of Public Sector Information (Ubaldi 2013).

Below we present the physical and virtual value chain, the value chain that integrates both physical and virtual, and the *Open Government Data Value Chain*. As we employ the context of Open Government Data Value chain in this research – due to the nature of our research – Open Government Data Value chain is extensively explained in section "Synthesis of an Open Data Dynamic Capability Framework".

Porter's Conceptualization of Value Chain Porter's value chain lies in the concept of the physical value chain of the firm (University of Cambridge 2016) which means that value chain is targeted toward manufacturing firms in which value of the organization activities are mostly concerned with the physical flow of material (Bhatt and Emdad 2005). Porter's value chain consists of two sets of activities: primary and secondary activities.

Primary Activities this includes Inbound Logistics or Input (receiving, storing, and disseminating inputs to the product), Process or Operation (transforming inputs into the final product), Outbound Logistics or Output (collecting, storing, and physically distributing the product to buyers), Marketing and Sales or Share (providing a means by which buyers can purchase the product and inducing them to do so), Service or Maintain (providing service to enhance or maintain the value of the product) (Finne 1997).

Secondary/Support Activities this includes Procurement (the function of purchasing inputs used in the organization value chain), Human Resources Management (the recruiting, hiring, training, development, and compensation of all types of personnel), Technology Development (know-how, procedures, or technology embodied in process equipment) and Infrastructure (general management, planning, finance, accounting, legal, government affairs, and quality management which support the entire chain and not individual activities) (Porter 1985; University of Cambridge 2016; Julien 2012; W3C Brazil 2012).

Figure 3 shows Porter's value chain.

Rayport and Sviokla's Conceptualization of Value Chain Rayport and Sviokla value chain lie on the concept of the virtual value chain of the firm which means 'information' play the key role in the chain. The virtual value chain is all about utilizing information to enhance the value chain. Therefore, in the virtual value chain, strategic decisions, and activities are built around information (Rayport and Sviokla 1995; Bhatt and Emdad 2005).

According to Rayport and Sviokla (1995), a virtual value chain consists of five stages; Gathering, Organizing, Selecting, Synthesizing, and Distributing. Figure 4 shows Rayport and Sviokla's value chain.

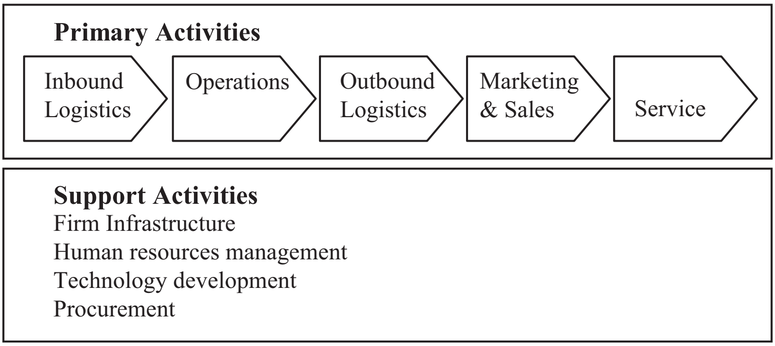


Fig. 3 Porter's value chain (Pant and Hsu 1996)

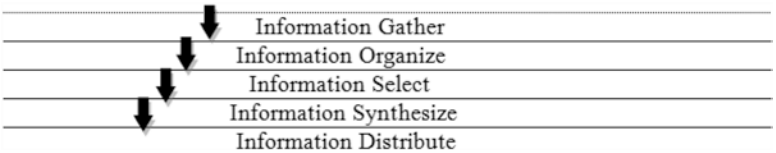


Fig. 4 Rayport and Sviokla virtual value chain (Rayport and Sviokla 1995)

Integration of Physical and Virtual Value Chains Integration of Porter's and Rayport and Sviokla's value chains can also happen in an organization when the organization aims to adopt both virtual and physical activities for offering customized products and services. Virtual value chain makes a large part of the transactions transparent by providing the organization with customer, suppliers and manufacturers information while physical value chain allows the organization to fulfill customer orders and assembling final product and services (Bhatt and Emdad 2005).

In the physical value chain, information performs a support function but, in virtual value chain information plays a critical and strategic role.

Open Government Data Value Chain The understanding of value chain is essential to grasp the vital elements of various activities related to open data (Ubaldi 2013). Value is not only money when speaking of value in open data context, the value can also be economic, social, transparency, democratic, etc. (Guidoin n.d.). By utilizing value chain, organizations can identify internal and external activities or processes to create value and improve efficiency and effectiveness (Rayport and Sviokla 1995; de Vries 2012). So, it is essential for an organization to establish value chain that suits the purpose of the organization (Rayport and Sviokla 1995).

Similarly, to create value from (government) open data, public sectors are required to utilize Open Government Data Value Chain in respect to European Commission Public Sector Information Directive. The value chain identified four main phases: Data Generation; Data Collection; Aggregation and Processing; Data Distribution and Delivery and Final Data Use (Ubaldi 2013).

Phase 1: Data Generation according to OECD working paper (Ubaldi 2013), data generation phase covers all capabilities required for generating data. This phase requires capabilities related to 'generating data', for example, technologies to collect substantial amount of data.

Phase 2: Data Collection, Aggregation and Processing Raw data may not have enough quality and meaning to be used, therefore; as it was reported in OECD working paper (Ubaldi 2013); data need to be aggregated, linked, and or manipulated in order to add value before being open and freely distributed. This phase requires capabilities related to 'data processing' and 'data storage and computing facilities', for example, data cleansing, mash-up, analysis, invalid or duplicate data deletion, standardization. Moreover, data storage and computing facilities are necessary to be pooled together for efficiency of data processing and aggregating, for example, computing facilities.

Phase 3: Data Distribution and Delivery according to OECD working paper (Ubaldi 2013), data processed need to be distributed to enable access and re-use. Public sector entities and other organizations are obliged to define precise publishing solutions, providing access to data and APIs and ultimately releasing data. This phase requires capabilities related to 'publishing solution', 'providing access to data and APIs' and 'data release', for example, publishing as linked data, data exposure via APIs and proactively releasing data.

Phase 4: Final Data use data previously distributed need to be re-used by different users to sustain public value creation (Ubaldi 2013). This phase requires capabilities related to 'data retrieval' and 'data usage', for example, guidelines on how to use data and supporting intermediaries.

The next section underlines what each aforementioned capability areas mean and briefly describes capabilities associated with them.

Value Capability Frameworks

Organization is seen as a tree, "mission and vision feed the tree, core competencies serve as roots and processes produce the fruits in terms of services and products" (Brits et al. 2007). According to Brits (2006), with the organization capability framework insight, an organization should be analyzed to extract the critical organizational information. This information includes (1) strategic artefacts such as vision, mission, objectives and goals, (2) organization entities such as suppliers and customers, (3) organization rules such as facts, derivations and definitions and (4) organization processes such as corporate, business units and operational. This information will serve as the foundation to construct business capability framework.

According to Keller (2010), capability is the ability to perform actions and in the context of the organization, capabilities:

- are the building blocks of the organization;
- represent stable organizational functions;

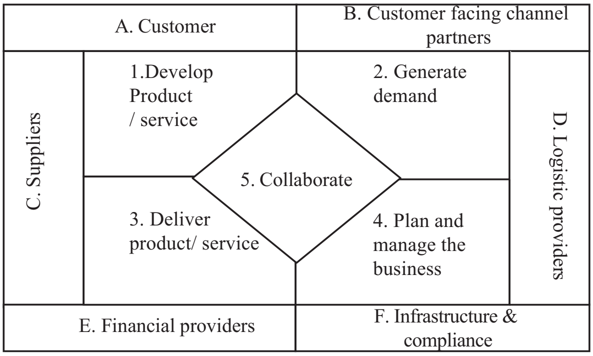
- are unique and independent of each other, however, one's result affect the others;
- are abstracted from the organizational model;
- capture the organizational interests.

Keller (2010) further presents a top-level capability model that he claims to be applicable to any industry and organization domain. Model is shown in Fig. 5.

While Keller's capability model captures top-level capabilities, the model described in Moller and Torronen (2003) presents a more detailed framework (Fig. 6) describing the capabilities organizations require for value production.

As shown in Fig. 6, value production is obviously dependent on the capabilities organization defines. Being able to produce core value is a necessary condition for achieving innovation and competitive advantage. Figure 6 clearly highlighted that different capabilities are the essence of value adding processes and value production. For example, a supplier with broad knowledge of process improvement and its respective capabilities could come up with more effective and efficient products and services for the customers (Moller and Torronen 2003).

Fig. 5 Top-level organization capability model (Brits et al. 2007)



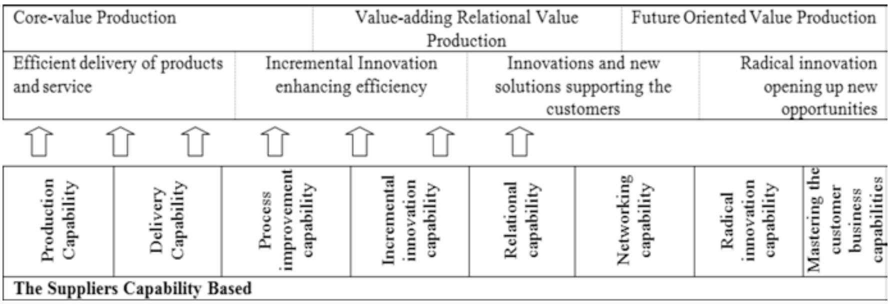


Fig. 6 Capability base and value production (Moller and Torronen 2003)

Open Data Value Capability Areas

To be competitive and generating robust and thriving revenue streams, open data-driven organizations tend to increase efficiency and effectiveness in respect to value-adding processes related to generating data, processing data and re-using data. To increase efficiency and effectiveness, organizations are required to identify set of capabilities. List of open data value capability areas have been identified and extracted from open data literature. Capability areas are 'data generation', 'data processing', 'data storage and computing facilities', 'data release', 'providing access to data and APIs', 'publishing solution', 'data retrieval' and 'data usage'.

Data Generation This capability is associated with generating a new set of data from existing information, text, other raw data or from any device or software collecting data. This can include data generation from sensors or smart grids.

Data Processing This capability is associated with processing the generated or the original data to meet its potential purpose of use. Examples in this vein include utilizing processing software to mash-up of original data with other sources of information, harmonization of data with a specific application and cataloging data to suit the expected need and to the fruitful use of such data to enhance the organization (Ferro and Osella 2013).

Data Storage and Computing Facilities This capability is associated with data storage and back-ups such as storage capacity and computing facilities such as computer hardware or software, computer networks and communications systems and all networking and communications provision including connections to external computers. It is essential for an organization to estimate data storage and computing capacity appropriately to ensure data quality.

Data Release This capability is associated with the release of processed data to its users to enable data reuse. Capabilities such as data structuring, classification, and regular update. Data is considered as a good. Therefore, data should be released by the data release rules and regulations of a particular organization (Zuiderwijk et al. 2015; HM Government 2013).

Providing Access to Data and APIs This capability is associated with availability and accessibility of APIs to outside- organization users such as developers. Capabilities such as API development, data exposure via GUI and APIs and testing and bug fixing. There is still plenty more to do on making more data and APIs accessible (HM Government 2013).

Publishing Solution This capability is associated with publishing data in compelling formats which require methods and mechanisms. For example, publishing as Linked Data is one publishing solution.

Data Retrieval This capability is associated with data query. This includes extracting the requested data from data storage or datasets. This process requires sophisticated querying and appropriate planning for data retrieval.

Data Usage This capability is associated with enabling and supporting data users such as data intermediaries and developers to be able to use data. Data re-use will enrich the value of data.

Open data value capability areas and capabilities associated with each area are presented in Table 2.

Dynamic Capabilities: Theory Background

DCs have their antecedents in the RBV of the organization (Daniel and Wilson 2003). They are those specific physical (e.g., specialized equipment, geographic location), human (e.g., expertise in chemistry), and organizational (e.g., superior sales force) resources that can be used to implement value-creating strategies (Wernerfelt 1984). They include the local abilities or competencies' that are fundamental to the competitive advantage of an organization (Eisenhardt and Martin 2000; Alsos et al. 2008). Distinctive processes support the creation, protection, and augmentation of organization-specific resources and competencies (Griffith and Harvey 2013). If an organization possesses processes, resources, and competencies but lacks DCs, it has a chance to make a competitive return for a short period, but superior returns cannot be sustained. The possession and deployment of DCs provide the business enterprise with a chance to generate superior profitability over the longer run. When organizations are dynamically competitive, management will be active at sensing and seizing opportunities (Augier and Teece 2009).

According to Griffith and Harvey (2013), "DCs are derived from an organization leveraging its internal and external resources which in turn enhance its power in its global relationships, thereby enabling it to coordinate inter-organizational activities and respond rapidly, in a flexible manner, to global competitors' strategies". Therefore, the organization has to be continuously alert and in a process of identifying and exploiting new opportunities in order to transform its resources effectively into new competitive advantages (Alsos et al. 2008).

Dynamic Capability Constructs

A study by Teece and Pisano (1994) advances the argument that the capabilities of an organization rest on three main constructs: organizational **processes**, **position**, and the **path/strategies** available to it and these capabilities can provide competitive advantage. Teece (2014) also identified the core building blocks of DCs under the tripartite rubrics of processes, positions, and path/strategies. Below, we classify the dynamic capability types (Table 1) according to the three main constructs.

1. Process

According to Teece and Pisano (1994), the organizational process is referred to as the way things are done in the organization or what is called the organization's

Table 2 Open data value capability areas

OD value capability areas and capabilities associated with each area	References
Data Generation	
Efficient design and features to collect massive data	Ferro and Osella (2013)
Technology and Infrastructures	HM Government (2013)
Reuse of public sector information	HM Government (2013 and Rojas et al. (2013)
Linking information from different sources	Rojas et al. (2013)
Data Processing	
Cleaned data to fill gaps, eliminate invalid records or duplicates, standardize attribute values	Julien (2012)
Harmonizing data regarding format	Musings (2012)
Format transformations to allow effective machine reading	Julien (2012)
Create mash-up	Julien (2012) and Ferro and Osella (2013)
Data reform and refine	Julien (2012) and Ferro and Osella (2013)
Data Analysis, Visualization and Visual analytics	van den Broek et al. (2012), Julien (2012), Ferro and Osella (2013), and Musings (2012)
Data Validation	(Julien 2012; Musings 2012)
Data Quality	(Julien 2012; Musings 2012)
Cataloguing data	Julien (2012)
Usage of platforms capable of converting datasets into data streams	Musings (2012)
Data geo-referencing	Ferro and Osella (2013)
Provision of computing capacity	Ferro and Osella (2013) and Avital and Bjorn-Andersen (2012)
Standardizing Linked Data to allow joining to other datasets	Julien (2012)
Data Storage and Computing Facilities	
Data storage	Ferro and Osella (2013)
Computing capacity	Ferro and Osella (2013)
Data Release	
Proactively release data	Musings (2012)
Data structuring	Julien (2012) and Ferro and Osella (2013)
Data classification	Julien (2012) and Ferro and Osella (2013)
Support data with metadata	Musings (2012)
Data update and maintenance	Julien (2012) and Musings (2012)
Providing Access to Data and APIs	
Guarantee on data availability	Julien (2012) and Musings (2012)
Commoditization and democratization of data	Ferro and Osella (2013)
Data distribution channel quality	Julien (2012), Ferro and Osella (2013) and Osterwalder (2004)
Data exposure via GUI	Ferro and Osella (2013)

(continued)

Table 2 (continued)

OD value capability areas and capabilities associated with each area	References
Data exposure via APIs	Ferro and Osella (2013) and Musings (2012)
Freeing data	Julien (2012)
API development	Musings (2012)
Using APIs	Musings (2012)
Testing and Bug Fixing	Musings (2012)
Data change feed	Musings (2012)
Publishing Solution	
Publishing as Linked Data	Julien (2012)
Sustainable Publishing Solution	Ferro and Osella (2013)
Publishing in different format; machine-readable data	van den Broek et al. (2012), Ubaldi (2013), Julien (2012) and Musings (2012)
Publishing on the web as API to be queried or data dump to be downloaded as a whole	Julien (2012)
Development of software tools to visualize and create API services on the web	Julien (2012)
Data Retrieval	
Sophisticated Querying	Musings (2012)
Data Usage	
Help and guideline on accessing, using and adding data, information or knowledge to the original data source	van den Broek et al. (2012), Julien (2012) and Musings (2012)
Available data on the Web to the public and in formats that citizens can reuse	Rojas et al. (2013)
Support data intermediaries	van den Broek et al. (2012)
A general search engine helping to locate data	Julien (2012)
Dedicated service searching purely for datasets and providing useful categorization and tagging	Julien (2012)

'routines' or 'patterns' of the practices being performed in the organization. To better understand and achieve the necessary capabilities for renewing organizational processes, two types of general DCs are required: (1) DCs related to Process Innovation and (2) Knowledge Management. Both types are presented below.

Process Innovation The organization's processes use resources – specifically the processes to integrate, reconfigure, gain and release new resources – to match and even create market change (Daniel and Wilson 2003; Eisenhardt and Martin 2000). Processes embed the strategy and business model of the organization into the day-to-day routines of employees and leadership skills and ability of the organization's top management to design, develop, implement, and modify these routines in order to adjust to changing environments, and also to shape the (business) environment (Teece 2014).

More frequently, in dynamic markets, it makes sense to use DCs to build new resource configurations and move into new competitive positions using a path-breaking strategic logic of change (Eisenhardt and Martin 2000). Although often neglected, jettisoned resource combinations that no longer provide competitive advantage are also critical DCs as markets undergo change (Eisenhardt and Martin 2000). The organization's processes and positions collectively encompass its capabilities or competencies. According to Ambrosini et al. (2009) "DCs are built rather than bought in the market", and they include organizational processes or 'routines' that are employed to reconfigure or to combine the organization's resources and paths which are the choices open to the organization today and likely to be in the future. The main four processes are *reconfiguration* – transformation and recombination of resources and resources; *leveraging* – extending a resource by deploying it into a new domain; *learning* – allows tasks to be performed more effectively and efficiently; and *integration* – ability of the organization to integrate and coordinate its resources and resources). Similarly, Teece (2014) identifies the three classes of processes that are relevant to DCs: *integration*, *guided learning*, and *reconfiguration/transformation*.

In the same vein, Teece et al. (1997) identified technological, complementary (technological or otherwise), financial, reputational, market structure, and institutional resources. Teece and Pisano (1994) further claim the importance of external integration and sourcing, integration of external activities and technologies, and reconfiguration of resources on the competitiveness of the organization. In rapidly changing environments, there is obviously value in the ability to sense the need to reconfigure the organization's processes, and to accomplish the necessary internal and external transformation (Teece and Pisano 1994). The processes of organizational renewal are essential for the long-term survival and prosperity of the business organization. Enterprises must also combine the exploration of new opportunities with exploitation and renewal (Augier and Teece 2009). This requires constant surveillance of markets and technologies and the willingness to adopt best practices. In this regard, benchmarking is of considerable value as an organized process for accomplishing such ends (Teece and Pisano 1994).

Knowledge Management The essence of the DCs approach is that competitive success arises from the continuous development, alignment, and reconfiguration of organization-specific resources (Griffith and Harvey 2013; Augier and Teece 2009). This broader organizational capability is concerned with how organizations create and/or access new knowledge (Augier and Teece 2007; Bhatt and Grover 2005; Griffith and Harvey 2013), search, explore, acquire, assimilate, and apply knowledge about resources (Vivas López 2005; Griffith and Harvey 2013), opportunities, and how resources can be configured to exploit opportunities (Augier and Teece 2009), and how organization makes investment choices, and achieve necessary business model and organizational transformation. This is referred to as the 'intensity of organizational learning', which involves accumulation, sharing, and application of knowledge (Bhatt and Grover 2005). Some scholars including Weerawardena et al. (2007) suggest that whilst market-based learning enables the organization to learn what the market needs, the organization must acquire knowledge from other sources to develop leading edge innovative products and services that will fulfill organization's needs. This is called 'acquisition' and is one of the additional knowledge acquiring capability of a organization for speedier internationalization. Following this analogy, Weerawardena et al. (2007) suggests that a organization's capacity to acquire new knowledge depends on its internal knowledge base that directly relates to its internally focused learning activities.

In addition, in a fast-paced competitive environments where technological and market change rapidly, resource coordination, resource orchestration, creation of critical co-specialized resources, and adapting effectively to the changing environments are of several elements of a organization's DCs and are the central economic activities which are often difficult to achieve. However, to address the rapidly changing environment, there is the need for organization to engage in trading activities, and for managers to decide what investments are to be made, what resources are to be purchased, how to integrate, build, and reconfigure internal and external competences, and how complementarities are to be achieved (Augier and Teece 2009).

2. Position

The position is referred to as the current endowment of technology and intellectual property and organization's customer base and upstream relations with its suppliers (Teece and Pisano 1994) and is enhanced if the resources meet the RBV criteria. The way in which resources need to be deployed is likely to be dynamic (Teece et al. 1997) as in globally competitive environments, positions alone are generally of fleeting value (Teece and Pisano 1994). To better understand and develop the necessary capabilities for renewing organizational position in the market, two types of general DCs are essential: DCs related to Manufacturing Performance and Supply Chain Integration. Both types are presented below.

Manufacturing Performance Technological and non-technological opportunities and know-how allow innovation in all areas of value creation. In addition, they support superior organizational performance including manufacturing of products and services in several ways. First, organizations that emphasize technological know-how are better at adapting to and growing in new markets. Second, organizations that emphasize technological and non-technological know-how generate knowledge in greater amounts for more efficient retrieval that they can apply to address internal and external environmental challenges (Weerawardena et al. 2007). However, addressing Technological and non-technological opportunities involve maintaining and improving technological competencies and complementary resources and then, when the opportunity is ripe, investing heavily in the particular technologies and designs most likely to achieve marketplace acceptance (Teece 2007).

Supply Chain Integration To achieve the effective coordination of inter-organizational relationships, on a global basis that can provide a organization a competitive advantage (Griffith and Harvey 2013), decision makers need information on changing consumer needs and technology. Such information is not always available, or if it is available, is likely to be incomplete. Managers are of course decision makers and they must collect information, analyze it, synthesize it, and act upon it inside the organization (Augier and Teece 2009). The manager skills in coordinating and resource allocating capabilities featured in the DCs shape markets, as much as markets shape organizations however, these alone do not shape markets and provide information manager needs to implement goals. The organization and managers also require organization-level responses by competitors, suppliers, and customers (Augier and Teece 2009; Griffith and Harvey 2013). The network relationship specifically with the suppliers plays a significant role in enhancing the supplier network, sensing and seizing opportunities, knowledge creation, resource configuration and integration and know-how exchange (Augier and Teece 2009; Teece 2007).

3. Path / Strategy

Path is refered to as the strategic alternatives available to the organization (Teece and Pisano 1994). Authors of Griffith and Harvey (2013) highlight both internal (RBV) and external (Market Based View) resources which provide the power basis necessary for developing strategies. To better understand and achieve the necessary capabilities for renewing organizational path or strategies, Managerial Strategic Functions or capabilities are required. Managerial Strategic Functions is presented below.

Managerial Strategic Functions Once an organization is established, continuing to succeed in an open competitive economy requires high management and employees skills with capacities to combine and integrate (Augier and Teece 2007, 2009; Alsos et al. 2008). In particular, managers must think strategically and execute flawlessly (Augier and Teece 2009) to access niche markets and for building market positioning (Weerawardena et al. 2007) if they want to succeed (Augier and Teece 2009). They must also figure out how to harness competences (Daniel and Wilson 2003) and the skills of highly skilled employees who play a much more significant role in creative success and performance of the organization. Survival of a organization is not only about executing well but, about figuring out where to put resources, realizing opportunities and then moving on when competition arises (Augier and Teece 2009). Such capabilities, if built, constitute the DCs of a organization through allowing managers to strategically combine, recombine, and reconfigure resources and resources inside and outside of the organization's boundaries in order to generate and exploit strategic internal and external organization-specific competences (Augier and Teece 2009). Not many managers have the necessary skills, and fewer still succeed in building them into their businesses (Augier and Teece 2009; Daniel and Wilson 2003).

Linking Constructs to the Types

From the DC Theory literature, we identify three core constructs: *Process*, *Position*, and *Path* or *Strategy*. Based on extensive literature review of the domain, we have found sub-constructs and related dimensions to each sub-construct. In addition, previous studies show and investigate four types of DCs (Table 1). Here, we categorize DCs into five types: *Process Innovation, Knowledge Management, Manufacturing Performance, Supply Chain Integration,* and *Strategic Managerial Function.* In Table 3, we establish relations between the three main DCs constructs, DCs types, DCs sub-constructs and their respective dimensions.

Table 3 DCs constructs linked to the dynamic capability types

Three Constructs of DCs (Brazilian National Council for Scientific and Technological Development (BNCSTD) 2011; Verworn and Herstatt 2002)	Dynamic Capability Types (Bhatt and Grover 2005)	Sub-Constructs (Tanriverdi 2005; Verworn and Herstatt 2002)	Dimensions
Process	Process Innovation	Integration	Integrating and Adapting Resource; Combine the Exploration of new Opportunities with Exploitation and Strategic Renewal
		Leveraging	Extending, Building and Releasing Resources by Deploying it into a new Domain; Leveraging Critical Co-specialized Resources; Innovative Capability
		Reconfiguration	Transformation, Recombination, and Reconfiguration of Resources; Jettison un-necessary Resources; Quick Response to Strategic Renewal; Innovative Capability
	Knowledge Management	Learning and Knowledge Mngt.	Coordinate Resources; Resource Alignment: Resource Orchestration; Resource Continuous Development; Search, Explore, Configure, Acquire, Share, Assimilate, Accumulation, Integrate, and Apply knowledge; Strength Organizational Learning; Disseminate Information; Unlearning Routines; Unlearning Knowledge-based Practices; Creativity and Idea Management; Integrate Internally Generated Information
Position	Manufacturing Performance	Technology	Seize Technological Opportunities, Acquisition
		Intellectual Property	
	Supply Chain	Customer Relationship	Positive Relationship and Quick Response to Customers
		Upstream Relationship	Positive Relationship and Quick Response to Upstream Suppliers
Path/Strategy	Strategic Managerial Function	Strategies	Deploying Resources to Support Market Needs; Constance Surveillance of Market and Technologies; Make Timely and Market-Oriented Decisions; Niche Market Access; Adopt Best Practices; Benchmarking; Alliancing

Three Stages of Dynamic Capabilities

Drawing on existing empirical findings (Wang and Ahmed 2007), we identify three main stages for DCs: (1) Adaptive capability, (2) Absorptive capability and (3) Innovative capability.

Adaptive Capabilities (Search/Variations/External Observation) DCs which monitor the environment, to discover external knowledge (Büchel and Sorell 2012) and new possibilities. Searching for new ideas in this manner can provide an insight into how existing problems or new challenges may be managed and solved. To reveal the potential in the environment may be said to be the core of all entrepreneurial and innovative activities. An organization must have the ability to appraise the environment so as to constantly develop new ideas and business opportunities. This adaptive ability to appraise markets and technologies, and the willingness to adopt best practice, are therefore important (Alsos et al. 2008). In addition, adaptive capabilities can also help to trigger and guide strategic renewal processes (Rouse and Ziestma 2008).

Absorptive Capabilities (Selection/Evaluation/Acquisition) DCs which recognize the value of new, external information, assimilate it, and apply it to commercial ends (Wang and Ahmed 2007). Knowledge may be acquired through external contacts and connections. However, the acquisition of new knowledge is very time consuming and challenging as there may be considerable risks involved in investing in new acquired knowledge (Alsos et al. 2008). Yet, the expectations of advantages derived from new ideas may be achieved by analysis and debate concerning the values and risks. The ideas are evaluated on the basis of previous experience, expertise, and capabilities (Alsos et al. 2008). Stronger ability of learning from partners, integrating external information and transforming it into organization-embedded knowledge are the outcome of organizations with higher absorptive capability (Wang and Ahmed 2007).

Innovative Capabilities (Routinisation/Implementation/Reconfiguration and Renewal) DCs comprise product development routines, development and launch of new profitable products and services, strategic decision-making, introduce, combine or modify resources, and integrate new resources (Alsos et al. 2008) with innovative behaviors and processes (Wang and Ahmed 2007). This includes implementing newly approved initiatives to change within the organization and provides the opportunity to reorganize the organization's resources and the possibility to experiment with new ideas (Alsos et al. 2008). In this stage, organization puts the ideas from the selection phase into place in a competitive business platform. Thus, the process ends in a form of utilization through the implementation of the ideas (Alsos et al. 2008). Authors of (Wang and Ahmed 2007) suggest a range of possible innovative alternatives, such as developing new products or services, developing new methods of production, identifying new markets, discovering new sources of supply and developing new organizational forms.

Synthesis of an Open Data Value Capability Framework

The deconstruction of open data capabilities is a framework of strategic management and value chain analysis for open data-driven organizations, which aims at capturing all capabilities an open data-driven organization require – from generating data to final use and re-use of data – for creating and capturing value from open data.

The framework is a strategic tool for open data-driven organization of any scale to exercise and exploit for their organization. Capability framework allows open data-driven organizations to identify what capabilities are valuable to the organization. As different organizations have a different business model, specific open data capabilities for open data-driven organizations need to be specified.

Open data value capability framework (Fig. 7) is based on the general organization value capabilities, open data capability areas and the open government data value chain phases.

There is only one approach to utilizing capability framework in an open data-driven organization. Organizations need to identify specific individual, process, organization, IT infrastructure, technological infrastructure, and management capabilities for all value chain phases. The open data-driven organizations can use the capability tool to identify what capabilities are required for the organization. The process is initiated by identifying what capabilities are required for each capability areas correlated with the first stage of the value chain. For example, the first value chain phase is *Data Generation,* and this includes a set of capabilities required for generating data. Managers should identify what individual, process, organization, IT infrastructure, technological infrastructure, and management capabilities are required for generating data. Open data organization management/governance is necessary throughout the value chain to ensure the quality of the process.

	Data Generation	Data Collection, Aggregation and Processing		Data Distribution and Delivery			Final data Use	
	Generating Data	Data Processing	Data Storage & Computing Facilities	Data Release	Providing Access to Data & APIs	Publishing Solution	Data Retrieval	Data Usage
Individual/ Competences								
Business Process								
Organization								
IT Infrastructure								
Technological Infrastructure								
Management/ Governance								

Fig. 7 Open data value capability framework

Synthesis of an Open Data Dynamic Capability Framework

In this section, we define what DCT constructs (Process, Position, and Path) means in each the dynamic capability stages – Adaptive, Absorptive, and Innovative. In Table 4, we specify nine conditions for agility of ODDCs following the descriptions in section "Dynamic Capabilities: Theory Background". In addition, corresponding propositions are provided to succinctly capture these conditions.

Adaptive Position Capabilities (Sense and Search) ODDCs which monitor the environment, to discover external knowledge (Büchel and Sorell 2012) and new possibilities for positioning ODDOs in the OD industry. This capability includes: Search for knowledge that can be acquired from OD ecosystem such as maturity of

Table 4 DC constructs vs. DC stages – The definition in OD context

	Adaptive Capability	Absorptive Capability	Innovative Capability
Position	The ability to sense the need to reconfigure current endowment of open (linked) data technology, intellectual property and OD-driven organization customer base and upstream relations with OD suppliers from OD ecosystem.	The ability to seize the knowledge from OD ecosystem and to recognize OD market and technological opportunities in order to develop organization's scarce open (linked) data technological and non-technological resources to support market needs and gain advantage over rivals.	The ability to use knowledge from OD ecosystem to enhance and develop difficult-to-trade knowledge OD resources and resources complementary to them, as well as its reputational and relational resources which determine OD market share and profitability at any point in time.
Process	The ability to sense the need to reconfigure OD existing value-added processes by learning from OD ecosystem.	The ability to seize and integrate the external knowledge and information an OD-driven organization possess about the OD ecosystem in order to reconfigure the existing value-added processes.	The ability to transform the knowledge and information acquired from OD ecosystem into OD-driven organization-embedded knowledge in order to develop new value-added processes. This also includes balancing between existing value-added processes and the acquired value- added processes.
Path	The ability to sense the need to reconfigure the OD strategies in order to accomplish effective exploration and exploitation of OD strategies and the necessary internal and external transformation.	The ability to seize and assimilate knowledge acquired from OD ecosystem to develop OD strategic solutions and decisions.	The ability to deploy the knowledge from OD ecosystem to re-shape the past OD strategies and shape new OD strategies to be used in the future.

the existing OD ecosystem; Strength of the OD-driven organizational Learning skills and capabilities; OD product/service Intellectual Property; Network analysis of OD actors (businesses, government bodies and civil society actors); Learn about structure of the OD market and knowledge about the level of engagement of the organization with OD agencies, other organizations and developers.

Adaptive Process Capabilities (Sense and Search) ODDCs which monitor the environment, to discover external knowledge (Büchel and Sorell 2012) and new possibilities around processes for adding value to OD products and services. This capability includes: Search for and knowledge about the list of compatible licenses and knowledge on the number of businesses or other organizations using/seeking/demanding OD.

Adaptive Path Capabilities (Sense and Search) ODDCs which monitor the environment, to discover external knowledge (Büchel and Sorell 2012) and new possibilities for formulating new and reformulating existing OD strategies. This capability includes: Knowledge on OD marketplaces; Knowledge on the actors who have stopped releasing/using OD; Knowledge on actors using OD in existing field versus actors entering new fields and their purposes and knowledge about the types of datasets most published and used, types of actors most involved and types of outputs most produced from OD.

Absorptive Position Capabilities (Seize and Select) ODDCs which recognize the value of new, external information and knowledge, assimilate it, and apply it (Wang and Ahmed 2007) in ODDOs positioning in the OD industry. This capability includes: Seize open (linked) data technological opportunities, OD product/service acquisition; Measure of the centrality in openness in policy; Measure of the centrality of technology and data to government policy and Discovering new sources of OD supply and investment in open (linked) data technology.

Case Studies

To profoundly understand the open data value and dynamic capability framework in practice, this research conducts two case studies (open-ended interview) on both public and private ODDOs in Ireland.

Case Study of Open Data Value Capability Framework: The Case of Xpreso

This section describes findings from the use of the operationalization in Table 2 in investigating the VCs of Xpreso; one of the ODDOs in the downstream sector of the Irish OD Ecosystem. This case is used to validate our value capability framework operationalization and identification of critical factors based on the interviewee's opinion.

Brief Background of Xpreso

Founded on 2013, Xpreso is an open data-driven private organization based in Dublin, Ireland with a focus on communication platform which connects courier drivers with parcel recipients in real-time. The founders of Xpreso consider the business as both the data consumers and the data producers. Xpreso's business model is 'supporting primary businesses' according to the model definition in Zeleti et al. (2014).

Xpreso's Open Data Value Capability Framework

As a starting point, Xpreso attempts to understand fully the capability framework and its purposes. While there are obvious differences between value chain stages, capability areas, and general business value capabilities, to assist Xpreso to understand the capability framework as a whole and each component of the framework in specific, we developed and provided Xpreso a document containing detailed information of the capability framework. In the document, value chain stages, capability areas and general business value capabilities were described. Table 5 shows the Xpreso's open data capability.

Xpreso had four attempts towards completing the capability framework. During the completion of the framework, Xpreso raised some issues regarding the difficulty understanding the framework. About this, the following was expressed and argued by the COO of Xpreso, the interviewee:

> We did find it difficult to populate the cells at each stage in the value chain.

In respect to the components of the capability framework, the interviewee further adds:

> We found it somewhat difficult to differentiate between IT Infrastructure and Technological Infrastructure when filling out the database. Also, we found it difficult at first to fill out details for Individual/Competences for certain value chain stages. Also, while at certain value stages there was a clear division between Organisational competences and Management/Governance competences, at other stages we found it quite difficult to make a decision between the two areas.

Equally important is to note that Xpreso verifies the significance of utilizing the capability framework in open data-driven organizations more especially start-ups in order to generate and capture the real value of data. With reference to this, the interviewee adds:

> The framework allowed us to, for the first time, fully examine the processes required to produce and publish the datasets which we are considering, which helped to greatly clarify the requirements of producing such data. It also allowed us to examine our organization from in terms of the key business areas described in the framework, which we found to be a very useful tool in its own right.

Consequently, Xpreso has never carried out any capability audit before engaging in this research, and they find the capability framework a very useful tool to identify, create, develop and manage open data capabilities.

Table 5 Xpreso's capability framework

	Data Generation	Data Collection, Aggregation and Processing		Data Distribution and Delivery			Final data Use	
	Generating Data	Data Processing	Data Storage & Computing Facilities	Data Release	Providing Access to Data & APIs	Publishing Solution	Data Retrieval	Data Usage
Individual/ competences	App-development, Competency with GPS technology, Ability to produce reliable API, Ability to add GPS recording redundancy	Capability to efficiently process geographical data understanding of GIS, Understanding of OSM data-formats, Ability to aggregate Lat-Lng occurrences, Understanding of Database Architecture	Understanding of Database architecture	Have member of OSM community verify data integrity		Understanding of REST, Understanding of API design	Competency with REST APIs and OSM APIs, Knowledge of Xpreso API implementation specifics	
Business Process	Address data, Parcel data source, Drivers driving around, using tablet-app Driver click on finish button on the app	Geocoding, Parcel data are correlated to GPS data from driver, GPX data used to understand the route of the driver				Data is automatically uploaded to OSM, Postcode data is automatically available through API		
Organization	Drivers must know to finish jobs at the correct address	The GPS aggregation process must be monitored						

(continued)

Table 5 (continued)

	Data Generation	Data Collection, Aggregation and Processing		Data Distribution and Delivery			Final data Use	
	Generating Data	Data Processing	Data Storage & Computing Facilities	Data Release	Providing Access to Data & APIs	Publishing Solution	Data Retrieval	Data Usage
IT Infrastructure	GPS Sensors, Android Tablets for App, Mapping software in- app	Extract traffic data, Database Implementation	We could store in different data system Relational database/ webserver	GPX Data uploaded to OpenStreetMap	API for traffic data, OpenStreetMap automatically provides open access to Geo-Data	Publish documentation for traffic API, Pub lie documentation for Postcode API	Traffic Data REST API, Postcode REST API	Web End
Technologies Infrastructure	GPX traces recorded on app, Record: GPS position of driver finishing job, API receives data from table	GPS Data is correlated with driver territory, GPX traces are cleaned to remove incorrect data, Algorithm required for spotting incorrect data	Relational databas e/ webserver					
Management/ Governance	App must be deployed across full courier, Driver-Trainer must teach drivers correct use	Cleaned data must undergo clerical review				Must ensure that user understand that these APIs are less accurate than commercial alternatives		

Case Study of Open Data Dynamic Capability Framework: The Case of the Marine Institute

This section describes findings from the use of the operationalization in Table 4 in investigating the available DCs and their relative importance at the Irish Marine Institute; one of the major players in the upstream sector of the Irish OD Ecosystem. This case is used to validate our dynamic capability framework operationalization and identification of critical factors based on expert opinion.

Brief Background of the Marine Institute

The Marine Institute is an agency which operates under the aegis of the Department of Agriculture, Food and Marine (DAFM), and the national agency, responsible for undertaking marine research and development that critically informs policy, regulatory objectives, management and sustainable development strategies for Ireland's marine resources. The Marine Institute Act states that the Institute will have the following general functions:

> to undertake, to co-ordinate, to promote and to assist in marine researchand development and to provide such services related to marine research and development that in the opinion of the Institute will promote economic developmentand create employment and protect the environment

The Marine Institute's Open Data Dynamic Capabilities

During the interview with Marine Institute, a variety of ODDCs and identified:

Dynamic Capabilities for Positioning

Adaptive Position Capabilities Marine Institute's DCs include: Searching for existing OD Products and services, technological opportunities, potential government agencies, potential partners for collaboration, skills and expertise necessary, existing interest groups or agencies, future market.

Absorptive Position Capabilities Marine Institute's DCs include: Marine data collection; developing agreement with other government agencies for data services; identifying new technologies, platforms and applications; Identifying skills and expertise required.

Innovative Position Capabilities Marine Institute's DCs include: Producing as much marine data as possible; leading provider of data on marine environment and Data Cataloging in Ireland; Feeds information into making decisions and support growing resources of marine environment; Experts for technologies for provision of online services; Brand recognition; Generate economic activities; Facilitate data to aid other agencies for their decision making.

Dynamic Capabilities for Processes

Adaptive Process Capabilities Marine Institute's DCs include: Searching for existing knowledge from outside organization in order to identify potential processes, OD standards and European directives, linked-data opportunities, data management tools, set of requirements to develop prototypes, best practices around adding value to data and processes, agencies and companies for resource exchange and integration, other potential project resources; aquaculture process opportunities; discovering new online cataloging systems.

Absorptive Process Capabilities Marine Institute's DCs include: Assess and evaluate processes, platforms, and applications in order to define potential tools for adding value to marine data; Adopting new online cataloging systems such as GeoNetwork; assessing and identifying series of best practices (W3C best practices); Open license for Marine Institute; Developing a set of technical requirements and specifications for developing the planned prototype; adopting appropriate data standards such as ISO 19139 (Data Standardization) and ISO 19156 (Observation and Measurements); adopting appropriate European Directives such as OD Standard for Inspire Directive, Standards for Marine Strategy Framework Directive, and Data Standards for Water Framework Directive.

Innovative Process Capabilities Marine Institute's DCs include: Improve marine data management processes; data cataloging; data management processes (using generic marine related Data Models); software development and project management processes; linked marine data; connecting to processes of agencies; develop and enhance internal processes; utilizing defined specification to develop the prototype further; added value to data through new prototype and initiatives such as Ireland's Marine Atlas, Irish Spatial Data Exchange, Ireland's Digital Ocean, Ireland's Marine Renewable Energy Portal and connecting to Ireland's OD Portal; utilizing evaluated tools such as ERDDAP to add value to marine data and enhance data cataloging; Encourage and enhance Marine Institute Data License (existing for 11 years); developing new application that handles standards; developing new application that deliver data to user.

Dynamic Capabilities for Path/Strategies

Adaptive Path Capabilities Marine Institute's DCs include: Searching for smart strategies from potential and influential actors/players and experts in the industry; searching for best practices around strategies in general and data strategies in specific; Seeking new and unique expertise; organize workshops for strategic decision making; Searching for other organization's advanced projects In order to identify new areas and new knowledge.

Absorptive Path Capabilities Marine Institute's DCs include: Assessing and evaluating identified actors/players and experts and connect with them; Developing new expertise; Adopting best possible collaborative approach; identifying and assessing series of best practices that could help organization's expert groups to define strategic areas and decisions; define strategic objectives or areas to tackle during the workshop; assess and evaluate new knowledge gained from existing projects and develop new objectives for organization.

Innovative Path Capabilities Marine Institute's DCs include: Big and leading contributor of environmental data in Ireland; Strengthening marine environment status; Close and constant collaboration with companies and continuously providing them with the data being produced; open and constant communication with expert groups within organization; Working with and in parallel with big Irish players such as Sustainable Energy Ireland and Department of Communication Energy and Natural Resources; Provide high quality support services for marine food safety; use marine data for service area collaborations; acting as one primary communication forum between agencies; directive driven organization; standard driven organization; strengthening the organization brand; high level and educated employees; share capabilities within organization and with other agencies; strengthening the collaborative environment; Organization's expert groups to make smart decisions; adopting OD strategy best practices; moving from 3 (CSV) star to 5 star (linked-data); adopting other organization's strategic best practices; follow and maintain citation strategy; encouraging organization's employees to use best practices for their tasks; making sure all data are of high quality and available online; easy and usable data; more datasets; other project connectivity; always use powerful tools; always be ahead of other agencies; always monitor market; Access resources from other agencies; to grow jobs in sector.

After carefully analysing the interview, in Table 6, we present a set of critical factors for developing ODDCs.

Discussion

Transformation in the market requires the development of capabilities and development of capabilities require the organization to understand them very well. To our understanding, the capability is the ability to perform better than competitors, using a set of organizational attributes that is distinctive and difficult to replicate. Similarly, Brits et al. (2007) highlights that capability is a capacity for a set of resources to interactively perform a stretch task.

Open Data Value Capability Framework

As a basis for clarification, orientation and better understanding of the ODVCs framework, we aim at case study research to explore the framework in practise. Number of organizations was contacted but, we were able to include Xpreso's case

Table 6 Critical factors for developing DCs

		Adaptive Capability	Absorptive Capability	Innovative Capability
MA for downstream organizations	Position	Discovering the OD market niche Discovering and identifying potential collaborators and projects	Developing agreement with other agencies for collaboration and data services Absorption of new technologies, platforms and applications Introducing new OD products or services Developing OD Business Model	Producing as much valuable data as possible Brand recognition Generate economic activities Facilitate data to aid other agencies for their decision making
MA for upstream organizations	Process	Discovering Data Management Tools and Processes, OD online cataloging systems, OD standards and related European Directives, and Linked-Data opportunities Discovering OD best practices Discovering Data Licenses Discovering successful (Relational) Data Models	Define and assess Tools, Processes, Platforms, and Applications to add value to the Data Define and assess appropriate European Directives Define and assess series of best practices Define and assess OD license Define and assess appropriate Data Standards Define and assess appropriate (Relational) Data Model	Adopt Tools, Processes, Platforms, and Applications to add value to the Data Improve Data Cataloging Process and (Relational) Data Model Improve Data Management, Software Development, and Project Management Processes Alliance-based processes Heavily utilize well-known and completed projects for adding more value to the OD product or service and to fasten the customer-supplier communication (Sufficient delivery) Active participation to the Local and National Portals

Applicable for downstream organizations Applicable for upstream organizations	Path/Strategy	Strategic coordination/collaboration (Strategic Alliances) Seeking new and unique data/OD strategic solutions from potential and influential actors/players, successful national and international level projects, and experts in the industry Discovering best practices on data/OD strategies Discovering differentiation strategies	Define strategic objectives through knowledge gained from existing projects, partners and OD products and services Define and assess best possible strategic collaborative approach Assess and evaluate identified actors/players and experts in the field Identify new domain experts Define and assess series of OD strategic best practice Define and assess unique strategy for differentiation	Strengthening the collaborative and communicative environment – Internally and externally (Expert groups, projects, and resources) Educated human resource – Domain specific education Continuously provide available and easy-to-use high quality OD products and services and support Differentiating OD products and services Maintain standard-driven organization status Constantly magnify and strengthen organization's brand Use organization's capabilities to identify areas of collaborations Share capabilities and resources within organization and with other organizations Generating OD strategic best practice out of employed ones Promote and use citation strategy for OD products and services Constantly monitor market for powerful tools

Table 7 Discovered open data value capabilities

Data processing	Data storage and computing facilities	Data release	Data usage
Aggregation process (GPS)	Database architecture	Verifying data integrity	Web-based front-end

in this study. During our various attempts in involving other organizations, we discovered that new and small establishments have difficulty understanding different elements of the framework and that how framework can be used in assisting them in identifying value capabilities while, the framework was fully understood and appreciated by medium to larger organizations as they could relate to all the elements and the integration. In parallel, our experience in engaging organizations specially new and small establishments in this research process show that open data-driven organizations and start-ups also need to be eager and more engaged with the research community in the domain if they want to defeat the challenges of the dynamic market.

Previously in open data and organization literature, no open data value capability framework exist. Therefore, comparison of the developed open data capability framework with similar frameworks is not possible. Therefore, we have sought to analyze this convergence as a form of alignment in which we expect open data value chain to support directly open data value capability framework to shape open data-driven organization value capabilities. *The analysis of the value capability framework and case study research show that value chain stages (data generation; data collection, aggregation and processing; data distribution and delivery; and final data use) extracted from open government data value chain by providing us the baseline to cluster top-level capabilities have significant impact on shaping open data value capabilities.* As the framework can be explored in practice and by open data-driven organizations, new open data value capabilities can emerge that can be useful to other organizations in building their value capabilities (Table 7).

Moreover, we observe that open data-driven organizations out more emphasis on 'generating data', 'data processing' and 'publishing solution' capabilities. This shows that the open data-driven organizations are more eager to develop capabilities which result on generating data, processing data and publishing data. Other open data capability areas receive less attention.

Open Data Dynamic Capability Framework

Despite existing critiques and ambiguities in literature on RBV, DCT and DCs, we have found these three paradigms not as challenging as presented in the literature and we have been able to join them very adequately and generate an easy-to-understand dynamic capability framework taking into an account essentialities of the two theories and the DCs of the organization. The framework can be utilized by all types of organizations specially ODDOs regardless of their size and maturity levels. However, we encountered number of challenges in identifying the critical aspects of the theories and the organizational DCs for addressing the objectives of our study but, relying on our experience and knowledge in the domain, and by utilizing the critical aspects identified, we developed a framework that can address critiques and ambiguities exist in the literature. The framework is applicable for all types of organizations and the application of the framework is fairly simple however, we have number of observations regarding how framework could be more effectively used by organizations.

Positioning Upstream and leading organizations have already positioned themselves in the market. In this regard, defining organizational position in the market is mostly applicable for downstream organizations, new entrants to the industry and small organizations.

Process Development Upstream and leading organizations should constantly seek and discover powerful data management tools, platforms and technologies and reconfigure their existing value-added processes due to the fact that many downstream and small organizations rely on the OD products and services they provide. In this regard, engaging in process configuration and reconfiguration is highly recommended and MA to upstream organizations.

*Strategy Development S*trategy must go hand in hand with processes. Strategy needs to be consistent, coherent, and embrace innovation. While it is necessarily shaped by the legacy of the past, it also shapes the path ahead. Strategy will determine which products to make, which customers to target, how to deploy the organization's resources, what the optimal timing will be, and how to keep competitors at bay. Downstream organizations must develop an effective strategy and renew strategies every often in order to defeat the challenges in the dynamic market, while upstream organizations set long-term strategies.

ODDOs regardless of being at upstream or downstream, need to recognize and utilize the successful experiences or what is so called "best practices" of other organizations. It is very essential to develop a collaborative and communicative environment with other organizations and use organization's capabilities to identify areas of collaborations. In OD industry, being connected to a network of organizations plays a significant role in the success of the organizations in the network as shared resources and capabilities can lead to innovative OD products and services (Zhenbin Yang and Kankanhalli 2013; Conradie and Choenni 2014; Wang and Lo 2015). ODDOs' managers and experts groups should constantly monitor the market for changes in order to move toward the dynamic market and be able to be ahead of the competitors. ODDOs must establish strategies to ensure desired participation rate and those organizational technological and human resources are used in a way that innovative OD products and services are produced. In addition, the ODDOs should increase the number of domain-specific experts as in OD industry, domain knowledge is very vital as many OD products and services are domain specific. However, success happens in an environment with learning, sharing, and collaborating culture.

Conclusion

A number of list of political, social and economic benefits have been associated with the use and impact of OD. The economic aspect of OD has naturally generated a lot of interest resulting in a number of OD business models. In this paper, we developed an OD capability matrix as a tool to support design of OD business capabilities. In addition, the OD Capability Matrix could help the implementation of OD business models. Matrix can assist OD business managers to understand and describe how capabilities should be utilize and extended throughout the OD value chain of the business. As there is no OD capability framework in literature, our OD Capability Matrix provides a significant starting point for OD businesses to plan and develop the requisite capabilities to support their business models. With time, concrete experience from practice will be useful in refining the capability framework.

Regarding future work, our main interest is to develop the framework into a concrete tool (similar to the Business Model Canvas) to support OD practitioners. In this regard, business modelers and managers are encouraged to utilize the Matrix.

From the research perspective, we intend to refine the capability matrix to reflect maturity levels of OD capabilities. To represent the matrix as a modeling technique, a potential future work would be to offer more specific guidelines for designing the matrix. Moreover, we are considering the possibility of generation of OD capability patterns from the OD capability matrix. Another potential future work would be to study how capability driven development approach can support evolving OD businesses and facilitates adjustment of capabilities according to changing context.

References

Alsos GA, Borch OJ, Ljunggren E, Madsen EL (2008) Dynamic capabilities – conceptualization and operationalization. In: The academy of management conference, pp 1–28

Ambastha A, Momaya K (2004) Competitiveness of firms: review of theory, frameworks and models. Singapore Manag Rev 26(1):45–61

Ambrosini V, Bowman C (2009) What are dynamic capabilities and are they a useful construct in strategic management? Int J Manag Rev 11(1):29–49

Ambrosini V, Bowman C, Collier N (2009) Dynamic capabilities: an exploration of how firms renew their resource base. Br J Manag 20(SUPP. 1):1–41

Arnold E, Thuriaux B (1997) Developing firms' technological capabilities

Augier M, Teece DJ (2007) Dynamic capabilities and multinational enterprise: Penrosean insights and omissions. Manag Int Rev 47(2):175–192

Augier M, Teece DJ (2009) Dynamic capabilities and the role of managers in business strategy and economic performance. Organ Sci 20(2):410–421

Avital M, Bjorn-Andersen N (2012) The value of open government data: a strategic analysis framework. In: SIG eGovernment pre-ICIS workshop, no. 2002

Bharadwaj AS (2000) A resource-based perspective on information technology capability and firm performance: an imprical investigation. MIS Q 24(1):169–196

Bhatt GD, Emdad AF (2001) An analysis of the virtual value chain in electronic commerce. J Enterp Inf Manag 14(1):78–84

Bhatt GD, Emdad AF (2005) An analysis of the virtual value chain in electronic commerce. Logist Inf Manag 14(1):78–85

Bhatt GD, Grover V (2005) Types of information technology capabilities and their role in competitive advantage: an empirical study. J Manag Inf Syst 22(2):253–277

Brazilian National Council for Scientific and Technological Development (BNCSTD) (2011) The relationship between technological capability and firm performance in an emerging economy, Rio

Brits J-P (2006) Conceptual framework for modeling business capabilities. Tshwane University of Technology

Brits J, Botha GHK, Herselman ME (2007) Conceptual framework for modeling business capabilities. In: Proceedings of the 2007 informing science and IT education joint conference conceptual

Büchel B, Sorell M (2012) Assessing your adaptive capability: Where do you 'stand out' within your industry

Cepeda G, Vera D (2007) Dynamic capabilities and operational capabilities: a knowledge management perspective. J Bus Res 60(5):426–437

Conradie P, Choenni S (2014) On the barriers for local government releasing open data. Gov Inf Q 31:S10–S17

Daniel EM, Wilson HN (2003) The role of dynamic capabilities in e-business transformation. Eur J Inf Syst 12(4):282–296

de Vries M (2012) 14 years of PSI policy and its impact. In Madrid conference, February

den Hertog P, van der Aa W, de Jong MW (2010) Capabilities for managing service innovation: towards a conceptual framework. J Serv Manag 21(4):490–514

Easterby-Smith M, Prieto IM (2008) Dynamic capabilities and knowledge management: an integrative role for learning? Br J Manag 19(3):235–249

Eisenhardt KM, Martin JA (2000) Dynamic capabilities: what are they? Strateg Manag J 21(10–11):1105–1121

Ferro E, Osella M (2013) Eight business model archetypes for PSI re-use, London

Finne T (1997) Information security implemented in: the theory on stock market efficiency, Markowitz' s portfolio theory and porter' s value chain. Comput Secur 16(May 1967):469–479

Gheysari H, Rasli A, Roghanian P, Jebur H (2012) The role of information technology infrastructure capability (ITIC) in management. IJFPSS 2(2):36–40

Griffith DA, Harvey MG (2013) A resource perspective of global dynamic capabilities. J Int Bus Stud 32(3):597–606

Guidoin S The value of open data

Hallgren M (2007) Manufacturing strategy , capabilities and performance. Linköping University, Linköping

Helfat CE, Peteraf MA (2003) The dynamic resource-based view: capability lifecycles. Strateg Manag J 24(10):997–1010

HM Government (2013) Seizing the data opportunity: a strategy for UK data capability, UK

Jaques E, Stamp G (1995) Level and type of capability in relation to executive organization, Brunel

Julien N (2012), Business opportunities arising from open data policies. Imperial College London

Keller W (2010) Using capabilities in enterprise architecture management, Lochham

Mata FJ, Fuerst WL, Barney JB, Mata BFJ (2013) Information technology and sustainable competitive advantage: a resource-based analysis. MIS Q 19(4):487–505

Mithas S, Ramasubbu N, Krishnan MS, Sambamurthy V (2009) Information technology infrastructure capability and firm performance: an empirical analysis, Michigan

Moller KEK, Torronen P (2003) Business suppliers' value creation potential: a capability-based analysis. Ind Mark Manag 32:109–118

Musings J (2012) Open data business models. [Online]. Available: http://www.jenitennison.com/blog/node/172

Oliveira P, Roth AV, Gilland W (2002) Achieving competitive capabilities in e-services. Technol Forecast Soc Chang. 69:721–739

Osterwalder A (2004) The business model ontology: a proposition in a design science approach, UNIVERSITE DE LAUSANNE ECOLE
Pant S, Hsu C (1996) Business on the web: strategies and economics. In: Fifth international world wide web conference
Porter ME (1985) Competitive advantage: creating and sustaining superior performance. Free Press, New York
Rai A, Patnayakuni R, Seth N (2006) Firm performance impacts of digitally supply chain integration capabilities. MIS Q 30(2):225–246
Rayport JF, Sviokla JJ (1995) Exploiting the virtual value chain. McKinsey Q
Rojas LAR, Lovelle JMC, Tarazona GM, Montenegro CE (2013) Open data as a key factor for developing expert systems: a perspective from Spain. Int J Interact Multimed Artif Intell 2(2):51
Rouse MJ, Ziestma C (2008) Responding to weak signals: the emergence of adaptive dyanmic capabilities for strategic renewal. In: The international conference on organizational learning, knowledge and capabilities, pp 1–23
Steiner S, Abraham B, Mackay J (1997) Understanding process capability indices, Waterloo
Symphony Technologies Pvt Ltd, Measuring Your Process Capability, India
Tanriverdi H (2005) Information technology relatedness , knowledge management capability , and performance of multibusiness firms. MIS Q 29(2):311–334
Teece DJ (2007) Explicating dynamic capabilities: the nature and microfoundation of (sustainable) enterprise performance. Strateg Manag J 28(August):1319–1350
Teece DJ (2014) A dynamic capabilities-based entrepreneurial theory of the multinational enterprise. J Int Bus Stud 45(1):8–37
Teece D, Pisano G (1994) The dynamic capabilities of firms: an introduction. Ind Corp Chang 3(3):537–556
Teece DJ, Pisano G, Slwen A (1997) Dynamic capabilities and strategic management. Strateg Manag J 18(7):509–533
Townsend P, Cairns L (2003) Developing the global manager using a capability framework. Manag Learn 34(3):313–327
Ubaldi B (2013) Open government data: towards empirical analysis of open government data initiatives, 22
University of Cambridge (2016) Porter's Value Chain. University of Cambridge. [Online]. Available: http://www.ifm.eng.cam.ac.uk/research/dstools/value-chain-/
Verworn B, Herstatt C (2002) The innovation process: an introduction to process models, 12
Vivas López S (2005) Competitive advantage and strategy formulation: the key role of dynamic capabilities. Manag Decis 43(5):661–669
W3C Brazil (2012) Open government data value chain, Brussels
Walters D, Rainbird M (2007) Cooperative innovation: a value chain approach. J Enterp Inf Manag 20(5):595–607
Wang CL, Ahmed PK (2007) Dynamic capabilities: a review and research agenda. Int J Manag Rev 9(1):31–51
Wang H, Lo J (2015) Adoption of open government data among government agencies. Gov Inf Q.
Weerawardena J, Mort GS, Liesch PW, Knight G (2007) Conceptualizing accelerated internationalization in the born global firm: a dynamic capabilities perspective. J World Bus 42(3):294–306
Wernerfelt B (1984) A resource based view of the firm. Strateg Manag J 5(2):171–180
van den Broek T, Rijken M, van Oort S (2012) Towards open development data
Xia W, King WR (2002) Determinants of organizational IT infrastructure capabilities: an empirical study
Zeleti FA, Ojo A (2014) Capability matrix for open data. In: 15th IFIP working conference on virtual enterprises.
Zeleti FA, Ojo A, Curry E (2014) Business models for the open data industry: characterization and analysis of emerging models. In: 15th annual international conference on digital government research

Zhenbin Yang, Kankanhalli A (2013) Innovation in government services: the case of open data. IFIP Adv Inf Commun Technol 402:644–651

Zuiderwijk A, Janssen M, Poulis K, van de Kaa G (2015) Open data for competitive advantage: insights from open data use by companies. In: Proceedings of the 16th annual international conference on digital government research (dg.o 2015), pp 79–88

Fatemeh Ahmadi Zeleti is a researcher at the e-Government unit at the Insight Centre for Data Analytics @ National University of Ireland Galway (formerly Digital Enterprise Research Institute (DERI) – a leading center in Semantic Web and Linked Open Data research). At the Insight Centre, her research and development work addresses capabilities for open data-driven organizations and how business (for-profit and nonprofit) entities can effectively leverage [Linked] Open [Government] Data for optimizing business processes and product and service innovation. In 2016, her research results have been selected as the best practice to address and achieve European PSI Directive (2003/98/EC). She is the moderator of the World Bank Open Data Innovation Network and an active member of the Swedish Research Network in e-Government and Immigration Policy 2.0.

Dr. Adegboyega Ojo is Senior Research Fellow at the Insight Centre for Data Analytics, National University of Ireland Galway (NUIG). He leads the E-Government Group at Insight Centre, serves as Adjunct Lecturer at the College of Engineering and Informatics. His current research interests include data driven innovations in government, Open data policies and Infrastructures, data analytics and governance of smart cities. He is member of the Editorial Boards of the Government Information Quarterly and International Journal of Public Administration in the Digital Age.

Water Analytics and Management with Real-Time Linked Dataspaces

Umair ul Hassan, Souleiman Hasan, Wassim Derguech, Louise Hannon, Eoghan Clifford, Christos Kouroupetroglou, Sander Smit, and Edward Curry

Abstract Due to predictions of water scarcity in the future, governments and public administrations are increasingly looking for innovative solutions to improve water governance and conservation. The problem is exasperated due to low levels of awareness about water consumption among the general public. This calls for a holistic approach to effectively manage resources during all stages of water usage. Implementation of such an approach heavily relies on advanced analytics technologies that combine data from different sources to enable decision support and public engagement. The next-generation of water information management systems must overcome significant technical challenges including integration of heterogeneous and real-time data, creation of analytical models for diverse users, and exploitation of ubiquitous devices to disseminate actionable information. This chapter presents a new approach for water analytics in public spaces that is built upon the fundamental concepts of Linked Data technologies. The chapter also presents a concrete realization of the Linked Data approach through the development of water analytics applications for buildings in public educational institutions.

U. ul Hassan • S. Hasan • W. Derguech • E. Curry (✉)
Insight Centre for Data Analytics, National University of Ireland Galway, Galway, Ireland
e-mail: umair.ulhassan@insight-centre.org; souleiman.hasan@insight-centre.org; wassim.derguech@insight-centre.org; ed.curry@insight-centre.org

L. Hannon • E. Clifford
College of Engineering & Informatics, National University of Ireland Galway, Galway, Ireland
e-mail: louise.hannon@nuigalway.ie; eoghan.clifford@nuigalway.ie

C. Kouroupetroglou
Ultra4, Thessaloniki, Greece
e-mail: kouroupetroglou@ultra4.eu

S. Smit
BM-Change, Eindhoven, The Netherlands
e-mail: sander@bm-change.nu

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_7

Introduction

One of the sustainable development goal set out by the United Nations, as part of its agenda for 2030, is to ensure availability and sustainable management of water and sanitation for all (General Assembly, United Nations 2015). Furthermore, recent projections by the Organization for Economic Cooperation and Development estimate that more than 40% of the world's population will be living in areas under severe water stress by 2050 (OECD 2012). This problem is expected to worsen due to a high global demand for water from manufacturing, thermal electricity generation and domestic use. Commercial uses of water are depleting the world's freshwater supply in both quantity and quality. A key factor contributing towards scarcity of water is the historical belief that water is not a vital resource that needs to be managed. Nonetheless, a recent study has highlighted the effects of water scarcity on economic growth (Hertel and Liu 2016). The same study also recommends conserving water through increased efficiency in existing uses. This underlines a significant opportunity for research and development of ICT tools to raise awareness, improve management, and increase conservation of water (Pereira et al. 2003).

In order to manage water holistically, it is important to use decision support tools that present meaningful and contextual information about usage, pricing, and availability of water in an intuitive and interactive way. Different users have different information requirements to manage water, from home users managing their personal water usage, business users managing the water consumption of their commercial activities, to municipalities managing regional distribution and consumption at the city level. In order to develop water information services for such diverse users, it is necessary to leverage knowledge from across a number of different domains, including metering, collection and catchment management, environmental, water quality, energy usage, utility information, end-user feedback, occupancy patterns, meteorological data, etc. However, many barriers exist to interoperability across domains and there is little interaction between these islands of information. The design of next-generation water information management systems poses significant technical challenges in terms of information management, integration of heterogeneous data, and real-time processing of dynamic data.

Linked Data technology leverages open protocols and W3C standards for sharing structured data on the Web. In this chapter, we discuss the use of Linked Data as an enabling technology for water data services. The objective of this approach is to create an integrated well-connected *Real-time Linked Dataspace* (Franklin et al. 2005; Heath and Bizer 2011) of information relevant to managing water in public spaces. Representing water usage data within the Linked Data format makes it open; thus, allowing it to be easily combined with data from other relevant domain silos. This chapter describes the fundamentals of the Linked Data approach for water data services (Curry et al. 2014); in addition, it details a concrete implementation of this approach for water analytics in public spaces. Section "Motivation" motivates the need for contextual water information management. Section "Linked Data for Water Information Integration" introduces the main concepts of the Linked Data approach.

Section "Linked Real-time Dataspace for the Waternomics Project" details the architecture developed for enabling this approach, in the context of Waternomics project. Section "Water Management in Public Spaces" describes the pilots used for testing and validation of proposed approach. Section "Realization of Waternomics Platform" details the water management applications designed a university building and a school. Section "Related Work" discusses related literature and section "Summary" provides a brief summary of this chapter.

Motivation

Sustainability requires information on the use, flows, and destinies of energy, water, and materials including waste, along with monetary information on environmental costs, earnings, and savings. This type of information is essential if we are to understand the causal relationships between the various actions that can be taken, and their impact on sustainability. However, the problem is broad in scope, and the necessary information may not be available, or difficult to collect. Within the context of water management, improving the sustainability of water consumption, especially through changing the way a household, organization, or city operates (Curry and Donnellan 2012). This requires a number of practical steps that will include the need for a systematic approach for information-gathering and analysis.

Contextual Water Management

One of the key problems of modern water management systems is the lack of data management and decision support tools that present meaningful and personalized information about usage, pricing, and availability of water in an intuitive and interactive way to end-users. This introduces limitations in the efforts to manage water as a resource, including:

- **User Awareness**: End-users do not have access to water information (i.e. availability, consumption, and pricing) at the moment water consumption decisions are being taken.
- **User Incentives**: Due to billing, pricing, awareness, or metering aspects, end-users may not have an incentive to change their behavior.
- **Integrated Information Provision & Analysis**: Decision makers do not have access to information platforms to make organizational changes. Personalized water information can only be created by combining publicly available water data with private water usage data that is only available to water service providers.
- **Benchmarking**: End-users do not know if their individual water consumption pattern is high or low compared to others.

Water Footprint and Water Information Ecosystems

The demand for business transparency is driving multinational companies towards more holistic assessments of their water footprint and associated impact. By understanding all the freshwater sources and uses related to a business or a product, decision-makers can identify environmentally conscious and programmatic changes to reduce their freshwater impact or footprint. Water footprint assessments are emerging concepts that require obtaining water data from many participants within an organization's supply chain. Numerous data sources can be used for this purpose, including weather data, geo-location data, historical records, product usage data, user behavior habits, etc. There is no single source to provide such data and a considerable number of different data sources must be integrated to collect the information necessary to generate an accurate water footprint. In short, successful management of water data requires consideration of all sources of water consumption, including indirect ones, augmented with water network distribution information.

Linked Data for Water Information Integration

Information integration projects typically focus on one-off point-to-point integration solutions between two or more systems in a customized but inflexible and ultimately non-reusable manner. The fundamental concept of Linked Data is that information is created with the mindset of sharing and reuse. Linked Data leverages open protocols and W3C standards, emerging from research into the Semantic Web, for sharing structured data on the Web. It proposes an approach for information interoperability based on the creation of a global information space. Linked Data has the following advantages:

- Separate systems that are designed independently can be later linked at the edges.
- Interoperability is added incrementally when needed and where it is cost effective.
- Data is expressed in a mixture of vocabularies.

Linked Data is facilitating the publishing of large amounts of structured data on the web. The resulting interlined data can be considered as a Web scale dataspace supported by the Semantic Web technologies. The *Linked Open Data*[1] represents a large number of interlinked datasets that are being actively used by industry, government, and scientific communities. Linked Data promotes four basic principles for exposing, sharing and connecting data. The first principle encourages the use of *Uniform Resource Identifiers* (URIs[2]) for naming things. The second principle

[1] http://lod-cloud.net/

[2] https://tools.ietf.org/html/rfc3986

recommends the use of *Hyper Text Transfer Protocol* (HTTP[3]) for URIs, so that data can be retrieved from names using standard protocols. The third principle promotes the use of standard web formats, such as the *Resource Description Framework* (RDF[4]) or the *JavaScript Object Notation* (JSON-LD[5]), for making data available through URIs. The fourth principle encourages contextualization of data by providing links to other related URIs, thus creating a data network. Within the context of water analytics, following these principles enables standardized access and supports interoperability for applications that aim to exploit water information.

Linked Real-Time Dataspace for the Waternomics Project

The goal of the *Waternomics*[6] project is to provide personalized and actionable information about water consumption and water availability to households, companies, and cities in an intuitive and effective manner at a time-scale that is relevant for effective decision making (Curry et al. 2014). Access to such information will increase end-user awareness and improve the quality of the decisions regarding water management and governance. Waternomics accomplishes this by combining water usage related information from various sources and domains to offer water information services to end-users. The Waternomics platform enables sharing of water information services across different groups of users by providing a convergence layer on top of existing water infrastructures with minimal disruption. The objective is to expose the data within existing systems, but only linking the data when it needs to be shared. Representing water usage data within the Linked Data format makes it open; thus, allowing it to be easily combined with data from other relevant domains.

Architecture

The main components of the envisioned architecture, as illustrated in Fig. 1, are the data sources of water usage on existing metering systems, a dataspace consisting of Linked Data, a set of support services, and the resulting applications for water management.

- **Water Metering**: At the bottom of the architecture are the operational and legacy information systems. Adapters perform the "RDFization" process, which transforms multiple formats and legacy data to lifts it to the dataspace. Linked Data principles play a crucial part here since they enable interoperability a cross-linking

[3] https://tools.ietf.org/html/rfc2616
[4] https://www.w3.org/RDF/
[5] http://json-ld.org/
[6] http://www.waternomics.eu

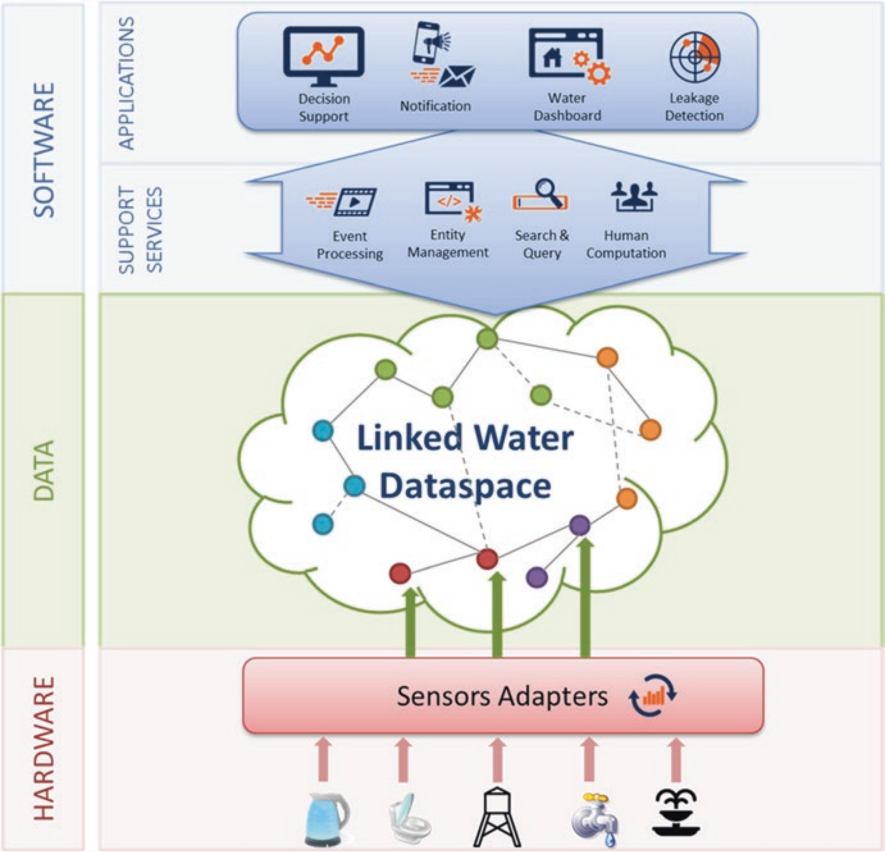


Fig. 1 The Waternomics platform

of water information across different sensors. Furthermore, this RDFization enables contextualization of local water information with the openly available Linked Data such as geographical and meteorological information.

- **Data Integration**: The Linked Data integrates at the information-level (data), instead of at the infrastructure-level (system), by focusing more on the conceptual similarities (shared understanding) between information. The resulting Realtime Linked Dataspace is rich with knowledge and semantics about water usage performance indicators and forms the basis for real-time water usage analytics and other applications with the help of support services. A key aspect of integration based on Linked Data principles is the re-use or mapping of existing vocabularies and ontologies for describing water data, thus facilitating semantic linkage within and beyond the dataspace.
- **Dataspace Support Services**: The support services are designed to simplify the consumption of the Real-time Linked Dataspace by encapsulating common services for reuse (e.g. search and query, entity management, event processing, etc.). These

support services exploit Linked Data technologies and provide additional tools for aggregation, analysis, and improvement of basic data gathered through water metering. Furthermore, these services enrich the aggregated data for complex analytical queries. The primary purpose of these services is to provide Application Programmable Interfaces (APIs) over the dataspace that can be re-used by application developers.
- **Water Analytics Applications**: At the top of the architecture are the water usage and management applications that consume the resulting data and events from the Real-time Linked Dataspace. These applications not only consume the information from the dataspace but also generate user-friendly views over the underlying data.

The support services play a crucial role in realization and exploitation of the Real-time Liked Dataspace. These services include but are not limited to:

- **Search & Query Service**: The query service concerns the technical aspects of enabling access to the data in the Real-time Linked Dataspace through structured queries or RESTful API calls. The query service also enables low latency data analysis. The search service provides keyword-based lookup queries over underlying data sources and their descriptions. The objective of such a service is to help developers and applications in a situation when their queries are not well-defined.
- **Entity Management Service**: This service provides a catalog that serves as the central registry of entities, datasets, and data sources. Within the catalog, all water related datasets, entities, and other sources of information are declared along with their descriptions. This includes a) the list of entities such as sensors or locations that are important for understanding water data and b) open data sources that are relevant to water management such as weather observation stations or forecast services. Besides the APIs and query endpoints provided by the individual data sources, the catalog also provides queries services over the descriptions of entities and datasets.
- **Event Processing Service**: The event processing service allows automatic matching of events similar to users defined rules based on a semantic model for water management. Thus, it simplifies the task of water sensor management. It allows the system to go up early, while administrators can add more meta-data for sensor management in a pay-as-you-go manner (Derguech et al. 2015; Hasan and Curry 2014; Hasan et al. 2013b).
- **Human Computation Service**: The support services, as described above, are primarily focused on providing management tools and programmable access to the constituent information of the Real-time Linked Dataspace. These services are further complemented with a human computation service that is concerned with the collaborative aspect of data management (Ul Hassan et al. 2013, 2016). Essentially, it allows small tasks for data management to be distributed among people who are willing to participate in the dataspace management and improvement process (Ul Hassan et al. 2012). The same service is further utilized for spatial tasks of data management in public spaces (Ul Hassan and Curry 2016).

Water Management in Public Spaces

One of the distinguishing aspects of the Waternomics project is its wide variety of end-users. Waternomics has four pilot sites to test and validate its research activities, data platform, and applications. The pilot sits represent use cases of water management in public spaces, as summarized in Table 1.

Linate Airport

The Linate Airport pilot targets corporate users that are staff members of the airport including building managers, technicians, and engineers. These are adult users that have an advanced level of education and skills to work in such environment. Besides staff members of the airport, target users also include passengers that range from a wide variety of casual to business travelers from different age groups from kids to adults.

Linate Airport is deeply embedded in the urban belt of the city of Milan in Italy. It has a total area of approximately 350 hectares. The airport clientele is predominantly passengers on particular national and international particular routes. In 2012, the Linate airport has operated for 6.3% of the passengers, and 2.2 % of the goods in transit through Italian airports. The airport has two runways for landing and take-off. The first runway (2442 m long) is intended for commercial aviation and the second runway (601 m long) is intended for general aviation. The airport aprons, ramps, and parking stands allow for the simultaneous parking of 46 aircraft. The passenger terminal extends over five levels with a total area of about 75,000 m^2 (of which about 33,000 m^2 are open to the public). The terminal is equipped with 71 check-in counters and 24 gates, five of which serve as a loading bridge. Approximately 21% of the area open to the public is dedicated to commercial activities (shops, restaurants, bars, car rentals, banking services, post offices, branches of public services) and 7.5% to the services provided by airlines (check-in, ticketing).

Given the complexity of an airport, a key aspect of this pilot site has been the cooperation with the company that operates the airport. In particular, information on commercial activities and information on key water consumers within the airport, as well as the water and wastewater infrastructure, have been readily made available.

Table 1 Summary of pilots for the Waternomics project

Pilot	Usage	User Groups
Linate Airport	Corporate	Corporate Staff, Travelers, Shop Owners
Municipality of Thermi	Domestic	Families
NUIG Engineering Building	Public	Building Managers, University Staff, and Students
Coláiste na Coiribe School	Public	Building Managers, School Staff, and Students

Municipality of Thermi

The pilot concerning the Municipality of Thermi in Greece targets domestic users. Families are the primary users including children, young adults, and adults. The Municipality of Thermi is situated in the eastern area of the prefecture of Thessaloniki, at a distance of 15 km from the metropolitan center of Thessaloniki.

The Municipality of Thermi consists of 14 communities with Thermi being the seat of the Municipality, covering an area of 38.34 hectares. The total population of the Municipality of Thermi is 53,070 according to the census in 2011; however, the actual population is now estimated at 70,000.

The main land use in the area is agriculture; however, land use is changing with more land being dedicated to various types of buildings and infrastructure. Thermi has a strong developmental relationship with an urban area located in close proximity: the Thessaloniki Urban Agglomeration (TUA). It is a rapidly growing and economically viable zone, which is developed as a residential expansion of the TUA, but also as a pole for the location of industrial plants, tertiary sector activities, and highly specialized services, maintaining, at the same time, the characteristics of a developed suburban agricultural economy. At the southeast part of the settlement, there is a planned area of soft manufacturing activities. Finally, there are some large land property areas, such as the military installations, the airport, the American Farm School and the buildings of Aristotle University of Thessaloniki (AUTH), which cover a significant amount of land in the area.

For the purpose of water management pilot, a selection of 10 households was made. These households were selected so that they represent a wide variety of types of houses and families in order to examine the effects of different types of domestic users.

NUIG Engineering Building

The pilot in National University of Ireland Galway (NUIG) targets staff members (including managers, technicians, and researchers) and students (including undergraduates and postgraduates). While staff members are interested in understanding water usage behaviors and detecting saving opportunities, students are interested in visualizing the building consumption and water consumption data in their projects and research works. The age groups of this pilot site range from young adults to adults. NUIG is one of the Ireland’s national universities, founded in 1845, it is ranked among the top 2% of universities in the world. Located in the city of Galway (population 70,000 approximately) on the west coast of Ireland, NUIG has more than 17,000 students and 2500 staff. The Engineering Building at NUIG is a state of the art educational facility designed to be a “living laboratory” where the building itself is an interactive teaching tool. The Engineering Building opened in 2011; it is the largest engineering building in Ireland and includes lecture halls, classrooms, offices, laboratory facilities, a café, showers, and bathrooms. The building accommodates approximately 1100 students and 100 staff on four floors (in 14,000 m^2 of floor space). The majority of students are undergraduates aged 18–24 years.

Coláiste na Coiribe School

Similar to the university, a secondary school in Galway has both staff members and students as target users. The main difference is the age groups of users which range from kids to adults on this site. Coláiste na Coiribe (CnaC) is an Irish language secondary school with approximately 350 students and 25 teaching and administrative staff. The existing school is housed at a small location in the city center. To facilitate the demand for places at the school and to address space pressures, a new school (7400 m^2) was under constructed at a suburban location in Galway.

This new school building serves as a pilot for Waternomics. The new school accommodates up to 720 students (aged 12–18) and includes classrooms, offices, sports halls and associated toilet and shower facilities. As the school was identified as a suitable pilot site at the early stages of construction it provided an opportunity for the Waternomics project team to engage with the designers and contractors in the deciding on the provision of water metering and water information infrastructure for the building. In addition, it provided a unique opportunity to monitor this new building from the beginning of its occupation.

The new school building opened in October 2015, it facilitated engagement with students at an early age regarding water consumption behavior. Furthermore, these students tested and gave feedback to the project on how the platform functions in communicating complex water-related data to a wider audience. The collaboration between the school and the Waternomics project resulted in students actively providing inputs to the project (e.g. user interface design, applications etc.). The school management faces key budgetary and conservation targets; to date reporting on water and associated energy consumption has been very limited. The pilot informs future design of similar buildings with a particular focus on water conservation measures and rainwater harvesting systems.

Realization of Waternomics Platform

In this section, we provide a concrete realization of the Real-time Linked Dataspace using the tools and techniques discussed in previous sections. We have implemented the dataspace, for the Waternomics project, as a realization of the Lambda architecture. The Lambda architecture was introduced with the aim of allowing seamless ingestion and processing of streaming events data (Yang et al. 2014). It consists of three layers: the batch layer deals with processing of large quantities of historical data, the speed layer processes real-time data to minimize latency, and the serving layer provides combined query access to data from other two layers. Our implementation departs from the original Lambda architecture due to the central role of catalog service in the

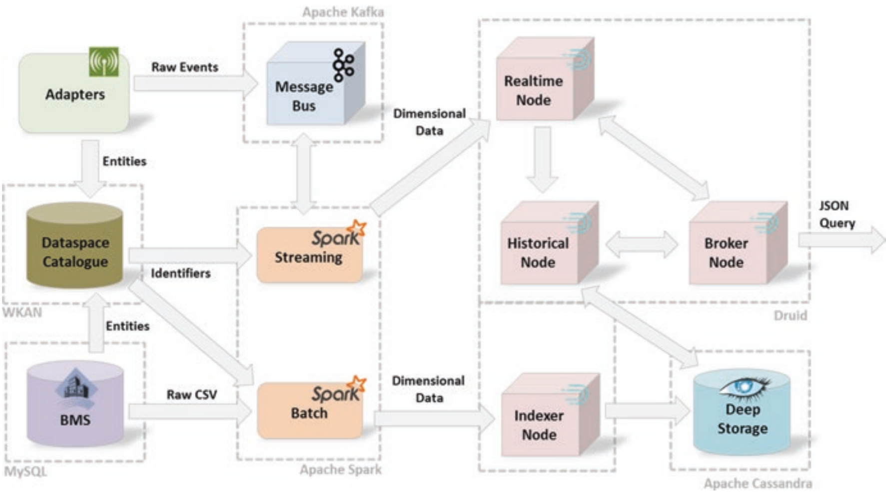


Fig. 2 Lambda architecture realization of the Real-time Linked Dataspace for the Waternomics project

implementation of the batch, speed, and serving layers. The support services in the dataspace are mainly implemented through customization of following open source software: Druid, Apache Spark, MySQL, Apache Kafka, and Apache Cassandra.

Figure 2 shows the data from a building management system (BMS) and water sensors in the Galway pilot being processed in the dataspace. All data sources and entities are defined in the catalog (WKAN) . The batch layer is implemented using Spark SQL when historical data from BMS is fed into the indexer node of Druid. Real-time data from sensors is fed into the Kafka message broker, which provides a high availability integration point for speed layer data from the different pilots. Real-time data from Kafka is processed through Spark Streaming to a real-time node of Druid. The combined code from Spark Streaming and Spark SQL provides a standardized way of generating dimensional data that is served using the Druid cluster. The Druid nodes use Cassandra as deep storage for historical data. The batch data is made available through the historical node and streaming data is made available through the real-time node. Periodically, the streaming data is pushed to the historical node as new data arrives. The broker node of Druid seamlessly exposes batch data and real-time data, without the need for writing queries for real-time and batch data separately.

Data Sources and Open Data

The pilots in the Waternomics project aim to collect both real-time and historical data for water management. For instance, the NUIG and CnaC pilots include following data sources for large buildings.

- Historical and batch data from building management system
- Real-time data from ultrasonic water sensors

A set of relevant open datasets for both pilot sites are included in the Waternomics catalog:

- Open data from weather prediction and observation services
- Public calendar data used by analytics services for distinguishing between water consumption in working days and holidays.
- Drought data in Ireland
- Updates from Irish Water services

All of the above-mentioned data sources joined the real-time dataspace for NUIG and CnaC pilots through definition in the WKAN catalog. Figure 3 shows a list of datasets for the NUIG pilot. It shows summary meta-data for each dataset in the form of tags and description. Users can select a data source to reveal further meta-data which includes the location of data. As a convention, all datasets for historical and real-time data from sensors of pilots are tagged as private. This way there associated meta-data is only visible to authorized users. By comparison, open data sets are defined as public datasets which can be used by everyone.

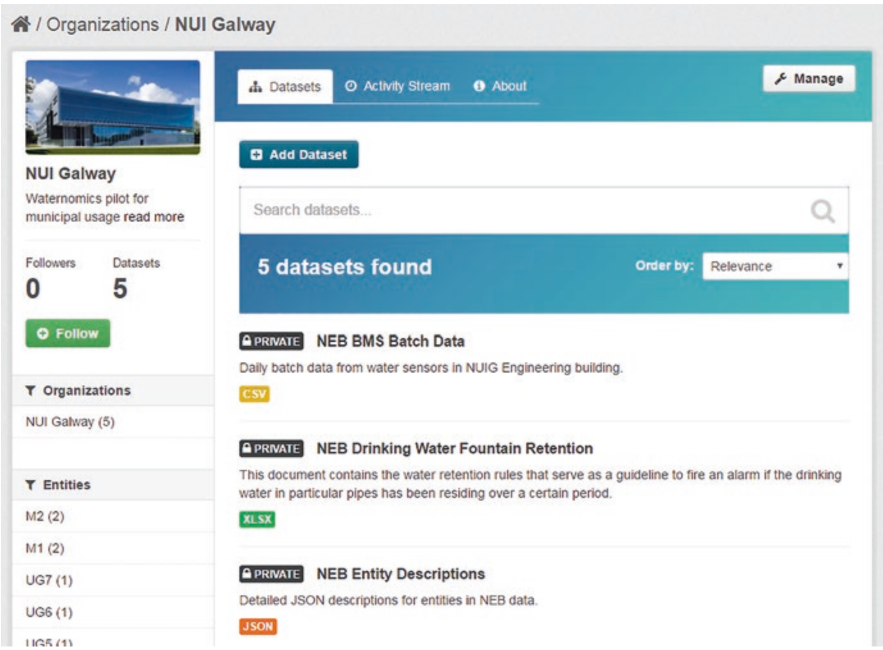


Fig. 3 Datasets and data sources in the WKAN catalog for the NUIG pilot

Applications

The applications that may be built on top of Waternomics dataspace are diverse; they include water awareness dashboards, decision support for the different targeted users (i.e. domestic users, organizations, cities), and water availability/forecasting, dynamic pricing, and water footprints.

- **Water awareness**: Low comprehension of water flows by users and over usage is one of the biggest causes of water wastage. A lack of awareness on the amount of water consumed leads to the lack of incentives to monitor and affect the situation. Water awareness requires different information for household, company, and city level, and where different decisions are taken to manage water on these levels. Therefore, water awareness dashboards need to be tailored to different needs of different water usage levels. The data collected by smart water meters is enriched with contextually Linked Data and processed in real-time; hence, allowing for deeper data analysis and faster reactions.
- **Water consumption**: Hydro-meteorological forecasts predict natural demand and supply of water and can be used to prepare and adjust water supply. Forecasting systems can achieve different goals depending on the level of the system deployment. At the household level, forecasts include analysis of occupants' behavior and water consumption based on similar historical water usage. These forecasts can be incorporated into dashboards and used as the drivers for water saving goal. Forecasting models can further leverage Linked Open Data at the neighborhood or city-level. At the company-level forecasts similar to those of the household level are also augmented by models or simulations of the water needs of subsystems within the organization. Linked Data can be used to perform benchmarking between similar organizations to identify areas of potential water optimization.
- **Water education**: Understanding the impact of a product or service requires an analysis of all potential water consumption associated with its entire lifecycle. For instance, a water footprint of a product would provide a quantitative cradle-to-grave analysis of the product/services global water costs (i.e., water used in raw materials extraction, through materials processing, manufacture, distribution, use, repair and maintenance, electricity generation, and disposal or recycling). Building a water footprint requires the gathering of water data from many participants within the supply chain. Linked Open Data can be a key enabler for the development of a global information ecosystem of water footprint inventory data on products, services, and organizations.

In the following, we present a set of applications developed for the NUIG Engineering Building and the CnaC School. Since both pilot sites have many commonalities, they share two main applications: the Public Display and the Manager Dashboard. Table 2 presents an overview of the applications developed in terms of their objective and target user groups.

Table 2 Mapping of applications against objectives and user groups

	Public Display	Manager Dashboard	Water Retention Time Observer	Observatories Control Panel	Wearable Info-centre	Goal-oriented Accessing Water
Objectives of Applications						
Increase Water Awareness	✓	✓	✓	✓	✓	✓
Reduce Water Consumption				✓		✓
Promote Water Education	✓					
User Groups in University						
President		✓	✓			
Building Services Manager		✓	✓	✓		
Chief Technical Officer		✓	✓	✓	✓	
Consultants/ Contractors		✓				
Technicians		✓	✓	✓	✓	
Staff/ Lecturers	✓		✓			✓
Researchers (PG/PD)	✓		✓			✓
Students	✓		✓			✓
User Groups in School						
School Principal		✓		✓		
Building Contractor		✓		✓		
Teachers	✓					
Students	✓					

Public Display

A key objective for both pilot sites in Galway was to increase water usage awareness in public spaces. Towards this objective, setup of a kiosk with an interactive dashboard can help attract people and engage them with discovering water usage details of their building. A public dashboard is a web application that shows generic information of the site's water consumption as compared with social norms; in addition, it displays information related to consumption per student, toilet flushes per day, etc.

Fig. 4 Public Display showing water data from the NUIG Engineering Building

The web application developed for Galway pilots, as shown in Fig. 4, serves as a communication medium to display the amount of water being consumed in various parts of the building. This application shows volumetric values of water usage in other dimensions such as cost, metaphors, and footprints. The image on left side of Fig. 4 shows the amount of water in terms of the number of standard size of water cooler bottles. This application visualizes water quantities in circles using colors to indicate if the water usage is high or low. This application also uses social media to inform users about the technology used within the Waternomics project, and its updates. Users can interact further with the application to explore the water usage data over a full month; furthermore, they can get more details about technologies used within the Waternomics project.

The public dashboard application uses the Water Analytics Support Service for querying the data from the dataspace. This service has been extended to serve as an extension of the public dashboard and allow users to explore further the water data by scanning QR codes near the sensors. As shown in Fig. 5, users are able to visualize the entire month's consumption. This extension aims to support students and researchers who can retrieve the data from this service via its API to use in their research projects.

Manager Dashboard

Managers in the NUIG Engineering Building and CnaC school are interested in watching the consumption at different points of the water network. In both pilots, dashboards can be considered rather as a family of applications targeting the

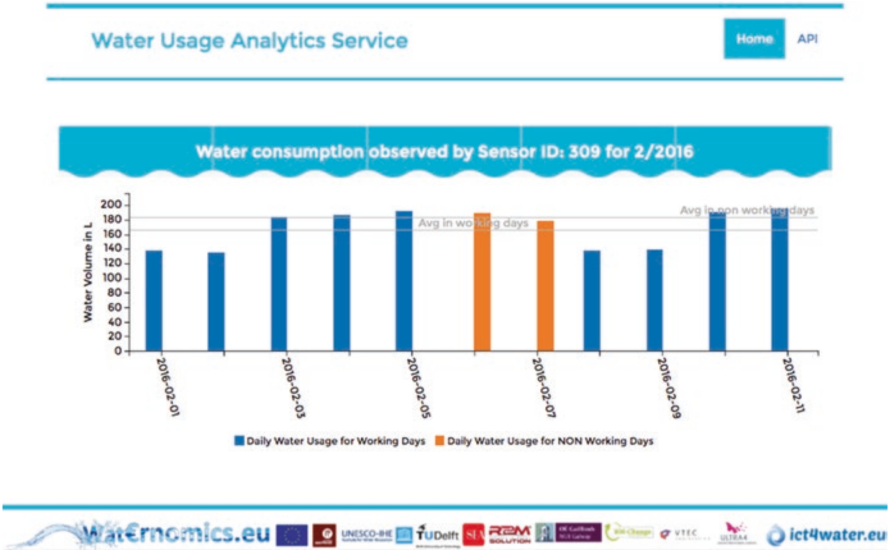


Fig. 5 Visualizing Water Analytics for the sensor 309 in February 2016

specific needs of managers than as a single application aiming to solve all problems for all users. One of the key elements used in the Manager dashboards are historical graphs showing the consumption in various points or groups of interests (see Fig. 6). Goal setting and tracking is also an important aspect for managers in the Galway pilots so comparison graphs are an important part of their dashboards.

Water Retention Time Observer

Making drinking water available becomes a major concern in public spaces. This can be guaranteed through a carefully selected location for drinking water fountains in order to make sure that water is always flowing in the pipes. However, in spaces such as a university building, drinking water fountains can remain unused during long holidays and weekends. Consequently, drinking water can reside in the pipes for long periods. Building managers want to make sure that residual water is still safe to drink.

In this context, the water retention time observer application can assist managers to guarantee that they receive timely notifications regarding water that has been residing for a long period in drinking water pipes. This is done by allowing them to setup a set of rules for tracking periods of inactivity in specific measurement points and automatically send notifications through the system to selected user groups. Figure 7 shows the list of active alarms detected by the application. The application is well aligned with one of the objectives of Waternomics project, i.e. giving actionable information to water users and managers.

Fig. 6 Manager Dashboard for NUIG Engineering Building

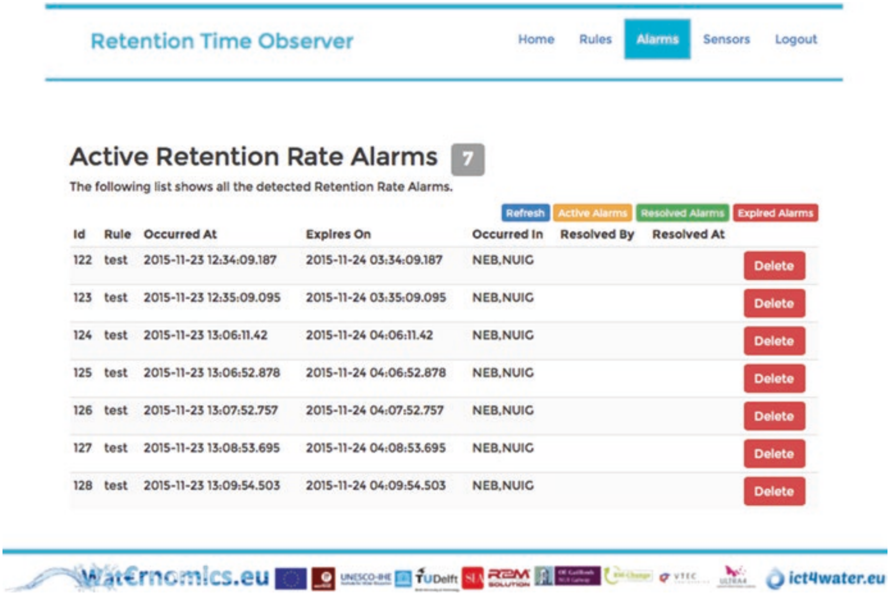


Fig. 7 Retention time observer and active alarms

Observations Control Panel

Both pilot sites in Galway also aim to improve water network management by assisting staff in coordinating and making better-informed decisions. An additional aspect in this context is the ability to communicate messages to specific user-groups related to their consumption in order to require actions or encourage behavior change. The observations control panel is an application that gives an overview of the status of all notifications within a timeframe. It provides an interface for managing notifications that can originate from any application that uses data from the dataspace. Based on the activity logging on different notifications, the user can see how much time it takes from the time of creation of a notification to the time of action or expiry. The application also allows to filter notifications based on the group they were targeting, criticality level and the source application. The control panel allows managers to not only show but generate custom notifications themselves to facilitate this communication with specific user groups.

Wearable Info-Centre

Managers at the Galway pilots are very mobile and they require instant notifications of important aspects of the water consumption in their building. In this case, however, users are more technology friendly and expressed their willingness to use more

Fig. 8 Wearable info-centre, receiving notification from the water retention time observer

advanced mechanisms for receiving notifications through smart devices. The wearable info-center application was developed for mobile notifications.

The wearable info-centre is an application that the user installs on a smartwatch to display notifications as they are received on the mobile phone. This way users don't have to check on their phones every time they receive notifications from the platform. Instead, they can check their smartwatches which is less obtrusive while communicating the information at any time. Figure 8 shows an example of using the wearable info-centre. The application provides an interface for displaying notifications that can originate from any application which uses data from the real-time dataspace. So, the application is indirectly uses all kinds of data provided by the real-time dataspace.

Goal-Oriented Accessing Water

One of the ideas explore during the user tests was the concept of allowing users to track their own personal consumption patterns. The patterns are based on the applications that are activated and connected with specific micro-sessions of user consuming water such as preparing coffee, drinking water, washing hands etc. One of the key outcomes in user tests was that mobile and wearable devices can offer a great opportunity in personalized tracking but this is hard to do if it requires an additional action to already existing routine (e.g. if it requires you to get your phone out of your pocket and scan a QR code). So, in the goal-oriented accessing water application we experimented with the idea of replacing an action in user's routine while in parallel providing some short pieces of information (Fig. 9).

This concept challenges the centuries old mechanism of operating a faucet, which in fact is a valve of various designs. The new system transforms water usage into goal-oriented activity such that accessing water is no longer just about enabling a valve. By setting up a touch enabled sink display next to a faucet (without its original turning knob), users were able to choose certain water activity such as "one cup of tea" or

Fig. 9 Goal-oriented Accessing water application

"one bottle of water". This message will be sent through wireless to a solenoid valve connected to a water pipe or faucet that provides a certain amount of water. In this manner, users were always aware of their water usage thus lowering the chance of wastage. A social network system was also implemented into the system such that users could report issues to each other or even to the building manager so that urgent problems can be solved more rapidly to prevent waste of water in any case.

Related Work

In general, data management is seen as a challenge for smart infrastructures (Cavanillas et al. 2016; Curry et al. 2016; Nam et al. 2011). As recent surveys show, a number of policies and standards for smart metering have been adopted in different countries, but most standards still contain a fragmented set of solutions with little support for adding contextual data (Liotta et al. 2012). Most policies and standards appear in the smart grid area and are adopted by other areas (Fang-Yuan Xu et al. 2010). Hydro-meteorological information is mainly described by drought indicators (Barua et al. 2011) such as Standardized Precipitation Index (Cancelliere et al. 2007) and Temperature Condition Index (Kogan 1995). Mostly these indices describe the present state of the system (Boken 2009).

It has been shown that water consumption awareness and the strength of motivation greatly affect the potential for water saving. For example, in Kappel and Grechenig (2009) the deployment of an experimental system that provided detailed water usage information in the shower showed the resulting decrease in water consumption. It also showed the division of users into two groups: those who continued to pursue conscious water behavior even after the experiment was over, and those who returned to previous water habits after the removal of informational displays. An overview of pro-environmental behavior models and key human-computer interaction techniques to promote and motivate such behavior are presented in Froehlich et al. (2010). In Makonin et al. (2011), a display to present gas, electricity, and water consumption in an artistic way is described. In

Lepe-Salazar et al. (2012), a persuasive application to promote a responsible attitude towards natural resources, food, and water during family interactions is described. The comparison between lightweight ambient and numeric displays is performed in Kuznetsov and Paulos (2010). Results showed that an abstract ambient display with color-coded visualization of water usage causes bigger water-saving behavior changes comparing to a numeric display. In Hasan et al. (2013a), group-based feedback is used to reduce the consumption of paper within an office environment.

All of these techniques are complementary to real-time dataspaces for water analytics. The approach we propose here aims to make it easier to implement such applications by reducing the cost of gathering the necessary data to drive the applications.

Summary

This chapter motivates the need for efficient water information management in public spaces and presents a Real-time Linked Dataspace approach for water data services. A high-level architecture, for the Real-time Linked Dataspace, realizes this approach in the context of the Waternomics project. The Waternomics project established the utility of this approach with the help of four pilot sites that represent different scenarios of public spaces. This chapter describes a concrete instantiation of the Real-time Linked Dataspace approach for two educational institutions, along with applications supported by the water data services.

Acknowledgments The research leading to these results has received funding under the European Commission's Seventh Framework Programme from ICT grant agreement WATERNOMICS no. 619660. It is also supported in part by Science Foundation Ireland (SFI) under Grant Number SFI/12/RC/2289.

References

Barua S, Ng AWM, Perera BJC (2011) Comparative evaluation of drought indexes: case study on the Yarra River catchment in Australia. J Water Resour Plan Manag 137(2):215–226

Boken VK (2009) Improving a drought early warning model for an arid region using a soil-moisture index. Appl Geogr 29(3):402–408

Cancelliere A, Mauro GD, Bonaccorso B, Rossi G (2007) Drought forecasting using the standardized precipitation index. Water Resour Manag 21(5):801–819

Cavanillas JM, Curry E, Wahlster W (2016) New horizons for a data-driven economy: a roadmap for usage and exploitation of big data in Europe. Springer, Cham

Curry E, Donnellan B (2012) Sustainable information systems and green metrics. In: Harnessing green it: principles and practices. Wiley, Chichester, pp 167–198

Curry E, Degeler V, Clifford E, Coakley D, Costa A, van Andel SJ, van de Giesen N, Kouroupetroglou C, Messervey T, Mink J, Smit S (2014) Linked water data for water information management. In: 11th international conference on hydroinformatics (HIC)

Curry E, Dustdar S, Sheng QZ, Sheth A (2016) Smart cities enabling services and applications. J Internet Serv Appl 7(1):6

Derguech W, Bhiri S, Hasan S, Curry E (2015) Using formal concept analysis for organizing and discovering sensor capabilities. Comput J 58(3):356–367

Fang-Yuan Xu, Long Zhou, Yi Lin Wu, Yingnan Ma (2010) Standards, policies and case studies in smart metering. In: IEEE PES general meeting, pp 1–5

Franklin M, Halevy A, Maier D (2005) From databases to dataspaces. ACM SIGMOD Rec 34(4):27–33. doi:10.1145/1107499.1107502

Froehlich J, Findlater L, Landay J (2010) The design of eco-feedback technology. In: Proceedings of the 28th international conference on human factors in computing systems, pp 1999–2008

General Assembly, United Nations (2015) Transforming our world: the 2030 agenda for sustainable development. Tech. Rep. 1

Hasan S, Curry E (2014) Approximate semantic matching of events for the internet of things. ACM Trans Internet Technol 14(1):1–23

Hasan S, Medland R, Foth M, Curry E. (2013a) Curbing resource consumption using team-based feedback. In: Lecture notes in computer science (including subseries Lecture notes in artificial intelligence and lecture notes in bioinformatics), vol 7822 LNCS, pp 75–86

Hasan S, O'Riain S, Curry E (2013b) Towards unified and native enrichment in event processing systems. In: Proceedings of the 7th ACM international conference on distributed event-based systems (DEBS '13). ACM Press, New York, p. 171. doi:10.1145/2488222.2488347

Heath T, Bizer C (2011) Linked data: evolving the web into a global data space. Synthesis lectures on the semantic web: theory and technology. Morgan & Claypool, San Rafael

Hertel TW, Liu J (2016) Implications of water scarcity for economic growth

Kappel K, Grechenig T (2009) "Show-me": water consumption at a glance to promote water conservation in the shower. In: Persuasive 09 Proceedings of the 4th international conference on persuasive technology, pp 1–6

Kogan FN (1995) Application of vegetation index and brightness temperature for drought detection. Adv Space Res 15(11):91–100

Kuznetsov S, Paulos E (2010) UpStream: motivating water conservation with low-cost water flow sensing and persuasive displays. In: Proceedings of the 28th international conference on human factors in computing systems – CHI '10. ACM Press, New York, p 1851

Lepe-Salazar F, Yamabe T, Alexandrova T, Liu Y, Nakajima, T (2012) Family interaction for responsible natural resource consumption. In: Proceedings of the 2012 ACM annual conference on human factors in computing systems (CHI '12), pp 2105–2110

Liotta A, Geelen D, van Kempen G, van Hoogstraten F (2012) A survey on networks for smart metering systems. Int J Pervasive Comput Commun 8(1):23–52

Makonin S, Pasquier P, Bartram L (2011): Elements of consumption: an abstract visualization of household consumption. In: Lecture notes in computer science (including subseries Lecture notes in artificial intelligence and Lecture notes in bioinformatics), vol. 6815 LNCS, pp 194–198

Nam T, Aldama FA, Chourabi H, Mellouli S, Pardo TA, Gil-Garcia JR, Scholl HJ, Ojo A, Estevez E, Zheng L (2011). Smart cities and service integration. In: Proceedings of the 12th Annual International Digital Government Research Conference on Digital Government Innovation in Challenging Times, dg.o '11, New York, pp 333–334

OECD (2012) OECD environmental outlook to 2050. OECD environmental outlook. OECD Publishing, Paris

Pereira AG, Rinaudo JD, Jeffrey P, Blasques J, Quintana SC, Courtois N, Funtowicz S, Petit V (2003) ICT tools to support public participation in water resources governance & planning: experiences from the design and testing of a multi-media platform. J Environ Assess Policy Manag 05(03):395–420

Ul Hassan U, Curry E (2016) Efficient task assignment for spatial crowdsourcing: a combinatorial fractional optimization approach with semi-bandit learning. Expert Syst Appl 58:36–56

Ul Hassan U, O'Riain S, Curry E (2012) Towards expertise modelling for routing data cleaning tasks within a community of knowledge workers. In: Proceedings of the 17th international conference on information quality, Paris

Ul Hassan U, Bassora M, Vahid AH, O'Riain S, Curry E (2013) A collaborative approach for metadata management for Internet of things: linking micro tasks with physical objects. In: Proceedings of the 9th international conference on collaborative computing: networking, applications and worksharing. IEEE, pp 593–598

Ul Hassan U, Zaveri A, Marx E, Curry E, Lehmann J (2016) ACRyLIQ: Leveraging DBpedia for Adaptive Crowdsourcing in Linked Data Quality Assessment. In: Blomqvist E, Ciancarini P, Poggi F, Vitali F (eds) Knowledge engineering and knowledge management. Springer, Cham, pp 681–696

Yang F, Tschetter E, Léauté X, Ray N, Merlino G, Ganguli D (2014) Druid: a real-time analytical data store. In: Proceedings of the 2014 ACM SIGMOD international conference on Management of data – SIGMOD '14. ACM Press, New York, pp 157–168

Dr. Umair ul Hassan (www.umairulhassan.org) is a postdoctoral researcher at the Insight Centre of Data Analytics, National University of Ireland, Galway. He has extensive work experience in industry, government, and academia. Umair has been directly involved in research and industry collaboration projects funded by the European Commission, the Science Foundation Ireland, and Enterprise Ireland. He regularly contributes to the programme task force of the Big Data Value Association. His general interests include collective computing, crowdsourcing, collective data management, collaborative dataspaces, Linked Data, Semantic Web smart cities, and smart buildings. Umair has published several research papers in well-recognized scientific conferences and journals, and served on the technical committee of international conferences and workshops.

Dr. Souleiman Hasan (www.souleimanhasan.org) is an adjunct lecturer and postdoctoral researcher at the Insight Centre for Data Analytics at the National University of Ireland, Galway. He leads the Big Data Processing Architectures special group at the Big Data Value Association (www.BDVA.eu), a non-profit European industry-led organisation for data-driven innovation. Souleiman investigates the data coupling and scalability problem of distributed event processing systems within heterogeneous environments, such as the Internet of Things, using advanced data analytics techniques for data representation. He has served as a program committee member and reviewer for several scientific venues and his work has been published in various journals and international conferences.

Dr. Wassim Derguech (www.wassimderguech.org) is a postdoctoral researcher at the Insight Centre for Data Analytics at the National University of Ireland, Galway. In his research, Wassim investigated the use of semantic web and related technologies for managing services and business processes applied to the e-government domain, customs clearance procedures and Internet of Things. He also tackled the problem of decision support and data analytics in the area of energy intelligence and smart water management. He is actively involved as a program committee member and reviewer of international journals, conferences and workshops.

Louise Hannon is a Senior Research Associate in Civil Engineering at NUI Galway, she is a Chartered Engineer with extensive experience in engineering infrastructure design and project management. Louise has spent most of her career to date in civil engineering consultancy involved in the design and management of highway infrastructure projects. Louise has been involved in civil engineering research at NUI Galway research since 2013, completing a Research Masters in 2016 as well as managing and contributing to a number of EU and Irish research projects. Her research interests include water and wastewater management, she has authored/contributed to a number of papers in the area in particular related to Sustainable management of water resources, Fault Detection and Diagnosis, Sustainable wastewater treatment, Effecting Water Use Behavioural Change, Operational Testing and monitoring at De-centralized Wastewater Plants.

Eoghan Clifford is a lecturer in Civil Engineering, NUI Galway with 15 years' experience in the areas of water and wastewater engineering in the academic, research and private spheres. His key research interests lie in the development of tools and technology that can improve outcomes in the water and wastewater sectors. He also has a particular interest in areas such as policy development and improving interaction between end users and technology that that lead to more sustainable water and energy usage at a local, national and international scale. He has managed national, EU and industry funded research projects with a total value of € 8 m in the last 7 year, has 100+ scientific articles in peer reviewed international journals and conference proceedings. He has written numerous reports for the Irish Environmental Protection Agency and has 3 patents in the wastewater technology sphere. Eoghan is a Chartered Engineer with a PhD in Environmental Engineering.

Christos Kouroupetroglou was awarded his PhD in 2010 and his thesis subject was "Semantically enhanced web browsing interfaces". During his PhD research he investigated the impact of Semantic-Web based assistive interfaces in web browsing for blind people and worked as a primary researcher of SeEBrowser project. In parallel, he also taught as a scientific and laboratory associate at the ATEI of Thessaloniki and in Mediterranean college of Thessaloniki in modules related to Web Applications Development. His latest research efforts include the participation in 2 EU funded projects dealing with the use of ICT to raise awareness for water conservation issues (http://www.waternomics.eu) and the use of robotics to combat loneliness and isolation of people with dementia (http://www.mario-porject.eu). He is the author of "Enhancing the Human Experience through Assistive Technologies and E-Accessibility" and has chaired a number of conference sessions and online symposia.

Sander Smit is founder and owner of BM-Change, a Dutch consultancy firm specialised in strategic innovation. For the past twenty years he has been working as a Project Manager and Business Consultant in product- and service-development projects in the domains Consumer Electronics, Telecom & Media, Smart Mobility, Smart Energy Networks and Smart Water Systems. Since 2006, Sander has specialised himself in strategic innovation. He has been responsible for business model design and exploitation activities in national- and international research projects. Sander has published multiple papers on business model innovation and is co-creator of the international bestselling book "Business Model Generation".

Dr. Edward Curry (www.edwardcurry.org) is Vice President of the Big Data Value Association (www.BDVA.eu) a non-profit industry-led organisation with the objective of increasing the competitiveness of European Companies with data-driven innovation. He is a research leader at the Insight Centre for Data Analytics (www.insight-centre.org) and a funded investigator at LERO The Irish Software Research Centre (www.lero.ie). Edward has worked extensively with industry and government advising on the adoption patterns, practicalities, and benefits of new technologies. Edward has published over 120 scientific articles in journals, books, and international conferences.

Fostering Citizens’ Participation and Transparency with Social Tools and Personalization

Vittorio Scarano, Delfina Malandrino, Michael Baker, Françoise Détienne, Jerry Andriessen, Mirjam Pardijs, Adegboyega Ojo, Michael Hogan, Albert Meijer, and Erna Ruijer

Abstract In this paper we present innovative solutions to the problem of transparency in Public Administrations (PAs) by opening up public data and services so that citizens participation is facilitated and encouraged with a Social Platform and a personalized user-friendly Transparency-Enhancing Toolset.

Introduction

In our research, transparency is a characteristic of an interactive collaborative process between local government and its citizens. Different forms of collaboration are characteristic of how local governments and its citizens interact, specific for

V. Scarano (✉) • D. Malandrino
Dipartimento di Informatica, Università degli Studi di Salerno, Salerno, Italy
e-mail: vitsca@dia.unisa.it; dmalandrino@unisa.it

M. Baker • F. Détienne
CNRS - Telecom ParisTech, Paris, France
e-mail: michael.baker@telecom-paristech.fr; francoise.detienne@telecom-paristech.fr

J. Andriessen • M. Pardijs
Wise & Munro Learning Res, Den Haag, The Netherlands
e-mail: jerry@wisenmunro.eu; mirjam@wisemunro.eu

A. Ojo
Insight Centre for Data Analytics, National University of Ireland Galway, Lower Dangan, Galway, Ireland
e-mail: Adegboyega.Ojo@insight-centre.org

M. Hogan
National University of Ireland, Galway, Ireland
e-mail: michael.hogan@nuigalway.ie

A. Meijer • E. Ruijer
Utrecht School of Governance, Utrecht, The Netherlands
e-mail: A.J.Meijer@uu.nl; H.J.M.Ruijer@uu.nl

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_8

each local context. When such interactions become more transparent, this may mean greater accessibility, more sharing of ideas, better understanding on how the other works and thinks, etcetera. Such processes can be studied at different levels of abstraction, from that of individuals to that of democratic systems. It is our contention that social media can support transparency, especially when the interactions are meaningful and deliberately focused on joint issues and backed up with knowledge about ongoing developments and facts related to the issue at stake. Such knowledge comes from the use of Open Data. Wide-spread access to the Internet has greatly reduced the cost of collecting, distributing, and accessing government information. But an important effect of the diffusion of networks in the population is the potential of ICT, by promoting good governance, strengthening reform-oriented initiatives, reducing potential for corrupt behaviours, enhancing relationships between government employees and citizens, allowing for citizen tracking of activities, and by monitoring and controlling behaviours of government employees, is able to effectively reduce corruption (Bertot et al. 2010).

Open data are significantly seen, in general, as the main instrument to improve transparency, at every level. In fact, transparency for local government can be defined in different ways. The traditional view of transparency is that governments provide information on their work, on the other hand, governments are requiring transparency also from their dependents (such as non-profit-organizations and entities that they regulate in the private sector) (Michener and Bersch 2011). Hence, transparency is an interactive concept.

The early attempts and most of the current open data efforts are somehow failing to enable the transparency in its interactive aspects. Some of the main barriers often cited by researchers is the complexity of the information that is provided and the lack or inadequateness of tools that can help citizens in making sense out of the highly specialized datasets that are provided by government. Of course, this is crucial, as noticed by Michener and Bersch (2011), since the quality of transparency does not only depend on how (and how much) information is made visible and accessible, but also on how the information provided can be fruitfully used to accurate inference.

Some researchers (Mishory 2013) have indeed noticed that transparency is not an "object" but it is rather a "relationship", and, in order to yield better outcomes from transparency programs, it is of primary importance to design a relationship toward greater trust between the "supplier" of open-data based transparency (government) to the "recipients" (i.e. the citizens). In this context, it is crucial to ensure that citizens must be facilitated in their work toward comprehension of what data is important for them.

Many have observed (Bonsón et al. 2012) that local governments in Europe are often well behind their citizens in the use of the social dimension of the Internet, since they usually prefer to use ICT technologies (and social networks and the Internet) only as a one-way channel where they can communicate easily and at low cost.

As noticed by Davies (2012), the task of opening up data to citizens is seen as completed once data is correctly published, missing the important dimension of open data as the catalyser of discussions, conversations and collaborations around data, between citizens and between citizens and the government. The lack of citizens engagement has led Tim Davies to present the "Five stars of Open Data Engagement", that range from the data being demand-driven (1 star), being put in context (2 stars), being supporting conversations (3 stars), being able to build capacity, skills and network (4 stars), to the full collaboration on the data as a common resource (5 stars) (Davies 2012).

Furthermore, as noticed in Colpaert et al. (2013), not only open data needs to be of good quality for others to transform them into knowledge and make them useful, but open data programs must also ensure that the citizens as well as developers can discuss about the datasets and around them, in order to stimulate and favor its re-use.

Summing up, research is clearly pointing out the direction where citizens

(1) must not be left alone in making their comprehension of open data and should be able to collaborate and interact socially around them,
(2) must be provided with tailored and contextualized data,

so that they can relate open data and transparency as a relationship between them (and their daily problems) and the government.

Our research is, then, motivated in providing an interactive solution for improving the engagement of the citizens

- by making them able to socially interact over open data, by forming or joining existing online communities that share common interest and discuss common issues of relevance to local policy, service delivery, and regulation;
- by providing a robust and more holistic understanding of transparency, by underpinning the next generation open-data based transparency initiatives, ensuring that published data are those of value to citizens, with a personalized view in different forms to different segments of the citizens and public based on their profiles for facilitate better understanding.

Our main purpose here is to engage citizens through a "purposeful and personalized relationship" between citizens and open data, not only on a personal basis, but between government and networks of citizens that collectively attribute meanings to this information. The information provided by Open Data is shared, interpreted, personalized, made easier to understand and discussed, to assess its meanings.

Concretely, we describe here our approach instantiated in the design, development and evaluation of

- a Social Platform for Open Data (SPOD) enabling social interactions among open data users and between open data users and government data;
- a Transparency-Enhancing Toolset (TET) as extension for existing major Open Data Platforms, enabling easier access to the relevant dataset, a better understanding of these datasets and integration with social platforms for sharing and discussing datasets

Our research is conducted within a Horizon 2020 European funded innovation project, called ROUTE-TO-PA (www.routetopa.eu) to improve the impact of ICT-based technology platforms for transparency. The ROUTE-TO-PA team is strongly heterogeneous and multidisciplinary. It integrates theory, research, innovation and transformation of local practices, by encompassing research partners, small and large companies, pilot Public Administrations (from four different countries) and one non-profit foundation. Our research partners have expertise in e-government, computer science, learning sciences and economy. In a sense, our team has been designed to tackle the challenges of transparency with a trans-disciplinary approach. To wit, the research described here is strongly embedded into all the areas of reference for the project.

Organization of the Chapter

The cyclical approach involves elicitation of requirements, design and implementation of the technology and evaluation of the result, in our trans-disciplinary effort consist of four phases. The first two phases involve focussing on user requirements from the bottom up (user workshops) and from a top-down perspective (model of the societal context). In out bottom-up approach we adopted a collective intelligence and scenario-based design approach (Warfield, 19..; Hogan, ...). Based on initial scenarios developed for each Public administration site we derived user stories based on general TET and SPOD affordances. On these, we collected user feedback about barriers and possible solutions to develop use case models and descriptions to obtain more detailed functionalities and capabilities of the system.

At the same time, we studied the context around the platform, i.e. the people and their relations, within their professional practices, in order to provide further requirements coming from an abstract representation of the "Societal Activity Model of Open Data Users" described in successive Section**.**

At this point we were able to begin the third phase, i.e., to provide the design and implementation of the ROUTE-TO-PA platform, that encompasses the two tools: the Social Platform for Open Data (SPOD) and the Transparency-Enhancing Toolset (TET), as described in section "The ROUTE-TO-PA Platform". The details on each tool is given in dedicated subsection.

Finally, in the fourth phase, the platform is undergoing an evaluation at the same user sites that were involved already during the user workshop, in Prato (Italy), The Hague and Groningen (The Netherlands), Dublin (Ireland) and Issy-les-Moulineaux (France).

It is worth noticing how the phases of modeling, design and evaluation are occurring iteratively, in repeating cycles, during the project, in order to allow experiments and pilots' feedback to be directly taken into consideration into the design and implementation.

Requirements and User Involvement

A series of carefully designed workshops were conducted, one in each pilot site, for the purpose of developing a comprehensive set of user needs, from the viewpoint of key stakeholders. Each workshop brought together experts, academics, industry specialists, open data practitioners, representatives of governments, open data researchers, and potential users (including citizens, representatives of citizens and social service institutes, and journalists) to brainstorm on open data platform adoption challenges, solutions to the challenges and a set of needs and requirements necessary for consideration in the design of the ROUTE-TO-PA platform. The emphasis on citizen participation and collaborative design in the methodology seeks to address the goals of improved government transparency and accountability for decision-making. Each workshop began with a collective intelligence (CI) analysis of barriers to accessing, understanding and using open data, followed by an analysis of options that may overcome these barriers. Participants then worked to develop scenario-based user needs, which involved profiling user needs in light of the barriers and options and high level scenarios of open data usage.

The methodology used to gather user-level requirements is inspired by a scenario-based design (SBD) approach (Rosson and Carroll 2002), but builds upon this approach by adding a collective intelligence (Warfield 2006) and agile user story development (Cohn 2004) approach. In the current application of CI, workshop participants worked to develop scenario-based user needs, which involved profiling user needs in light of the barriers and options and high level scenarios of open data usage. This included a separate focus on (1) information needs, (2) social and collaborative interaction needs, and (3) understandability, usability and decision-making needs. Idea writing was used for each cluster of needs. High level scenarios including multiple users were used to prompt thinking in relation to user needs. All the short user stories generated by participants were generated in the form:

As user type ________ , I want ______, so that I can _______

The wants (or needs) generated by participants across each pilot site were then analysed and key categories of user needs identified. Reasons for specified user needs were also analysed, and this analysis was used to advance our understanding of the scenarios and prospective use case models. This work in turn has shaped the test and evaluation framework (see Fig. 1).

The scenarios used addressed various contextual issues, relevant to each of the workshop sites, and aligned with the primary case focus in each pilot site. For example, the Dublin workshop focused on community networking and opportunity creation; the Groningen workshop focused on the use of Open Data in overcoming issues associated with population decline; the Den Haag workshop focused on Open Data in relation to employment and opportunity creation; the Prato workshop centered on local policy and budget issues; and finally, the workshop in Paris focused on Open Data in relation to start-up companies and the digital economy.

As such, there was some variety in user needs generated, across all there categories of needs: information needs, social and collaborative needs, and understandability, usability and decision-making needs (Hogan et al., submitted).

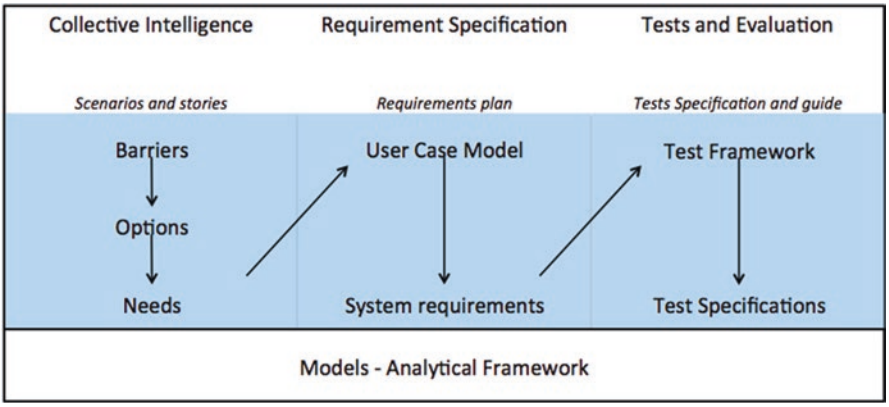


Fig. 1 Workflow for collective intelligence and link between collective intelligence and evaluation framework and test specifications

As workshop participants in each pilot site were working with a variety of scenarios, the user information needs generated were numerous and diverse. The information needs included, for example, demographic information needs; legal information needs; health information needs; social and community information needs; planning information needs; services, amenities and event information needs; business and financial information needs; jobseeker information needs. Essentially, the data and information that different pilot sites need depend on the problems they are working to solve in their scenarios. The ROUTE-TO-PA team are working to collate all available open data to make it available on the platform.

Participants then moved on to identify social and collaborative needs based on the user stories, in order to provide input for the design of SPOD. Social and collaborative needs were commonly specified across pilot sites. Categories of needs here included: dialogue and discussion spaces; moderation and maintenance of these spaces; platform tool capabilities for interaction; varied forms of social media interaction; personalisation of user spaces; and requesting and sharing information. Broadly speaking, participants identified a variety of forms of interaction which could be used over Open Data, and suggested a number of considerations and affordances which would increase the impact and appeal of such social and collaborative platforms.

Participants also used the scenarios provided to design user stories around understandability, usability, and decision-making needs, which will inform the design of the TET. The major categories of understandability, usability and decision-making needs were common across sites. Categories of needs here included: Affordances for the visualisation of complex information; data analysis and reporting tools; decision-making support tools; guidance and usage support tools; affordances for personalising platforms and/or data; and certification tools. Broadly speaking, participants frequently cited the need for data visualisation tools, among others, which would make data more easily understood, whether for personal or professional use.

Subsequent to gathering and integrating scenario-based user needs across all pilot sites, the Route-to-PA design team engaged in an exercise designed to rate the relative impact and feasibility of specified needs. This resulted in the first set of user needs selected for agile software development from M6 to M12 and this process continues iteratively into Year 2 as the design team revisits user needs and ways in which SPOD and TET design features can support those needs.

Societal Activity Model of Open Data User

Next to identifying user requirements for an open data platform from the bottom-up via collective design based workshops, we also identified user requirements from a top down perspective. After all, in order to design and implement a successful ICT platform, "the context" that includes people and their relations (Kuutti 1999) needs to be taken into account as well.

Information technologies should be able to support active users, while dealing with the organizational and societal context (Kuutti 1999). Yet, often this context of broader social forces and structures that influences the interaction between users and information technology, is left unexamined (Engeström 2005).

Therefore, based on democracy, transparency and activity theory, the Societal Activity model of Open Data use (Ruijer et al. 2016) was developed. The model takes three democratic processes as a starting point for the design of open data platforms: monitorial, deliberative and participatory democracy (Meijer 2012).

The Societal Activity Model of Open Data Use (Ruijer et al. 2016) enhances our understanding of user requirements of open data in a societal context. It helps to find the best fit between; on the one hand, the impetus for governmental organizations to provide open data, to increase accountability and transparency, and on the other hand the specific needs of citizen-users in particular domains.

The model was tested in five pilot sites, using interviews, analysis of official documents (where available), and workshops or focus groups where open-data providers and users met and discussed The findings show that different societal processes call for different roles of citizens and government and different user requirements for the design of open data platforms, and, also, provided input for the design of the ROUTE-TO-PA platform.

The ROUTE-TO-PA Platform

Our project will produce software by using open-source licensing model, and the platform will be given to the community of PAs and developers that, after the end of the project, will ensure further development and widespread, sustainable and scalable exploitation of the results achieved. The results of the project (both software and guidelines) will allow PAs to follow the economic and budgetary pressures that

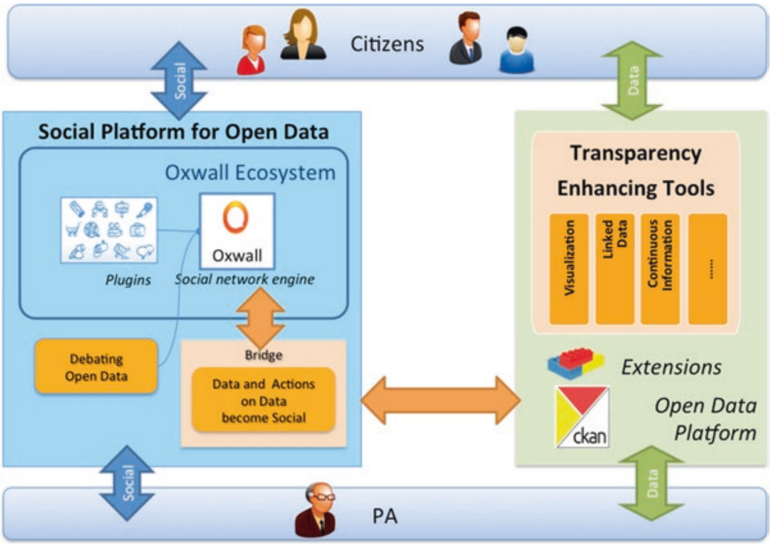


Fig. 2 ROUTE-TO-PA architecture

force administration to be more efficient and to reduce cost (EU DGCONNECT 2013) by adhering to the philosophy of "Doing more with less".

The software and the experiences will be highly reusable, given that they will be piloted in different contexts, in different countries, whose results will be elaborated in guidelines and recommendations at the end of the project. "Reuse rather than reinvent" is one of the guidelines to long-term success of ICTs in Transparency (Bertot et al. 2010) that we adopt as project "mantra" both from technological point of view (i.e., integration of existing popular open source products) and from the PA point of view (plug ROUTE-TO-PA onto existing experiences and needs by involving the Pilots) (Fig. 2).

Social Platform for Open Data (SPOD)

The SPOD platform architecture has multiple decoupled and modular components that communicate together. The architecture is based on mainstream, open source and modular technologies to guarantee interoperability with other external systems. The overall architecture is distributed, as the load of different tasks is taken by different servers (components), both server-side and client-side (e.g., the client-side visualization of data), thereby achieving the important non-functional requirement of Performance Efficiency.

SPOD is a Social Platform for Open data, so its primary requirement is the retrieval of data from Open data Providers. Therefore, SPOD interoperates with

TET, any CKAN based platform, UltraClarity and OpenDataSoft (and additional interoperability with OASIS is planned).

In addition, SPOD can retrieve open data from other existing third party data providers that use restful API. Hence, the interoperability with data provider platforms is based on Web 2.0 mainstream technologies (fulfilling an important non-functional requirement of Interoperability); in this way, SPOD can retrieve the open data to use within the social discussions. For instance, the user can create visualizations from the data available in the open data provider and use them to support its argumentation. SPOD can be configured to allow easy access to associated data providers, so that their datasets can be shown easily used to build visualizations (see Datalets below).

The platform administrator, using the administration pages, can add another data provider and make it available to end-users. In addition, in order to maximize the flexibility, during the creation of a data visualization, any user can copy and paste the data URL from any other external open data Provider as well as post directly the link or content on SPOD (Fig. 3).

The architecture has a ROUTE-TO-PA Authentication Server (RAS), which acts as OpenID Authentication Provider and administration tool to manage users' accounts. In accessing to the ROUTE-TO-PA platforms, users must seamless switch between SPOD and TET features in a user-friendly way. Therefore, a user must access to SPOD and TET, and any other feature federated system, with a unique

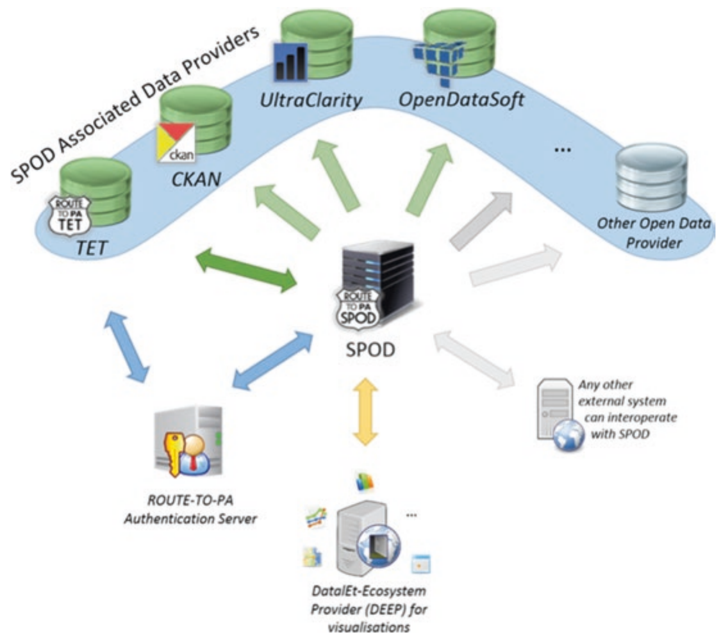


Fig. 3 SPOD architecture

username and password credential. In order to provide this, the architecture has a ROUTE-TO-PA Authentication Server (RAS) based on the OpenID protocol. Any time a user logs in SPOD or TET, his/her browser redirects to the authentication provider log in page. All the authentication server pages have a consistent Graphical User Interface (GUI) with SPOD and TET, indeed they have been specifically designed within the ROUTE-TO-PA project and it is based and compliant with the material design. In this way, TET, SPOD and authentication look and feel is the same, and the switching among their pages is seamless.

The overall architecture has a specific server for the authentication and the entire platform has deployed with a dedicated authentication server. In order to support the authentication through OpenID, SPOD team developer designed a new Oxwall plug-in that supports OpenID. SPOD can be deployed without the activation of the OpenID plug-in so it works without a dedicated authentication server and uses the existing Oxwall registration, log in pages and user accounts management.

The introduction of a ROUTE-TO-PA Authentication Server allows the interoperability of other systems with the ROUTE-TO-PA platforms, following the non-functional requirement of Interoperability. Both SPOD and TET can provide specific services and data to external systems in form of Restful API. Therefore, not only SPOD interoperates with existing data providers, but also itself can provides services to other platforms. Any other external system can authenticate to RAS and interact with SPOD through the restful API services. For instance, based on this architecture, the platform can provide a social widget to embed within any web site to easily share open data, add the content in the own private room or participate in a discussion. In a federated architecture, after the authentication the federated system can invoke a restful API service to perform an action on SPOD (e.g., post of content on SPOD, etc.).

SPOD enables the social collaboration around open data; in particular, it aims to support the collaboration around visualization of open data, allowing their creation, sharing, change and comment. The SPOD architecture provides the visualizations and their services through the DatalEt-Ecosystem Provider (briefly DEEP). DEEP is a repository of visualization web-components to use within SPOD and within any other web site or system that needs to visualise data.

The overall architecture is also useful to envision a "federation" of ROUTE-TO-PA systems. Several federated SPODs and TETs or other institutional systems can access to the ROUTE-TO-PA Authentication Server and share the same ID.

The SPOD architecture is modular and scalable: for instance, the DEEP component can be replicated and distribute around the world to improve performances and serve visualizations to end-users with high availability. Of course, multiple architecture instances can be deployed in different places.

Our distributed architecture, in general, follows the non-functional requirement of Replaceability, as each single component can be substituted with another specific one with the same interface (like a different dataset provider, or another Authentication server with OpenID).

SPOD on Oxwall

Oxwall is a free and Open Source Software (FOSS) social network engine that is able to power customizable online social networks and community-enabled websites. It provides all the basic functionalities of a social network, such as users' friendship, posting text or media comments, handling (private) groups group or event creation/joining. Oxwall architecture is based on plugins, few core plugins handle user/platform/access management. Additional features can be provided by plugins.

SPOD consists of several additional plugins for Oxwall that add to the "standard" social network (friends, status, etc.) the following functionalities:

- It is possible to attach to any social comment, status or answer a *Datalet* (i.e. a re-usable Web Component that provides real-time visualization of datasets, located on any compatible server (see the subsection below). In this way social interactions become enriched with the actual datasets, providing discussions with easy-to-use and easy-to-understand factual evidence. The process to build a datalet is provided by a user-friendly, wizard-like component, that provides the choice of the dataset (among the suggested ones from known providers or from a new one added by providing the link to the RESTful call), the filtering capabilities (choicing columns and rows) and the visualization (choice of the charts, parameters, preview). It is a very important characteristics of Datalets that load and show the actual dataset (1) directly from the source and (2) in real-time, when the user is loading the page, i.e., ensuring authoritative datasets.
- Any user is given the possibility to access a *Personal space*, i.e. a place where he/she can collect and annotate material that can be fruitfully re-used in social discussions later. The user can collect links to webpages, by providing URLs and a datalet is showing the real page in a miniature (that can be also navigated), Datalet for particular visualizations, and plain text notes. All the items can be further annotated, and full text search capabilities allow easy management of the material. The main purpose of the Personal space is to provide a space for *reflection* as the citizen may need time and thoughts to build an argument to be re-used in discussions.
- Discussions occur in *Public Rooms* grouped in an *Agora*. Each Public Room is a traditional threaded chat on the left, with the possibility to add Datalets to the discussion and the possibility to add an opinion (Neutral, Agree, Disagree) to the comment. The right part of the screen is used to provide synthetic information about the discussion, that also makes easier to navigate through long discussions. A graph based representation of the discussions is shown, where nodes are the comments and edges join the answer to a comment, with colors to represent opinions and size of the node representing the number of answers below the comment (see Fig. 6). Navigation is synchronized: clicking on a node on the tree shows the corresponding comment on the threaded chat on the left. Other graphs showing the datalets and the users can be also shown.

Datalets and DEEP

The ROUTE-TO-PA software architecture exploits a modular programming design in order to develop independent software. To achieve this design goal, an architecture completely decoupled from the main project SPOD was designed. The key idea was to realize a repository of components (software services) to be used for different purposes, so that it is possible to enclose some functionalities in a kind of widget and make it available on the Web. This architecture is realized using the Web-Component (WC) standard. We designed a Web service that allows distributing the code of each software component dynamically.

Therefore, each software component is a WC that is, an auto-consistent and independent component that provides some functionalities. A *datalet* is a Web Component that is an output presentation to the user based on the data dynamically loaded from the data source.

The service that allows downloading and using the Datalets is the DatalEt-Ecosystem Provider (DEEP). Within the SPOD software, DEEP architecture is an open, extensible, modular and pluggable service that provides WCs for visualization of open data datasets. DEEP allows sharing, collaboration and creating around customized data visualizations. Further users can create, reuse and share visualizations both in SPOD or in any Web page or other Web-based systems. Its modularity and extensibility fulfils the non-functional requirements of Adaptability and Replaceability.

DEEP is developed as a simple Restful service, providing the list of available datalets (i.e., listing service) and the mapping among the visualization names and their relevant URL within the WC repositories. The system is online and is the base of the architecture of SPOD (http://deep.routetopa.eu/).

Both the DEEP and the WC repository have been designed to be extensible: they can collect all the visualization requests so, as planned future work, they could also provide aggregated statistics on both users preferences and on data and their visualizations. For instance, the most popular datalet visualizations, most used datasets, most popular visualizations for a particular dataset, most visualised fields for a particular dataset, and so on.

The DEEP main task are the listing services which provides a list of available dataset and the mapping between the visualization names and their relevant URL within the "datalets repositories".

Transparency-Enhancing Toolset (TET)

What Is TET? The TET comprises a set of tools designed to extend available features on popular Open Data Platforms (ODP) to more adequately support transparency related qualities desirable by different categories of ODP end-users. Starting with the Comprehensive Knowledge Archive Network (CKAN) Platform (OKF

2014), the vision for TET is to extend major open ODPs platforms with features enabling easier access to the relevant dataset, a better understanding of these datasets and integration with social platforms for sharing and discussing datasets.

Technical Features TET is implemented as a set of plugins to extend the available features on the well-known CKAN Open Data Platform. The Alpha version of TET described in this report supports the following eight extensions: (1) Support for the use of the WordPress Content Management System as a rich client for CKAN, (2) Enhanced metadata schema to support provenance and alignment with latest W3C guidelines for publishing data on the web, (3) Validation of metadata quality, (4) Linking of related datasets, (5) Enhanced user profiles for personalization and recommendation, (6) Personalised search and dataset recommendation to users, (7) Recommendation of similar dataset to users and (8) Extension of data analytics function on CKAN to support pivot operations on datasets, (9) Interface with the Social Platform for Open Data (SPOD). These features are explained in briefly explained below.

1. Integration of Content Management System for Richer Client Experience – CKAN Integration with content management system enables publishers to publish content related to datasets and publish updates related to portal in an easy way. TET Wordpress plugin seamlessly integrates TET enabled CKAN to provide rich content publishing features to publishers and intuitive interface to end-users.
2. Enhanced Metadata for Improved Context – More metadata fields are added to dataset upload form to enable data publishers to specify richer metadata that will help users in discovery and in getting better understanding of the datasets. The metadata fields are guided by and comply with aligned with the "W3C guidelines for publishing data on the web". Additional fields supported include: Basic details related to the dataset; Target audience of the dataset; Theme/Category; Versioning; Provenance; Geospatial Coverage; and Temporal Coverage.
3. Metadata Quality Check and Validation – Additional validations to dataset entry form are added to prevent data entry errors and to ensure consistency. Quality check indicators guide publishers about the quality of metadata being entered. The features will also help end-users in assessing the metadata quality of dataset.
4. Relating Datasets – Dataset linking feature allow users to specify explicit links between datasets, which can be exploited for recommendations and data integration purposes.
5. Enhanced User Profiles for Personalization and Recommendation – Default CKAN user registration page is modified to allow more details related to the user to be captured, the feature plays essential role in creating a personalized user experience for the end user.
6. Personalization Search and Dataset Recommendation for users – enables users to search for datasets based on their profile or based on the desired category.

Users can select appropriate profile from the list of profiles provided or could select the category they are interested in from the list (see Fig. 7).

7. Recommendation for related datasets – enables recommendation of more datasets based on user group and dataset category selected in the user profile in addition to other contextual information. The feature guides users to find potentially useful and relevant datasets.
8. Extension of Available of Data Analytics Functions – CKAN platform lacks data analysis capabilities essential for working with data. To overcome this limitation as the first step, we added PivotTable feature which allows users to view, summarize and visualize data.
9. Enhanced Interface with the SPOD – builds on the CKAN APIs to enable the SPOD platform access datasets managed on the CKAN with the enhanced features for visualisation, sharing and discussion.

The above features resulted from analysis of the information on the barriers to open data use and needs of end-users gathered from the series of Collective Intelligence Sessions hosted by pilot partners in respective partner countries. In addition, transparency qualities including Accessibility, Usability, Understandability, Informativeness and Auditability described in Cappelli et al. (2013) and other transparency constructs such as those in Fung (2013) underpinned the development of the above features.

TET "Plug-and-Play" Architecture

In implementing the above features, the base CKAN platform were extended with a number of additional components implemented as "plug-ins". The architectural decision to implement TET as plug-ins is to enable easy coupling and removal of TET components and consequently minimal operational impact to the based open data platforms. This architectural style allows us to experiment easily with alternative design and implementations of the feature (Wang and Avrunin 2008). The TET components are grouped into three categories: Frontend, Data Platform and Analytics components as shown in Fig. 4.

In addition, an additional element (or plugin) enables integration with the social platform. The development of the above features was carried out through an Agile Software Development process which enabled the development an early prototype and subsequent short "develop-test-release" cycles to engage potential end-users of TET platform.

Status and Exploitation The above features have been successfully implemented as part of the Alpha release available at http://srvgal100.deri.ie:8081/. Some of the functionalities have already been deployed as part of CKAN instance managed by the Dublin City Council, Republic of Ireland.

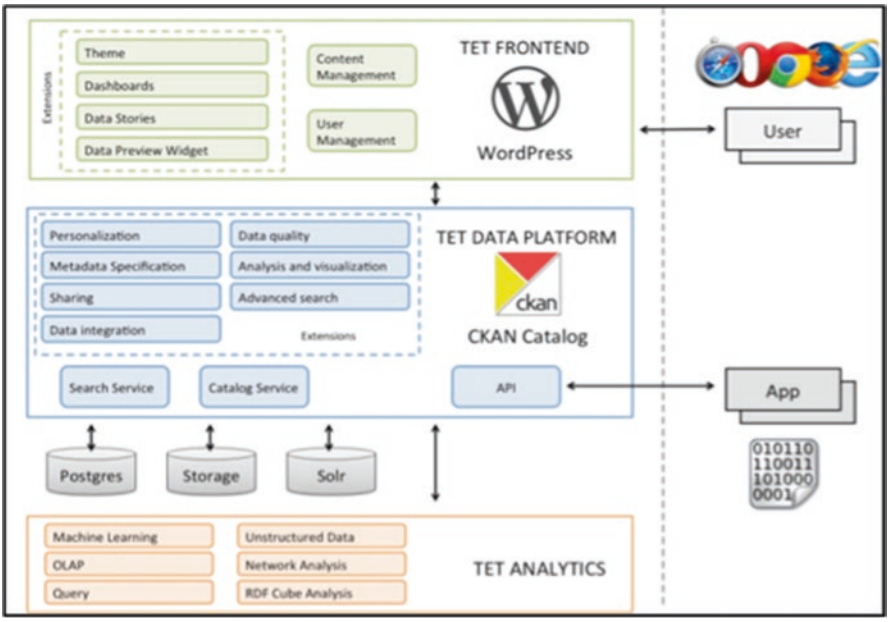


Fig. 4 TET architecture

Evaluation Plan and Pilots Description

Description of the Five Pilot Sites

The City of Prato (Italy) scenario case concerns *city budget management*. The goal is for citizens to monitor the allocation of the city budget by municipality and to propose expenditure priorities and suggestions. The city would like to increase transparency on budget management and possibly collect some of citizens' expenditure suggestions. It is important to know that this process is intended to be an improved version of existing democratic procedures of involving citizens in budget decisions.

The object or policy issue in **Groningen (NL)** focuses on population decline. One of the areas with the highest population decline in the Netherlands is situated in Groningen. The potential community of stakeholders is diverse consisting of citizens, public organizations (schools, health care organizations etc.) and private companies. Open data as an instrument can provide insight in the consequences of and might be able to contribute to innovative and collaborative solutions for population decline.

The **Dublin, Ireland** City Council is one of the founding partners of Dublinked. Dublinked is an ideas and information sharing network which connects the Dublin region's four local authorities with universities, companies and entrepreneurs. The scenario chosen for ROUTE-TO-PA evolves around capacity building, which focuses on increasing citizen engagement in a deliberative process with their city or more specifically their community. The scenario thus focuses on building community awareness with the ultimate outcome to "make my city great".

Issy- les- Moulineaux (France) is a city located near Paris. The city hosts many IT companies and welcomes start-up companies in the field of new technologies. The scenario focuses on the activity of two central groups: young entrepreneurs in ICT domain who form a major part of the local economic base and public administrators from Paris Region who collaborate with Issy-les-Moulineaux in the global open data policy.

The pilot in **The Hague (NL)** focuses on collaboration between public administrators and employers and can be characterized as a participatory process. Employers and the City of The Hague have a longer history of collaboration and meeting, the relationship between the Department and the local employers is quite good. The specific scenario or policy issue suitable for exploiting Open Data will be jointly developed, whereby the focus is on finding solutions for existing problems together. This is called co-creation.

Research Approach: Four Levels of Evaluation

Concerning evaluation of developments and outcomes at the five user sites, in terms of transparency, we have several sources of criteria. The identification of users' needs (section "Requirements and User Involvement"), are translated into design specifications for the tool, that is, the actions users are supposed to perform with the tool leads to a set of evaluation criteria at the technology and user levels. The modelling activity (section "Societal Activity Model of Open Data User") has provided abstract models at the society and community-levels. On the basis of these models we will be able to characterise and compare all cases with respect to their current and future states at four different levels:

1. The technology functioning according to design specifications, tested by usability studies and user consultation.
2. The individual user carrying out different actions: we shall develop a framework based on the well-known and studied Technology Acceptance Model (TAM) (more details in the next subsection).
3. The community, or small group working together to generate new ideas: the main dimensions of evaluation on this level can be formulated in terms of the characteristics of the participants, the structure of their interactions and their content within the OECoP, studied from a developmental perspective (Engeström 1987). The developmental, or diachronic, analysis draws on synchronic analysis of the OE-CoP (at a given point in time), and identifies relevant differences across time-points, with a view to identifying the overall trajectory (Dreier 1999; Ludvigsen et al. 2011) of the community, i.e. where it is heading.

4. The society, or the organisational context, adapting to the new possibilities for creating transparency. We will investigate the impact of our project within the organisation by observations, interviews and surveys.

Our evaluation activity also relates closely to the Models and Methods developed:

1. The Societal Model (year 1) relates to the above in terms of analysis of the object of activity (including community rules), and the expression of tensions. In these cases, the level of content analysis is relevant, for identifying 'what the participants are trying to achieve' (i.e. object of activity) in given exchanges, and, on the level of communicative functions, given that tensions will be correspond to argumentative functions and, most likely, to the salient expression of strong emotions.
2. The Community Model (year 2) provides the theoretical background and methodological tools for addressing the main research question, concerning evolution of SPOD-TET mediated collective activity towards a veritable epistemic community.
3. The Social Representations Model (year 3) concerns the evolutions of the OE-CoP participants' representations (attitudes, appraisals) of the community, of their perceived self-efficacy, of the degree of transparency and cooperativity of the Public Administration, and of the SPOD-TET tools themselves. This will be studied using interviews and questionnaires, but also on the basis of content analysis (what are the attitudes expressed using SPOD?). This can draw on appraisal theory (White 2002), i.e. the positive and negative attitudes and affects expressed in language.

The User Level

To evaluate the artifacts, we shall develop a framework based on the well-known and studied Technology Acceptance Model (TAM). The model was published by Davis (1989) and is the most widely accepted model for understanding the usage of Information Systems (IS) and its acceptance. It suggests, that external variables (such as system design and rich features) influence the perceived usefulness and perceived ease of use. Over time the model evolved to TAM2 (Venkatesh and Davis 2000) and was extended with additional external variables, relevant to IS utilised in the workplace: the social influence variables (i.e. subjective norm) and the cognitive instrumental variables (i.e. result demonstrability). Original TAM is presented in Fig. 5.

The definitions of the additional variables in TAM2 are defined as follow:

1. Voluntariness – "the extent to which potential adopters perceive the adoption decision to be non-mandatory".
2. Subjective norm – "a person's perception that most people who are important to him think he should or should not perform the behavior in question"

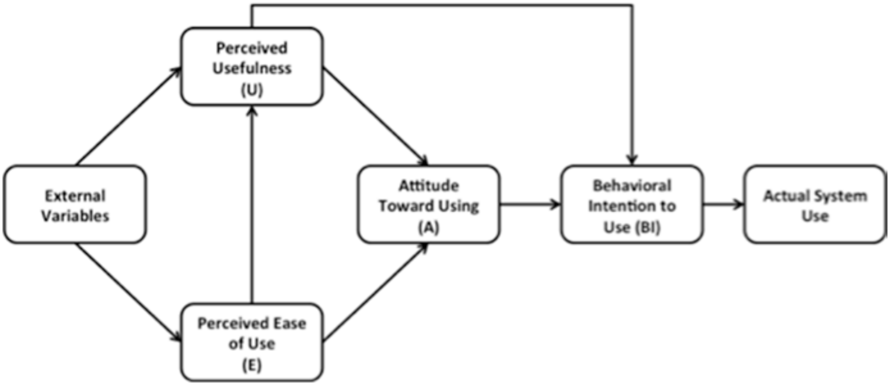


Fig. 5 Technology Acceptance Model (TAM)

3. Image – “the degree to which use of an innovation is perceived to enhance one’s status in one’s social system”
4. Job relevance – “an individual’s perception regarding the degree to which the target system is applicable to his or her job”
5. Output quality – “the tasks a system is capable of performing and the degree to which those tasks match the job goals”
6. Result demonstrability – “the tangibility of the results of using the innovation”

Based on the Technology Acceptance Model in the pilot evaluation, we evaluate the following parameters:

1. Relevance – how relevant is the use of open data and the TET/SPOD to the user’s job and daily life,
2. Output quality – what is the quality of datasets available on the platform? What is the perceived quality of TET and SPOD platforms?
3. Result Demonstrability – does the use of the TET and SPOD address the relevant user needs provided by users during the Scenario development workshop?
4. Perceived Ease of Use – how easy is it for non-technical users to use TET and SPOD?
5. Perceived Usefulness – how useful do users perceive TET and SPOD?
6. Intention to use – how wiling are the users to use TET and SPOD to support their information needs and decision making needs?

Conclusions and Future Actions

The team has just released the first Alpha prototypes of SPOD and TET as the project first year just finished (January 2016). SPOD and TET will be tested (in a first round) in the five pilots for the year 2016, starting late September. In 2017 a new version, beta, will be submitted to another round of testing from the pilots, leading to the release of a highly tested, jointly designed and citizen-centered software.

In this paper we have described a holistic, multi-disciplinary approach that starting from collective intelligence and scenario-based design approach, produced first scenarios and then user stories that were used to feed the initial technological design. At the same time, the activities on modeling, with the Societal Activity model of open data user provided contextual information, that further motivated the design. The design produced the first prototypes of a Social Platform for Open Data, for fostering participation, and Transparency-Enhancing Toolset, for improving transparency for citizens. The prototypes are going to be tested in September 2016 on five pilot sites that provide diversity and heterogeneity in our evaluation.

It must be stressed that our holistic multidisciplinary approach employs methodologies that, although coming from different fields, share a common vision of continuous user-centered design, from the collective intelligence approach, to the activity model to the technological employment of agile methodologies. We believe that our approach, that involves stakeholders since the very beginning of the design and development will be one of the key factors to the success of our project.

Of course, we are well aware that our research is strongly based on only five pilots in Europe, that, although heterogeneous in countries, size, state of the open-data programs, and scenarios, do offer a limited view of the overall scenario in the whole world with very diverse needs and contexts. Nevertheless, we are confident that, as the limitations of our work are evident to us as researchers, that methodologies and the technologies that have been designed and developed in order to be of wide impact, could be partly re-used and fruitfully employed to tackle, at least partially, the engagement of citizens through Open Data in diverse contexts.

The project will finish its activities on January 2018, with two rounds of pilot studies (February 2016 and February 2017) of SPOD and TET in the five pilots (see http://www.routetopa.eu for updates on the status of the activities) (Figs. 6 and 7).

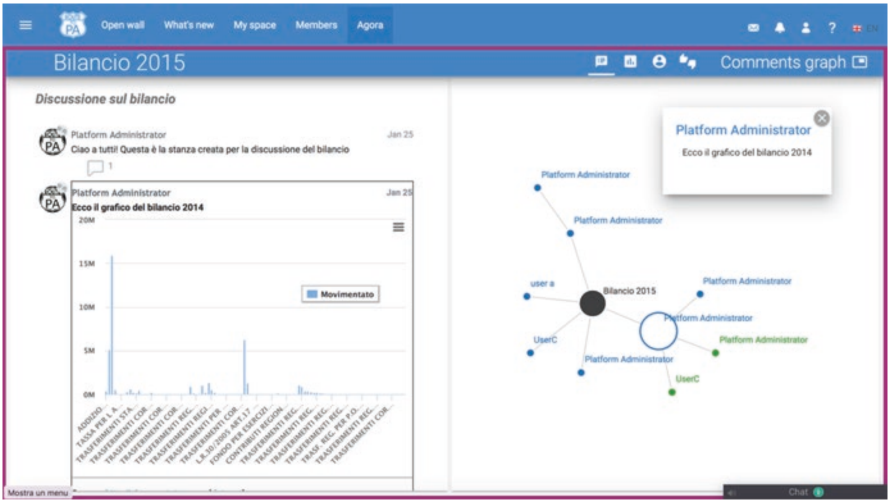


Fig. 6 SPOD example screenshot

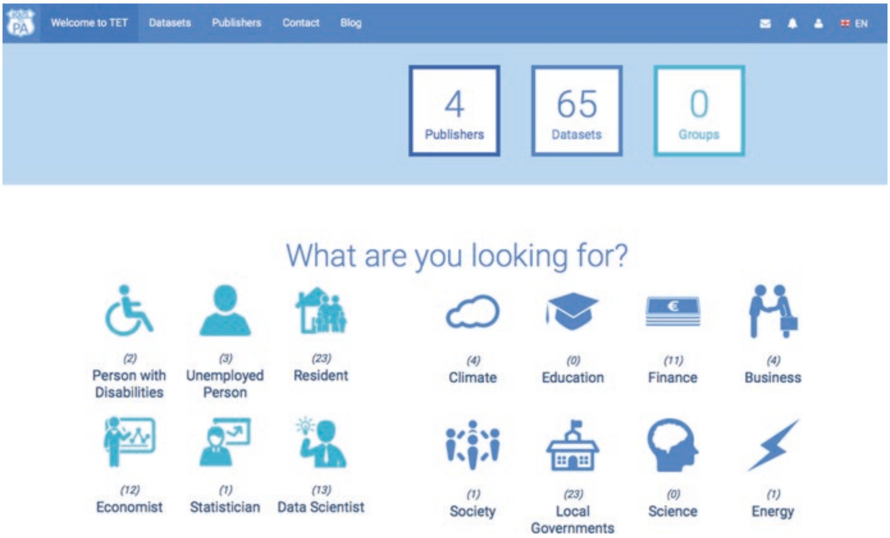


Fig. 7 TET example screenshot

Acknowledgments This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 645860.

References

Bertot J, Jaeger P, Grimes JM (2010) Using ICTs to create a culture of transparency: E-government and social media as openness and anti-corruption tools for societies. Government Information Quarterly *27*:264–271

Bonsón E, Torres L, Royo S, Flores F (2012) Local e-government 2.0: social media and corporate transparency in municipalities. Government Information Quarterly 29(2):123–132

Cappelli C, Engiel P, Araujo RMD, Cesar J, Leite P (2013) Managing transparency guided by a maturity model. In: 3rd global conference on transparency research, HEC, Paris, 24–26 October 2013, pp 1–17

Cohn M (2004) User stories applied for agile software development. *Addison-Wesley*, Boston

Colpaert P, Sarah J, Peter M, Mannens E, Van de Walle R (2013). The 5 stars of open data portals. In: 7th international conference on methodologies, technologies and tools enabling e-Government (MeTTeG), University of Vigo, Spain, pp 61–67

Davies T (2012) Supporting open data use through active engagement. In: Proceedings of W3C workshop "using open data: policy modeling, citizen empowerment, data journalism", 19–20 June 2012. http://www.w3.org/2012/06/pmod/pmod2012_submission_5.pdf

Davis FD (1989) Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly 13:313–339

Dreier O (1999) Personal trajectories of participation across contexts of social practice. Outlines: Critical Social Studies 1:5–32

Engeström Y (1987) Learning by expanding: an activity theoretic approach to developmental research. Orienta Konsu, Helsinki

Engeström Y (2005) Developmental work research: expanding activity theory in practice. Lehmanns Media, Berlin

EU DG-CONNECT (2013). A vision for public services. European Commission, "Public Services" unit of Directorate-General for Communications Networks, Content and Technology (DG-CONNECT). 13 June 2013

Fung A (2013) Infotopia: unleashing the democratic power of transparency. Polit Soc 41:183–212

Kuutti, K. (1999) Activity theory, transformation of work, and information systems design. In: Engestrom, Y.; Miettinen, R. & Punamaki, R.-L. (eds) Perspectives on activity theory. Cambridge University Press, Cambridge, 360-376

Ludvigsen S, Rasmussen I, Ingeborg K, Moen A, Middleton D (2011) Learning across sites: new tools, infrastructures and practices, Intersecting trajectories of participation: temporality and learning. Routledge, London, pp 105–121

Meijer AJ (2012) The do it yourself state. Inf Polity., IOS Press *17*:303–314

Michener G, Bersch K (2011) Conceptualizing the quality of transparency. In 1st global conference on transparency. Political concepts, Committee on Concepts and Methods Working Paper No. 49

Mishory E. N (2013). Clarifying transparency: transparency relationships in government procurement. In Government Procurement Seminar, Chris Yukins & David A. Drabkin, 4 November 2013

Open Knowledge Foundation (OKF) (2014). Comprehensive Knowledge Archive Network (CKAN) Developer Documentation

Rosson M, Carroll J (2002) Scenario-based design. In: The human-computer interaction handbook: fundamentals, evolving technologies and emerging applications. Lawrence Erlbaum Associates, Mahwah

Ruijer E, Grimmelikhuijsen S, Enzerink S, Meijer AJ (2016) The societal activity model of open data use. Deliverable 3.1

Venkatesh V, Davis FD (2000) A theoretical extension of the technology acceptance model: four longitudinal field studies. Manag Sci 46:186–204

Wang S, Avrunin G (2008) Plug-and-play architectural design and verification. In: Architecting dependable systems V. Springer, Berlin/Heidelberg

Warfield J (2006) An introduction to systems science. World Scientific, Hackensack

White PRR (2002) Appraisal—the language of evaluation and stance. In: Verschueren J, Östman J-O, Blommaert J, Bulcaen C (eds) The handbook of pragmatics. John Benjamins, Philadelphia, pp 1–23

Vittorio Scarano is Computer Science Associated Professor at the Dipartimento di Informatica of Università di Salerno. He is coauthor of more than 150 papers in journals and international conferences (with reviews) at IEEE, ACM etc. and was advisor (or co-advisor) of 12 PhD thesis in Computer Science at the University of Salerno. His research is mainly focussed on open data, distributed, parallel and cooperative systems, and to their applications in the fields of collaborative learning and virtual interactive environments (Cultural Heritage).

Delfina Malandrino is an Assistant Professor at the Dipartimento di Informatica of the University of Salerno. Her research activities mainly focus on: privacy, distributed systems, collaborative systems, social networking, privacy, social network analysis, green computing.

Michael Baker is a Research Director (tenured Research Professor) in psychology and language sciences, of the Centre National de la Recherche Scientifique (CNRS). He currently works in the Social and Economics Science Department of Telecom ParisTech, the French National Telecommunications Engineering School. His research aims to analyse and model the processes of knowledge elaboration in dialogues produced in learning and work situations, focussing on argumentation and the role of technological mediation. Michael Baker recently published the following book, with Baruch Schwarz: "Dialogue, Argumentation and Education: History, Theory and Practice" (Cambridge University Press, New York, 2017).

Françoise Détienne is research director at CNRS, Paris. Her research in cognitive ergonomics focusses on collaboration, design, creativity and online communities as well as on the role of socio-technical systems. She is associate editor of International Journal of Human Computer Studies, and member of the editorial board of Interacting With Computers and CoDesign.

Jerry Andriessen is a senior scientist and research director of Wise & Munro learning Research, The Hague, Netherlands. Wise & Munro participates in many innovative European projects, on technology, open data, collaboration, primary education, and cybersecurity. These projects add societal relevance to their scientific implications. Jerry has more than 25 years of experience in uses of technology for support of learning and collaboration in various settings. His current interest is in the qualitative interpretation of discourse and action, including the roles of emotions.

Mirjam Pardijs is an independent educational scientist. She is co-director of Wise & Munro Learning Research, the Hague, Netherlands. She specialises in the design, coaching, and interpretation of collaborative learning in educational and professional contexts. Her main interests are narratives as a tool for learning, appropriation of technology, and the role of pedagogical support for innovation in learning settings.

Dr. Adegboyega Ojo is Senior Research Fellow at the Insight Centre for Data Analytics, National University of Ireland Galway (NUIG). He leads the E-Government Group at Insight Centre, serves as Adjunct Lecturer at the College of Engineering and Informatics. His current research interests include data driven innovations in government, Open data policies and Infrastructures, data analytics and governance of smart cities. He is member of the Editorial Boards of the Government Information Quarterly and International Journal of Public Administration in the Digital Age.

Michael Hogan is a senior lecturer and researcher at NUI, Galway, Ireland. His research foci include individual, social and technology factors contributing to adult learning, motivation, and collaborative performance. He is a co-director of the Structured PhD in Perception, Cognition and Action, co-director of the Structured PhD in Learning Sciences, and a co-leader of the Health and Wellbeing theme at the Whitaker Institute for Innovation and Social Change, NUI, Galway.

Albert Meijer is a Professor of Public Innovation at the Utrecht School of Governance in the Netherlands. His research focusses on e-government, government transparency, co-production in the public sector and public innovation.

Erna Ruijer is a postdoctoral researcher at the Utrecht School of Governance in the Netherlands. Her research focuses on open data, government transparency, open government and government communication.

The 6-Values Open Data Business Model Framework

Fatemeh Ahmadi Zeleti and Adegboyega Ojo

Abstract Business models for open data have emerged in response to the economic opportunities presented by the increasing availability of open data. However, scholarly efforts providing elaborations, rigorous analysis and comparison of open data models are very limited. This could be partly attributed to the fact that most discussions on open data business models are predominantly in the practice community. This shortcoming has resulted in a growing list of open data business models which, on closer examination, are not clearly delineated and lack clear value orientation. This has made the understanding of value creation and exploitation mechanisms in existing open data businesses difficult and challenging to transfer. Following the Design Science Research (DSR) tradition, we describe a 6-Value (6-V) business model framework built as a design artifact to facilitate the explication and detailed analysis of existing open data business models in practice. Based on the results of the analysis, we identify business model patterns and emerging core value disciplines for open data businesses. Our results not only help streamline existing open data business models but helps in linking them to the overall business strategy through value disciplines.

Introduction

Recently, attention of major stakeholders in the open data (OD) community, including policymakers have shifted to the economic value of OD assets. OD constitute an important resource around the world due to its potential to empower citizens, businesses, change how government performs, and improve the delivery of public

F.A. Zeleti (✉)
Insight Centre for Data Analytics @NUI Galway, Insight Centre, IDA Business Park,
Lower Dangan, Galway, Ireland
e-mail: Fatemeh.Ahmadizeleti@insight-centre.org

A. Ojo
Insight Centre for Data Analytics, National University of Ireland Galway,
Lower Dangan, Galway, Ireland
e-mail: Adegboyega.Ojo@insight-centre.org

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_9

services (Manyika et al. 2013). Consequently, e-Government programs increasingly support opening up data and publishing OD on regional, national and international portals. This has spurred a growing number of small and medium enterprises seeking to tap into the potential of OD. As new entrants flood the marketplace, businesses are seeking to position themselves uniquely through specialization to create and capture value for their stakeholders (IBM Business Consulting Services 2005).

Business models are conceptual instruments for describing how value is created for OD customers (IBM Business Consulting Services 2005; Krcmar et al. 2011; Casadesus-Masanell and Ricart 2010; Brettel et al. 2012) and how revenue is generated and captured by organizations (Zott et al. 2010; Plé et al. 2008; Bekkelund 2011). Business models developed to harness the potential value of OD are increasingly available but not well understood. There are very few scholarly studies on business models for the OD industry. The lack of rigor (e.g. the use of a proper conceptual framework) in describing and analyzing existing Open Data Business Models (ODBMs) makes delineation and comparison of the models difficult. In fact, ODBMs are used interchangeably with revenue models, pricing strategies, distribution models, marketing techniques and architectural models (HM Government 2013; Relations et al. 2011). For example, while Howard (2014) claims that Open Source is an ODBMs, The 451 Group (2008) claims otherwise. Another example is the use of different names and labels for very similar business models making analysis difficult.

In this chapter, we address this problem by consolidating reported business models in both academic and practice literature, rigorously describe the models based on a 6V business model conceptual framework, and determining the ODBMs patterns and OD business value disciplines. Our contribution in this work is three-fold: (1) Consistent elaboration of existing business models based on the 6V business model conceptual framework we constructed grounded in traditional business models literature, (2) Determination of core OD business model patterns, (3) Determination of value disciplines for the open data-driven organizations.

Literature Review

Open Data

Nowadays, a surprising amount of data is generated and stored than at any other time in history (van den Broek et al. 2012; Avital and Bjorn-Andersen 2012). However, not all data can be published or made available to public for free. Some data is commercially confidential; some are sensitive personal information, which cannot be shared for reasons of privacy and security. However, where it is appropriate to do so, and the right protections have been taken, such as removing personal identifiers or aggregating data, sharing or linking data can bring both social and economic benefits (HM Government 2013; Fensel 2013).

As a practice of good governance, governments globally started to open up their public information in various domains, such as transportation, education, mobility, and meteorology (van den Broek et al. 2012; Relations et al. 2011). This is what is so-called OD. When data is freely accessible and re-usable by public, it could have a larger impact on citizens' ability to hold governments accountable and stimulate innovation (van den Broek et al. 2012).

The more technical view of OD is when OD is considered as machine-readable information, particularly government data available to others (Manyika et al. 2013; Davies et al. 2013). OD is published in common standards, accessible through non-proprietary software, and subject to open licenses (Julien 2012). Data can be raw data or processed data. It may be related to public services or related to internal processes (Julien 2012; Vickery 2011; Ren and Glissmann 2012; IBM Institute for Business Value Government 2011; Deloitte 2012). However, there are also limits to what can be released (Vickery 2011).

OD can help uncover consumer preferences, allowing businesses to improve new products (Manyika et al. 2013), increase revenue, and expand the supply and value chain (Capgemini Consulting 2013). Julien (2012) has also claims that OD will provide market intelligence for businesses. However, to benefit and capture value from OD and build or expand the business value chain, businesses are required to develop sufficient business model.

Business Models

A business model describes how value is created and captured by an organization through the decisions made and the resulting consequences (Lambert 2008). In our study, we adopt the notion of the business model provided by Osterwalder (2004) which considers a business model as a conceptual tool that contains a set of interrelated elements that allows a company to earn money. It comprises a description of the value a company offers to one or several segments of customers, the architecture of the firm, and its network of partners for creating and delivering this value to generate profitably and sustainable revenue streams.

Three major business models are reviewed in this section. The various elements or components of these models were elicited from various sources including Plé et al. (2008), Morris et al. (2005), Calia et al. (2007), Lambert and Davidson (2013), Boons and Lüdeke-Freund (2013), Casadesus-Masanell and Ricart (2009), Casadesus-Masanell and Zhu (2011), Bonina (2013), Lüdeke-Freund (2009), Angot (2010), and Janssen and Zuiderwijk (2014).

Osterwalder and Pigneur Business Model

Osterwalder and Pigneur (Osterwalder 2004; Osterwalder and Pigneur 2009) presents a business model canvas with nine building blocks. Model is presented in Fig. 1. The model includes key partnership, key activities, key resources, value

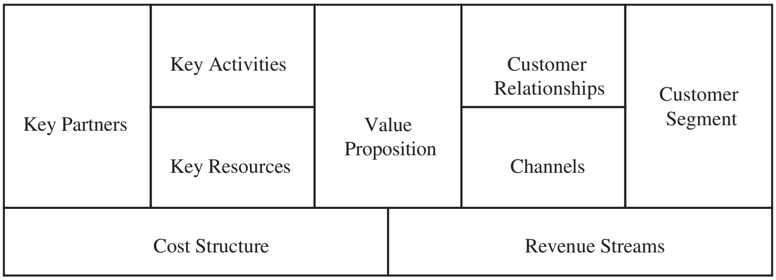


Fig. 1 Osterwalder business model canvas (Osterwalder and Pigneur 2009)

proposition, relationships with the customers, customers, channels, revenue stream and cost structures.

Customer Segment: It defines the groups of people or entities a business aims to reach and serve.
Customer Relationship: It describes the types of relationships a business establishes with specific Customer Segments.
Channel: It describes how a company communicates with and reaches its Customer Segments to deliver a Value Proposition.
Value proposition: It describes the bundle of products and services that create value for a specific Customer Segment.
Key activities: They describe the most important things a company must do to make its business model work.
Key resources: They include important assets required to make a business model work.
Key partners: They describe the network of suppliers and partners that make the business model work.
Revenue stream: It represents the cash a business generates from each Customer Segment (costs must be subtracted from revenues to create earnings).
Cost structure: It describes all costs incurred to operate a business model.

Shafer, Smith and Linder Business Model

Shafer et al. (2005) based their framework on the four elements common to most business models: Strategic choices; value creation; value network; and capture value. Figure 2 presents the model.

Strategic choices: It defines strategies a business has to be able to develop to offer a unique product to the customer. This is an element of the strategy formulation process. Strategic choice adds value to a strategy.
Value network: It defines a network of suppliers and partners required to implement the business model.
Create value: It describes value creation mechanisms from the different activities.
Capture value: It defines the process of recovering some or all of the value created for the customer.

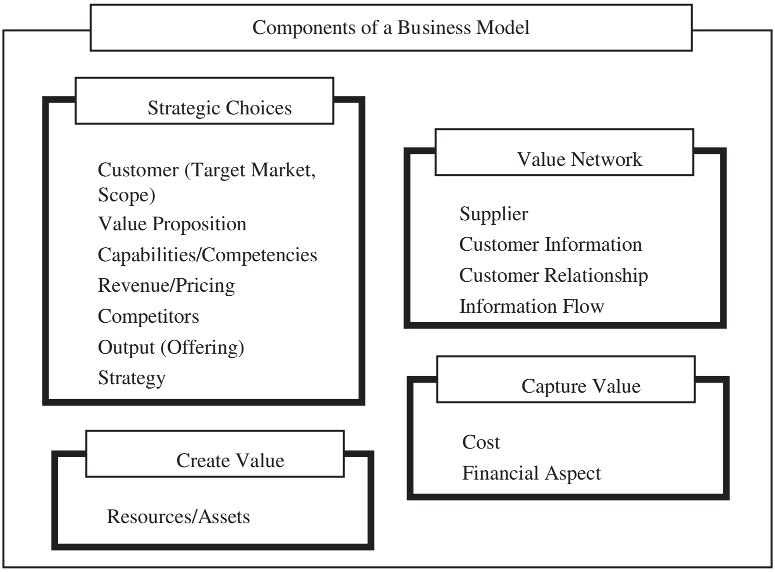


Fig. 2 Four components of a business model (Shafer et al. 2005)

Hamel Business Model

The business model framework described by Hamel (2000) characterizes a business model with three main components: Customer benefits (link between the strategy and the customer needs), Configuration (company-specific combination of resources, skills and procedures, which is used to support a given strategy) and Company frontiers (decisions regarding activity, which require recourse to the added value of an external network). Figure 3 presents the framework.

Customer logic: It defines a segment of people a business aim to reach and serve. The Logic part defines all the activities required to maintain and improve the segment.
Strategy: It defines strategies a business must develop to offer a unique product to the customer. This is an element of the strategy formulation process. Strategic choice adds value to a strategy.
Resources: It describes the most important assets required for a business model work.
Network: It defines a network of suppliers and partners that make the business model work.

Existing Business Models

Various business models have been identified in the literature, mainly in the practice community. These include: Howard (2014), Ferro and Osella (2013) identified eight ODBMs: Premium, Freemium, Open Source, Infrastructural

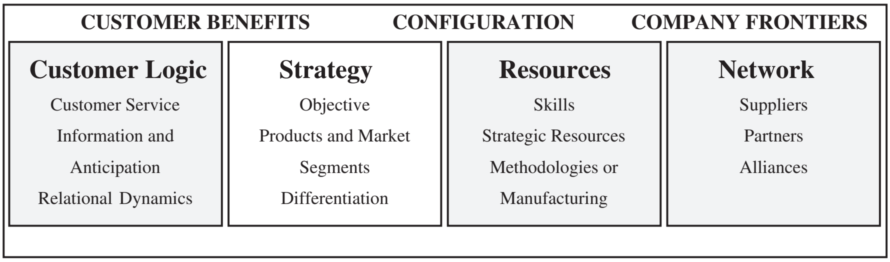


Fig. 3 Hamel business model (Hamel 2000)

Razor and Blades, Demand-Oriented Platform, Supply-Oriented Platform, Free as Branded Advertising and White-Label Development. Models identified by Musings (2012) are Cost Avoidance, Sponsorship, Dual Licensing, Support, and Services, Charging for Changes, Increasing Quality through Participation, and Supporting Primary Business. Description of each model above is presented in the appendix as well as in Zeleti et al. (2014)). Models above are not clearly defined and mix many concepts. Table 1 presents a very brief description of each model.

Conceptualization

Building on existing conceptual and theoretical roots, it is possible to develop a standard framework for characterizing a business model. Therefore, our 6V conceptual model is grounded in the extant literature of business models, as shown in Fig. 4. By consolidating elements of the various business model frameworks and careful analysis of the literature, we identified six core elements of a successful business model. We refer to our resulting framework as the *6-V Business Model Framework* (see Fig. 5).

The elements of the 6-V framework include *value proposition*; *value adding process*; *value network*; *value in return*; *value capture*; and *value management*.

Value Proposition specifies the value that business is offering. Value proposition included product, services, distribution channel, information, and price.

Value Adding Process delivering value requires value-adding process including key activities and resources such as physical resources, human resources, supply chain management, partnerships, and technology. Value adding process is classified into three:

Operational includes activities, organizational structure, technologies and logistics systems, revenue model, resources and assets and financial model;

Table 1 List of existing ODBMs

Models	Description
Premium	In the premium business model, the offering is high-end products and services, and the customer has to pay (Huber 2011).
Freemium	In the freemium, quality product is given away for free for a short period and then customers are asked to pay when they are hooked on the free product (Teece 2010).
Open Source	Product in this model is provided in a totally open format that allows free elaboration, usage, and redistribution without any technical barrier (Ferro and Osella 2013).
Infrastructural Razor and Blades	A razor-blade business model is about selling a product for a low price to generate revenues from the complementary products (Graeme Pietersz 2013).
Demand-Oriented Platform	This model involves charging consumers (e.g. developers) for the added value (Howard 2014)
Supply-Oriented Platform	This business model entails the presence of an intermediary business actor having an infrastructural role (Ferro and Osella 2013).
Free as Branded Advertising	This model encourages audience towards a brand or a company by delivering commercial messages through visualized data which is also called “display advertising” (Ferro and Osella 2013).
White-Label Development	A white-label product is a new product or service developed by one company but acquired and rebranded by another as theirs (Howard 2014).
Cost Avoidance	This model reduces the cost of data publishing by having a sustainable publishing solution (Epimorphics Ltd 2012).
Sponsorship	This model entails giving the product for free to customers and obtaining revenue from some sponsors (Casadesus-Masanell and Zhu 2011).
Dual Licensing	Dual licensing is based on the idea of the simultaneous use of both open source and proprietary licenses (Välimäki 2003). Products are given away in an open license for certain purposes and under a closed license for others (Musings 2012).
Support and Services	This model ensures that the paid packages are given away with guarantees for paying customers (Musings 2012).
Charging for Changes	In this model, the fee is applied for changes made to the product (Musings 2012).
Increasing Quality through Participation	This model involves increasing participation and satisfaction of the customer with the goal of generating higher margins (Angot 2010).
Supporting Primary Business	This model is used when releasing product naturally supports the primary goal of business or organization (Musings 2012).

Strategic planning includes market or the target customer, competencies, capabilities, pricing and the control of costs, branding, differentiation, legal issues, mission and trust;

Knowledge management includes innovation and documents.

The Value in Return what is received from the value adding process either monetary or non-monetary value including revenue, advertising space, future contracts and opportunities and rent or commission.

Value Capture Value capture is the process of retaining some percentage of the value provided in every transaction. This allows the business to use the output from the value in return to rethink and redesign to support the value proposition.

Value Management top managers play a significant role in the whole process. This includes mindset, organization, governance, stakeholders and shareholders.

Value Network all the business activities are done within the value network. This includes customers, suppliers, information flow, product flow, service flow and partner businesses.

Extending the 6-V business model framework presented in Fig. 4 and to better understanding the model components, we present the 6-V model in table form that provides second-level and third-level components. Each of the 6-V business model main component includes sub-components (second-level components) in which each sub-component consists of other sub-components (third-level components).

Authors/ Papers studied

Context	Lambert, 2008	Shafer et al., 2005	Hamel, 2000	Lauguna et al., 2004	Sandberg, 2013	IBM Bus. Cons., 2005	Goethals, 2009	Casadesus & Ricart 2010	Boons & Lüdeke, 2013	Chesbrough & Rosenbloom, 2002	Klievink & Janssen, 2012	Hamel, 2000	Demil & Lecocq, 2010	Chesbrough & Rosenbloom, 2000	Teece, 2010	Brettel et al., 2012	Massa, Zott, & Amit, 2010	Closs, 2011	Osterwalder, 2004	Yip, 2004	Wikström et al., 2010	Klievink & Janssen, 2012	Pandav, 2012	Doligalski, 2010
Value Network																								
Customer	x	x	x	x	x		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Information Flow		x							x		x											x		
Product Flow		x				x			x															
Service Flow		x	x						x															
Supplier	x	x	x	x					x	x		x	x	x			x	x	x	x	x		x	x
Partner Businesses		x			x				x			x	x	x		x	x	x	x	x	x	x	x	x
Value Proposition																								
Product	x	x		x					x	x	x	x	x	x	x		x	x	x		x	x	x	x
Service	x	x				x			x	x	x	x	x	x			x	x			x	x		x
Channel	x	x			x	x				x		x			x		x	x	x	x	x	x	x	x
Information	x	x	x	x									x						x					x
Price		x	x			x				x	x	x		x			x		x		x	x		x
Value Adding Process																								
Operation																								
Activities	x			x	x	x							x				x	x	x				x	
Org. Structure	x																							
Tech/Systems	x		x		x				x	x							x		x					
Revenue Model		x			x	x	x			x	x				x		x	x	x			x	x	
Resources/Assets	x	x	x			x	x					x	x				x	x			x		x	

Fig. 4 Components of a business model

Financial Model		x							x								x					x		
Strategic Planning																								
Market/ Segment	x	x	x		x					x		x			x		x	x			x		x	
Competencies	x	x	x		x					x		x	x		x		x				x		x	
Capabilities	x	x			x					x		x			x		x		x		x		x	
Cost & Pricing		x			x					x					x	x	x	x			x	x	x	
Branding		x															x							
Differentiation		x	x		x							x					x							
Legal issues																	x							
Mission		x	x														x		x					
Knowledge Mngt.																								
Innovation							x	x	x	x					x	x	x		x		x			
Documents												x												
Value in Return																								
Revenue	x									x			x		x		x							
Advertising Space	x																							
Future Contracts	x																							
rent	x																							
Commission	x																							
Value Capturing																								
Profit Formula										x					x		x							
Profit		x			x						x				x	x	x							
Financial Performance											x						x							
Value Mngt. Model																								
Mind-set												x					x							
Organization								x									x			x	x	x		
Governance								x														x		
Stakeholders								x								x	x							

Fig. 4 (continued)

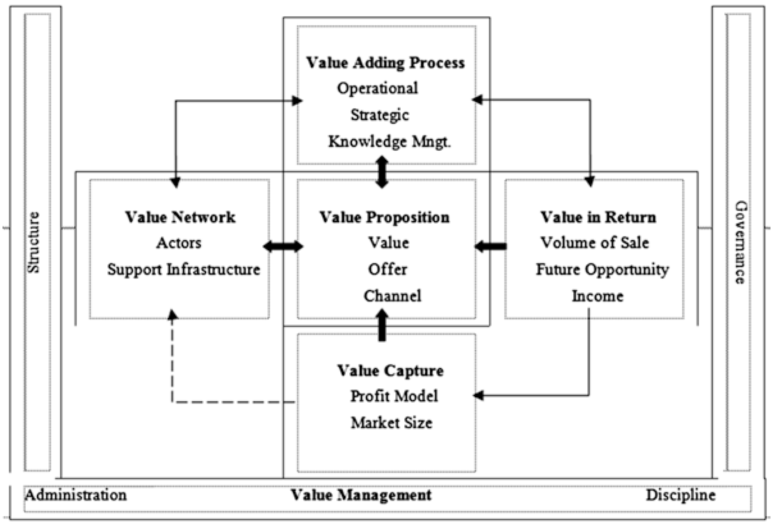


Fig. 5 The 6-V business model conceptual framework

Table 2 6-V model's top-level and low-level components

6-V Model Components	Second-Level Components	Third-Level Components
Value Proposition	Offer	Product, Service; Information
	Channel	Delivery Method
	Value	Price/Value for Money
Value Adding Process	Operational	Activities and Processes; Technologies and Systems; Resources and Assets
	Strategic	Market Segment/Position/Geographical Expansion; Logistic Systems; Competencies and Capabilities; Profit Model/Stream/Formula; Revenue Model/ Sources/Stream/Mechanisms; Financial Model; Pricing Mechanisms; Competitors and Competitive Outcomes; Internal Value Chain Structure; Cost Structure and Pricing; Branding and Marketing; Networking and Resource Leveraging; Differentiation; Legal Issues; Mission
	Knowledge Management	Innovation (Incremental and Disruptive); R&D
Value in Return	Volume of Sale	Volume of Product Sale
	Income	Revenue; Rent and Commission
	Future Income Opportunities	Advertising Space; Future Contract
Value Capture	Market Size	Product Cost and Quality
	Profit/Margin Model	Profit/Margin; Financial Performance
Value Network	Actors	Customer; Partner Businesses
	Supporting Infrastructure	Customer Relationship/Interface; Product, Service, Information and Resource Flow; Supplier/Supply Chain; Logistical Stream
Value Management	Discipline	Mind-Set and Dynamic Consistency
	Governance	Governance
	Structure	Organizational Structure (Organization Entity and Arrangement);
	Administration	Administrative Processes

For example, value proposition can include an *offer*, *channel,* and *value* in which *offer* can include *product*, *services* and *information*; *channel* can include a *delivery method* and *value* can include better *price* or the *value for money*. Table 2 shows this classification.

Model Elaboration

In this section, we apply the 6-V model described in section "Conceptualization" to characterize the 15 business models in the context of OD. We do not include Value Management in the analysis because it executes control over the performance of the entire model to ensure the components are set appropriately to meet the objective/s. The resulting information is presented in Table 3 and highlighted below.

Cost Avoidance offers sustainable publishing solution, cost avoidance, and improved meaning of data and data integration as a value in return.
Sponsorship offers free and useful data to the public and provides availability of data to public as a value in return.
Freemium offers free but limited data and high-quality data at some cost and provides limited availability of useful free data to public and perceived value of data as a value in return.
Premium offers specific customer need and provides perceived value of data as a value in return.
Dual-Licensing offers free data for non-commercial uses and high-quality data for commercial use and provide limited availability of useful free data to public and perceived data as a value in return.
Support and services offer high value-adding data services and provide perceived value of data as a value in return.
Charging for changes offers free but limited data services and high-quality data at some cost and provides limited availability of useful free data to public and perceived value of data as a value in return.
Increasing quality through participation offers a higher quality of data and provides higher data quality as a value in return.
Supporting primary business offers strategic support to the business objective and provides improved in business results as a value in return.
Open source offers free data for non-corporate use and quality data for corporate use and provides limited availability of useful free data to public and perceived value of data as a value in return.
Infrastructural razor and blades offer incomplete data at a discount price while the complementary parts cost higher. It provides perceived value of data as a value in return.
The demand-oriented platform offers high quality and reliable data at some cost and provides commoditization and democratization of data as a value in return.
Supply oriented platform offers efficient and scalable infrastructure and provides perceived value of data as a value in return.
Free as branded advertising offers useful data for public and provides perceived value of data as a value in return.
The white-label development offers useful data services and Apps and provides saving in development time and budget as a value in return.

Analysis: Open Data Business Model Partners and Value Disciplines

The ultimate goal of understanding the business model variations in the digital world is to be able to analyze them to address the real-world problems that the business faces. It's one thing to understand what business model mean for different

Table 3 ODBMs elaboration based on the 6-V model

	Value Proposition	Value Adding Process	Value Network	Value in Return	Value Capture
Premium	• Meeting specific customer data need	• Publishing • Data maintenance	• Mostly business clients	• Perceived value of data	• Lump sums Revenue
Freemium	• Free, but limited data services • High-quality data at some cost	• Availability of different machine-readable formats • Unconstrained numbers of API calls • More sophisticated querying, • Access to data dumps rather than through an API (or vice versa) • Provision of feeds of changes to the data • Enhancement of the data with additional information • Early access to data • Provision of data on DVDs or hard disks rather than over the net	• Clients (mostly consumers B2C)	• Limited availability of useful free data to public • Perceived value of data	• Revenue from the small % of the free users • Charges for additional data or advanced features
Open Source	• Free data for non-corporate use • High-quality data for corporate use	• Publishing data • Data maintenance	• Mixed clients (B2B,B2G, B2C)	• Limited availability of useful free data to public • Perceived value of data	• Revenue from added value services
Infrastructural Razor & Blades	• Incomplete data at low cost • Complete data at higher cost	• Update data • Maintenance	• Developers • Clients	• Perceived value of data	• Revenue from data

Demand-Oriented Platform	• High quality and reliable data at some cost	• Refining Datasets • Collecting and cataloging data • Harmonizing data regarding formats and exposed through APIs	• Developers	• Commoditization and democratization of data	• Revenues in exchange for advanced services and refined datasets or data flows
Supply-Oriented Platform	• Efficiency • Scalable infrastructure	• Data retrieval • Standardization of formats • Automated external exposure of data via APIs and GUI	• Technology companies • Publisher (who is selling)	• Perceived value of data	• Revenue from potential advertisers
Free, as Branded Advertising	• Useful data for the public	• Data visualization	• Software development • Companies • Developers	• Perceived value of data	• Revenue from Adverts
White-Label Development	• Useful data services and Apps	• App making • App upgrading	• Mostly Business Clients • Developers	• Save development time and budget	• Lump sum Revenue
Cost Avoidance	• Sustainable publishing solution • Cost avoidance	• Publishing data as Linked Data • Data retrieval	• EU, parliaments • Government department • People	• Improve the meaning of data and data integration	• Sustainable publishing practice • Proactive data release
Sponsorship	• Free data and useful for public	• Publishing process	• Sponsors • Clients	• Availability of data to public	• Revenue from sponsors
Dual Licensing	• Free data for non-commercial use • High-quality data for commercial use	• Publishing data • Data maintenance	• Developers • Clients	• Limited availability of useful free data to public • Perceived value of data	• Revenue from added value services

(continued)

Table 3 (continued)

	Value Proposition	Value Adding Process	Value Network	Value in Return	Value Capture
Support and Services	• High value-adding data service	• Guarantees on data availability • Prioritization on bug fixes (both in data and its provision) for paying customers • Timely help for customers using the data • Services around data visualization • Analysis and mashing with other data	• Mostly business clients	• Perceived value of data	• Revenue • Presence in the service market
Charging for Changes	• Free, but limited data services • High-quality data at some cost	• Update data • Availability of different machine-readable formats • Unconstrained numbers of API calls • More sophisticated querying • Access to data dumps rather than through an API (or vice versa) • Provision of feeds of changes to the data • Enhancement of the data with additional information • Early access to data	• Mostly business clients	• Limited availability of useful free data to public • Perceived value of data	• Revenue from added value services
Increasing Quality through Participation	• Availability of higher quality data	• Update data • Cleansed data • Feedback	• Developers • Lawyers • Academics and government • Clients as an active player	• Higher quality data	• Revenue • Client satisfaction
Supporting Primary Business	• Open data supporting strategic business objective	• Publishing data • Providing APIs	• Developers • Clients	• Improved business results	• Revenue • Customer satisfaction

businesses, but it's quite another for a business to be able to distinguish different business models and understanding what business model suits their business. The elaboration in Table 3 shows that the 15 reported business models are ODBMs as they are well defining each component in the context of OD and therefore can be utilized by OD businesses. We further seek commonalities in the 15 ODBMs, and this will give us insight into what are the core ODBM patterns available and what OD business value disciplines can best define the model a business wish to employ. ODBMs patterns and value disciplines aid businesses especially innovative start-ups to define the right business model. Business model patterns and value disciplines are described below.

Open Data Business Model Patterns

The first part of our analysis identifies the major patterns of business models focusing on value propositions – a central element of the business model which are directly associated with customers and external entities. The centrality of the value proposition in the design of business models is clearly reflected in our 6V business model conceptual model in section "Conceptualization". Specifically, we determined the business model patterns from the 15 ODBMs (see Table 3) by examining the similarities between value propositions as well as a careful comparison of what each model offers, tries to achieve and how. Our analysis resulted in five major business model patterns including *Freemium*, *Premium*, *Cost Saving*, *Indirect Benefits* and *Parts of Tools* categories. In Table 4, we describe specific ODBMs comprising each pattern. We also identify what 'offer,' 'Channel for delivering value', and 'Price/Value for money' mean and can include in each pattern.

Fermium includes *Fermium*, *Dual-Licensing*, *Charging for Changes*, *Open Source*, and *Free as Branded Advertising* models. All the models in this category offer limited data free of charge and apply fees for additional request for complete and higher quality datasets.

Premium includes *Sponsorship*, *Support and Services*, *Demand-Oriented Platform*, *Supply-Oriented Platform*, *White-Label Development* and *Premium* models. Data in this category is not offered free of charge. However, data are offered in high quality and complete form at some cost.

Cost Saving includes *Increase Quality through Participation* and *Cost Avoidance* models. Models in this category do not entirely cover the cost, but reduce the cost of opening and releasing data by engaging participants and publishing data as Linked Data. Data user or re-user participants play a vital role in this category as by active participation publishing data can happen at a lower cost.

Indirect Benefit includes *Supporting Primary Business* model. Opening up data in this category is strategic and releasing open data naturally supports the primary goal

Table 4 ODBM categories

Fermium Pattern	Offer	Channel	Price/Value for Money
Fermium, Dual-Licensing, Charging for Changes, Open Source, and Free as Branded Advertising	Limited data services, Quality data, Useful data	Data Portals, Data visualization platforms or display advertising	Limited dataset for free of charge, quality dataset at some costs
Premium Pattern			
Sponsorship, Support and Services, Demand-Oriented Platform, Supply-Oriented Platform, White-Label Development and Premium	Data services, Quality data, Efficient and scalable infrastructure, Useful data	Data Portals, Data Publishing Platforms, APIs, and Graphical User Interfaces	Quality data provided at a fee
Cost Saving Pattern			
Increase Quality through Participation and Cost Avoidance	Quality data, Sustainable publishing solution, Cost reduction	Data portals, Linked Data	Reduce cost of opening and releasing data
Indirect Benefit Pattern			
Supporting Primary Business	Quality data for supporting business strategic objectives	Data portals, Apps, Marketplace of created tools and Apps by other organizations	Releasing organization's data for free that can be used by others to make tools that improve the releasing organization
Parts of Tools Category			
Infrastructural Razor and Blades	Incomplete data, Complete data	Cloud computing platforms, API	Incomplete data for lower cost and complementary or dependent data at a higher cost.

of the business. Model in this category allows the business to develop its data and data infrastructure by using the third-party infrastructures that are created because the data is open and available.

The Parts of Tools includes *Infrastructural Razor and Blades* model. The business strategy in this category is to offer the first set of data at a discount while offering complementary or dependent data at a considerable higher price.

As can be seen from Table 4, most of the 15 ODBMs belong to *Fermium* and *Premium* categories. Consequently, in the open data business community, more emphasize is given to *Fermium* and *Premium* models than the other three categories.

Value Disciplines

A business model – and value proposition in particular – is shaped by the business's underlying value discipline which describes different ways a business can differentiate itself from competitors. It is a strategic focus that enables a business to set its vision and objectives. Value discipline helps a business to tailor value proposition to exactly match the need. Therefore, before identifying the business model, defining business value discipline is necessary.

Our approach to identifying the implicit value disciplines for ODBMs patterns is based on the analysis of the model attributes such as value proposition and value in return. Determination of the value disciplines enables analysis of the required capabilities to enable attainment overall business objectives. A Delphi-like process involving the three co-authors of the research was adopted in the analysis of Table 3, resulting in four types of value disciplines for OD businesses. The identified value disciplines converged on *Usefulness*, *Process Improvement*, *Performance* and *Customer Loyalty*, which are explained below:

Usefulness, tailors, value proposition to support directly the needs of consumers in one way or another. Business strategic focus, corporate vision, and business objectives should be defined to meet usefulness of the offer. *Usefulness* is associated with the *Freemium*, *Dual-Licensing*, *Charging for Changes*, *Open Source* and *Free as Branded Advertising*. These models all somewhat focus on the usefulness of the data offered to the clients as the business value disciplines.

Process Improvement, tailors value proposition to match to the needs of the customer specifically for improving processes. *Process improvement* is associated with *Cost Avoidance* model. Business oriented on *Process Improvement*, aim at greater efficiency to reduce cost by optimizing its processes. OD published based on this discipline targets improving business processes.

Performance, tailors, value proposition for better performance. Performance is associated with *Support Primary Business* model. Businesses with this orientation aim to release data which support their primary business objectives.

Customer Loyalty, tailors, value proposition to target customer loyalty. This is associated with *Premium* and *Infrastructural Razor and Blades*. Business with *Customer Loyalty* value discipline should apply *Premium* or *Infrastructural Razor and Blades* model to adjust their processes to meet the clients' satisfaction and build customer loyalty.

Table 5 shows that *Usefulness* value discipline is the most popular value discipline in the open data industry followed by the *Customer Loyalty*.

Summary

Finally, we organize existing ODBMs regarding their inherent value disciplines and their respective categories as shown in Table 5. For instance, an OD business which aims to focus on customer loyalty can have two choices for their business model which are *Infrastructural Razor and Blades* and *Premium*. Business can choose one depending on the business model category they aim to target.

For OD businesses aiming at increasing performance as their value discipline can have one choice for a business model which is *Support Primary Business*.

Table 5 ODBMs and value proposition categories

	Value Disciplines				
		Usefulness	Process Improvement	Performance	Customer Loyalty
Category	Parts of Tools	NA	NA	NA	Infrastructural Razor and Blades
	Indirect Benefit	NA	NA	Support Primary Business	NA
	Cost Saving	Increasing Quality through Participation	Cost Avoidance		NA
	Premium	Sponsorship, Support, and Services, Demand-Oriented Platform, Supply-Oriented Platform, White-Label Development	NA	NA	Premium
	Fermium	Fermium, Dual-Licensing, Charging for Changes, Open Source, Free as Branded-Advertising	NA	NA	NA

Similarly, for OD businesses aiming at improving processes as their value discipline can have one choice for a business model which is *Cost Avoidance*.

Most of the business models are targeting *Usefulness* value discipline. The nature of useful value provided will vary from one customer to another. *Increasing Quality through Participation*, *Sponsorship*, *Support and Services*, *Demand-Oriented Platform*, *Supply-Oriented Platform*, *White-Label Development*, *Freemium*, *Dual-Licensing*, *Charging for Changes*, *Open Source,* and *Free as Branded-Advertising* belongs to this value discipline. Depending on the business model patterns, a business can come up with a proper business model for the business. Table 5 shows this positioning.

Conclusion

All businesses either explicitly or implicitly should employ a particular business model. Similarly, OD businesses must utilize ODBMs. The first and foremost activity of emerging businesses is to identify the value discipline before identifying a particular business model. This particular research field; OD business value disciplines; is missing and literature on ODBMs is also very limited to some number of websites and presentation files. Besides, regarding business models, various scholars present generic business model differently.

Our research findings clearly answered to the problems above both at the research and business levels. We also confess that the 6V business model conceptual framework, core ODBMs patterns – *Freemium, Premium, Cost Saving, Indirect Benefit* and *Parts of Tools* – and new OD business value disciplines – *Usefulness, Process Improvement, Performance* and *Customer Loyalty* – contribute significantly to business model and ODBMs literatures and assist not only start-ups and SMEs but also big businesses to deliver full value to their stakeholders.

This study provides insight to governments and government authorities by providing knowledge of the importance of availability and accessibility of OD for innovation and transparency. This allows more businesses and development of OD products like APIs. For example, with a focus on realistic local solutions, initiatives like CitySDK are working with pilot cities to create uniform APIs that have standard approaches to how APIs expose local government data. Therefore, governments have a new way of saving and making money by becoming a provider for the city. By opening the data, governments allow city (businesses and developers) to create products. Governments can also establish a partnership with private sectors to benefit. Therefore, governments should seek to identify how publishing OD can be done in a way that it provides value to general public and facilitates the development of both free and commercial products.

References

Angot J (2010) Customer-integrated business models : a theoretical framework. Management 13:226–265

Avital M, Bjorn-Andersen N (2012) The value of open government data: a strategic analysis framework. In: SIG eGovernment pre-ICIS Workshop, no. 2002

Bekkelund KJ (2011) Succeeding with freemium. Norwegian University of Science and Technology, Trondheim

Bonina CM (2013) New business models and the value of open data: definitions , challenges and opportunities, London

Boons F, Lüdeke-Freund F (2013) Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. J Clean Prod 45:9–19

Brettel M, Strese S, Flatten TC (2012) Improving the performance of business models with relationship marketing efforts – an entrepreneurial perspective. Eur Manag J 30(2):85–98

Calia RC, Guerrini FM, Moura GL (Aug. 2007) Innovation networks: from technological development to business model reconfiguration. Technovation 27(8):426–432

Capgemini Consulting (2013) The open data economy unlocking economic value by opening government and public data

Casadesus-Masanell R, Ricart JE (2009) From strategy to business models and to tactics

Casadesus-Masanell R, Ricart JE (2010) From strategy to business models and onto tactics. Long Range Plann 43(2–3):195–215

Casadesus-Masanell R, Zhu F (2011) Business model innovation and competitive imitation: the case of sponsor-based business models

Davies T, Perini F, Alonso JM (2013) Researching the emerging impacts of open data ODDC conceptual framework

Deloitte (2012) Open data driving growth, ingenuity and innovation

Doligalski T (2010) Strategies of value proposition on the Internet. Perspect Innov Econ Bus 5(2):2–4

Epimorphics Ltd (2012) Linked open data business models. Epimorphics Ltd. [Online]. Available: http://www.epimorphics.com/web/blogs/martin.

Fensel D (2013) Steps towards a data value chain, Salzburg

Ferro E, Osella M (2013) Eight business model archetypes for PSI re-use, London

Graeme Pietersz (2013) Razor-blade model. Graeme Pietersz. [Online]. Available: http://money-terms.co.uk/razor-blade-model/

Hamel G (2000) Leading the revolution, New York

HM Government (2013) Seizing the data opportunity: a strategy for UK data capability, UK

Howard A (2014) Open data economy: eight business models for open data and insight from Deloitte UK. O'Reilly Media, Inc.,. [Online]. Available: http://radar.oreilly.com/2013/01/open-data-business-models-deloitte-insight.html.

Huber MH (2011) Designing your business model slideshare.net. [Online]. Available: http://www.slideshare.net/hubesm/designing-your-business-model

IBM Business Consulting Services (2005) Component business models Making specialization real

IBM Institute for Business Value Government (2011) Opening up government: how to unleash the power of information for new economic growth, New York

Janssen M, Zuiderwijk A (2014) Infomediary business models for connecting open data providers and users. Soc Sci Comput Rev 32:694–711

Julien N (2012) Business opportunities arising from open data policies. Imperial College London

Krcmar, H, Böhm, M, Friesike S, Schildhauer T (2011) Innovation , society and business: Internet-based business models and their implications. In: 1st Berlin symposium on Internet and society

Lambert S (2008) A conceptual framework for business model research. In: 21st Bled eConference on eCollaboration: overcoming boundaries through multi-channel interaction, pp 277–289

Lambert SC, Davidson RA (2013) Applications of the business model in studies of enterprise success, innovation and classification: an analysis of empirical research from 1996 to 2010. Eur Manag J 31(6):668–681

Lüdeke-Freund F (2009) Business model concepts in corporate sustainability contexts for "business models for sustainability"

Mai L, Zhang Z, (2011) The Freemium Business Model in Gävleborg's Open Source Software Industry – a Case Study on ArcMage AB

Manyika J, Chui M, Groves P, Farrell D, Van Kuiken S, Doshi EA (2013) Open data: unlocking innovation and performance with liquid information

Morris M, Schindehutte M, Allen J (2005) The entrepreneur's business model: toward a unified perspective. J Bus Res 58(6):726–735

Musings J (2012) Open data business models. [Online]. Available: http://www.jenitennison.com/blog/node/172

Osterwalder A (2004) The business model ontology: a proposition in a design science approach, UNIVERSITE DE LAUSANNE ECOLE

Osterwalder A. Pigneur Y (2009) Business model generation

Plé L, Lecocq X, Angot J (2008) Customer-integrated business models: a theoretical framework. Management 13:226–265

Relations K, Huijboom N, Van Den Broek T (2011) Open data: an international comparison of strategies

Ren G-J, Glissmann S (2012) Identifying information assets for open data: the role of business architecture and information quality. In: IEEE 14th international conference on commerce enterprise computing, pp 94–100

Shafer SM, Smith HJ, Linder JC (2005) The power of business models. Bus Horiz 48(3):199–207

Teece DJ (2010) Business models, business strategy and innovation. Long Range Plann 43(2–3):172–194

The 451 Group (2008) Open source is not a business model, New York
Välimäki M (2003) Dual licensing in open source software industry. Syst d'Information Manag 8(1):63–75
van den Broek T, Rijken M, van Oort S (2012) Towards open development data
Vickery G (2011) Review of recent studies on PSI re-use and related market development, Paris
Zeleti FA, Ojo A, Curry E (2014) Business models for the open data industry: characterization and analysis of emerging models. In: 15th annual international conference on digital government research
Zott C, Amit R, Massa L (2010) The business model: theoretical roots, recent developments and future research, Madrid

Fatemeh Ahmadi Zeleti is a researcher at the e-Government unit at the Insight Centre for Data Analytics @ National University of Ireland Galway (formerly Digital Enterprise Research Institute (DERI) – a leading center in Semantic Web and Linked Open Data research). At the Insight Centre, her research and development work addresses capabilities for open data-driven organizations and how business (for-profit and nonprofit) entities can effectively leverage [Linked] Open [Government] Data for optimizing business processes and product and service innovation. In 2016, her research results have been selected as the best practice to address and achieve European PSI Directive (2003/98/EC). She is the moderator of the World Bank Open Data Innovation Network and an active member of the Swedish Research Network in e-Government and ImmigrationPolicy2.0.

Dr. Adegboyega Ojo is Senior Research Fellow at the Insight Centre for Data Analytics, National University of Ireland Galway (NUIG). He leads the E-Government Group at Insight Centre, serves as Adjunct Lecturer at the College of Engineering and Informatics. His current research interests include data driven innovations in government, Open data policies and Infrastructures, data analytics and governance of smart cities. He is member of the Editorial Boards of the Government Information Quarterly and International Journal of Public Administration in the Digital Age.

Technology Innovations in Public Service Delivery for Sustainable Development

Jeremy Millard

Abstract This chapter focuses on how ICT can be deployed to assist in the design and delivery of innovative public services in support of sustainable development. In many parts of the world, and especially in developing countries, basic public services like education, health, basic infrastructures, as well as water and sanitation, are often poor and patchy even when available. Such services are reflected in the United Nations Sustainable Development Agenda for 2030, and also address challenges like poverty, food, housing and employment. All of these need innovative public service delivery if targets are to be achieved by 2030. However, the provision of such services is increasingly challenged by the diversity of social needs across different locations and population segments. Mainstream, largely off-the-shelf, ICT has tremendous potential today and in the near future to innovatively address these needs and challenges, and there are already many valuable experiences both from developed and developing countries about how this can make huge differences to public service delivery. The chapter also addresses the governance and policy issues that need to be addressed in this context.

Introduction

The use of new technologies by governments in many countries around the world has led to widespread innovations and transformations across many aspects of the public sector over the last 15 years. The most significant technological advance over this period has been in information and communications technology (ICT) which has dramatically impacted public services and their delivery, both via websites and portals over the Internet, mobile and especially smart phones and social media, as well as being available through kiosks located in places accessible to the public. ICT-enabled public service delivery is having significant impact by generally being more cost effective than traditional supply investments. They also give the service user large benefits in terms of access, convenience through 24/7 availability, savings

J. Millard (✉)
Danish Technological Institute, Taastrup, Denmark
e-mail: Jeremy.millard@3mg.org

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_10

in time and the cost of travel to physical premises, as well as the possibility of completely new types of public services.

The role of ICT in public service delivery needs to be seen in context. First, especially in developing countries, non-digital service delivery channels, such as traditional post, telephone call centers, over the counter face-to-face services in citizen centers, as well as TV and radio, remain important. However, these can be significantly improved by adding a digital channel, for example, by using satellite broadcasting and multi-channel learning services through mobile Internet centers connecting teachers, learners and communities. The back offices of service providers can also be digitized and joined-up to provide innovative solutions for enhancing service delivery.

Secondly, many service components require direct human interaction in health, care, education and building personal and trusting relationships through dialogue and empathy, where ICT can be a valuable support tool for front-line staff. ICT is being used innovatively to provide instant access to remote and hard-to-reach people regardless of time or location over large areas and distances. ICT solutions have been used to better handle and analyze large amounts of data in more standard, routine and rule-governed processes and transactions, thereby reducing overall transaction costs and increasing process efficiency. It can, when this is rationally planned, enable the re-deployment of staff and other resources away from routine government processes into face-to-face engagement with users where this adds most value.

Third, ICT has emerged as a key tool for capacity building by streamlining administrative processes and providing opportunities for the learning and training of public servants. ICT should thus be seen as a very powerful additional channel enabling new types of innovative service delivery. It should be on the agenda of all public service providers alongside existing traditional channels, and for delivering new services for which previously there were neither adequate resources nor means of delivery.

A basic aim of innovative public service delivery is to ensure the universality of basic services in order to "leave no one behind"[1] as this is absolutely essential in order to achieve the United Nations Sustainable Development Goals (SDGs) by 2030.[2] Given that many developing countries still have not been able to deliver basic services like education, health, water and sanitation, as well as infrastructures and other utilities, to all their population regardless of who they are or where they live, a much greater focus on ICT needs to be made given its extremely low cost, its power of reach and its ability to be relatively rapidly rolled out (Ericsson and the Earth Institute 2016). Thus, the aim in these countries is to ensure access for all through the universal availability of such basic services. The more developed economies have, by and large, already realized universal access, so here the focus tends to be on more advanced and personalized services enabled by ICT as the next step, although there are also many examples of such services in developing countries as this chapter demonstrates.

[1] http://www.una.org.uk/content/global-development-goals-leaving-no-one-behind

[2] http://www.un.org/sustainabledevelopment/sustainable-development-goals/

According to the Global Opportunities Network (2016), which surveys leaders in business, civil society and politics on how to turn global risks into opportunities for collaborative action specifically in relation to the SDGs, technology must play a significant role. In fact, of the three dimensions surveyed – technology, economy and political will power – technological capacity is consistently perceived to be the lowest barrier to change. Hence, technology is a strong driver of all opportunities identified including in relation to public service delivery. However, technology tends to be a weaker driver in lower Human Development Index (HDI) regions, pointing to a strong need for technology transfer to developing countries. The survey also shows that, of the three dimensions, political will power consistently scores low across all nine geographical regions, except China. The government sector shows the largest gap between the perception of being affected by the opportunities and their expressed likelihood to pursue them. Hence, leaders in the public sector tends to recognize the opportunities of technology, feel affected by them, but do not think they have the capacity to act on them.

This is a serious challenge especially given that ICT has become today's 'general purpose' technology, just as steam power and electricity were in the past, i.e. it underpins and enables most other technological advances, without which these would not be possible. These include new technologies like:

- the Internet of Things (IoT) using sensors to link everything including physical objects to the Internet for monitoring environmental pollution wearable technology enabling sensors attached to the human body to monitor vital life signs
- robotics providing assistance for disabled people and older persons who are housebound artificial intelligence used, for example, in education and health to assist in decision making
- so-called 'big data' where public service data is combined with data from many other sources and can be made open for greater transparency and accountability, as in open government or science data smart electrical grids for improving the efficiency and effectiveness of power supplies
- 3D printing and other additive manufacturing technologies which public administrations can use to produce one-off or specialized components for a wide range of technical and maintenance tasks, including for example in war zones to rapidly fabricate prosthetic limbs for the injured the use of drones to deliver vital medical or other supplies to remote areas or in emergencies
- the potential of new blockchain technologies for secure and distributed archives, registers and records, participatory decision-making, etc.

All these new technologies, made possible by ICT, are currently used to design and deliver innovative public services in a few countries, and this is certain to increase significantly in future with lessons already being drawn. However, in many parts of the world, and especially in developing countries, such public service delivery applications are still some years in the future. On the other hand, mainstream, largely off-the-shelf, ICT has tremendous potential today and in the near future in such countries, and there are already many valuable experiences both from developed and developing countries about how this can make huge differences to public service delivery. This chapter focuses largely on this issue, together with the use of such mainstream ICT alongside and in support of the more traditional delivery channels mentioned above.

Whereas some countries have exploited the full potential, there remain large disparities in whether and how ICT is used for innovative public service delivery between global regions, between and within countries, between different target populations and for different types of services. In particular, many developing countries have hardly begun to exploit ICT in this way, despite the huge potential benefits in doing so. In developing countries in general, there is a lack of reach and quality of public services, a lack of efficiency and effectiveness in service provision, and infrequent linking to issues of good governance. ICT can do much to directly remedy these disparities which this chapter addresses.

Structure of This Chapter

The rest of this chapter examines, in turn, four main focus areas in which technology innovations can significantly enhance public service delivery in the context of sustainable development.

- Section 2: "Improving Access to Basic Public Services Using Innovative ICT"
- Section 3: Strengthening the Governance of Basic Services Through Innovative Technology Solutions
- Section 4: Meeting the Social Needs of Target Populations
- Section 5: Enhancing the Policy and Strategic Framework for Basic Services

In each of these areas, the analysis and examples will focus mainly on the so-called universal 'basic' public services of education, health and water, as well as on infrastructure and utilities, as these are fundamental building blocks needed for sustainable development to take place.

The analysis in each of the above sections consists of two main parts. First, an examination of the challenges which need to be addressed. Despite the great potential of ICT for innovating public service delivery and the fact that many achievements have already been made, there remain many significant challenges to overcome, especially inequity in digital infrastructures and services between and within countries; insufficient use of technologies to improve governance; the highly diverse social needs of target populations which need to be met; and inadequate policy and strategic frameworks.

The second part in each chapter will examine how technology innovations can significantly improve public service delivery for sustainable development. Governments are by far the most important actor in public service delivery, although this often takes place in collaboration with non-public actors, so their role is also critical in meeting the SDGs by 2030. This means that, rather than relying only on existing solutions which are clearly failing to make the progress needed, a significant investment in ICT will be necessary. Research undertaken by Ericsson and the

Earth Institute (2016) characterizes the SDGs as highly ambitious "stretch" goals that "will require a transformation of societies that is far deeper and faster than in the past. If they are to be achieved, these goals must leverage existing and widely deployed technologies, such as broadband, but also require new innovative services and improved reach of technological solutions." "ICT will play a special role in today's low-income countries, a point strongly and cogently emphasized by the UN's Broadband Commission (Broadband Commission 2014). In essence, ICT are "leapfrog" and transformational technologies, enabling all countries to close many technology gaps at record speed." According to the United Nations (2015), public service delivery comprises a number of strategies. First, both enhancing both the quality and reach of public services, as well as improving the efficiency of public service delivery. Second, providing strong public sector leadership and government structures, and collaborating with non-state actors, especially civil society, and sharing information and resources. Third, improving the overall effectiveness of the public sector and promoting good governance. All of these strategies can be significantly enhanced by the use of ICT and other new technology, as will be demonstrated for each of the four focus areas mentioned above.

The scope of this chapter is global given that the SDGs have been agreed by virtually all member states of the United Nations in September 2015 as part of the 2030 Sustainable Development Agenda.[3] Thus, the examples used to illustrate each of the four areas are drawn from countries around the world. The final section "Conclusions and Lessons Learnt" of the chapter provides overall conclusions and lessons learnt.

Improving Access to Basic Public Services Using Innovative ICT

Challenges to Be Addressed

There are significant disparities in digital infrastructure and services between countries, within countries and between various groups within a country. These constitute serious barriers to the successful use of new technologies for the delivery of public services especially in the developing countries which need it most. The inequity directly contributes to socio-economic inequalities generally, reflecting the multivariate causes of poverty and deprivation in many countries and which seriously challenges the potential for sustainable development (Millard 2015a).

For instance, new technologies including ICT, can assist in education and learning but its innovative use is limited in many countries. Even where Internet access is available, many people in developing countries do not possess the necessary basics of computer literacy. Figure 1 illustrates wide inequities among regions with Africa as a region lagging far behind others.

[3] http://www.un.org/sustainabledevelopment/development-agenda/

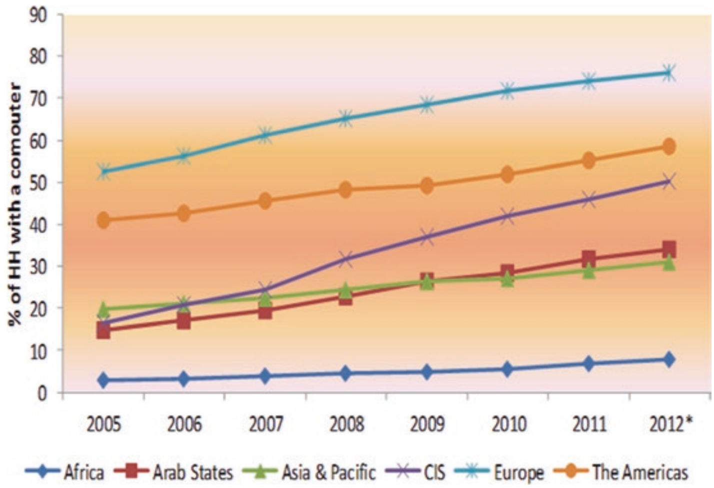


Fig. 1 Global functional digital literacy (International Telecommunications Union 2013)

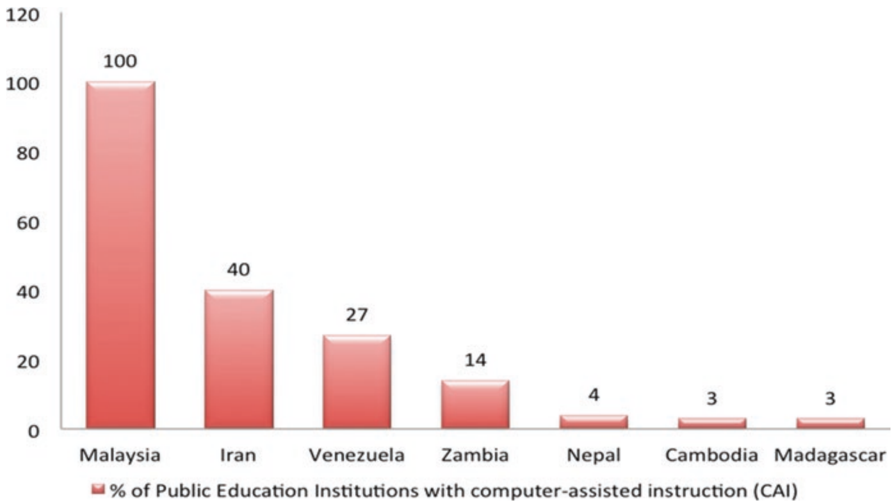


Fig. 2 Public Education Institutions with Computer-Assisted Instruction (CAI) in 2012 (UNESCO Institute for Statistics (2014). ICT Infrastructure 1 – ISCED 1,2 and 3. Retrieved from: http://www.uis.unesco.org/DataCentre/Pages/BrowseCommunication.aspx)

The challenge in many developing countries is both lack of opportunity for basic education as well as limited programmes in schools for computer literacy. There are also wide disparities in the access and use of ICT in education among developing countries. For instance, as Fig. 2 shows, while 100% of the public institutions in Malaysia provide computer-assisted instruction (CAI) at the secondary school level, only 3% of public schools in Cambodia and Madagascar do so.

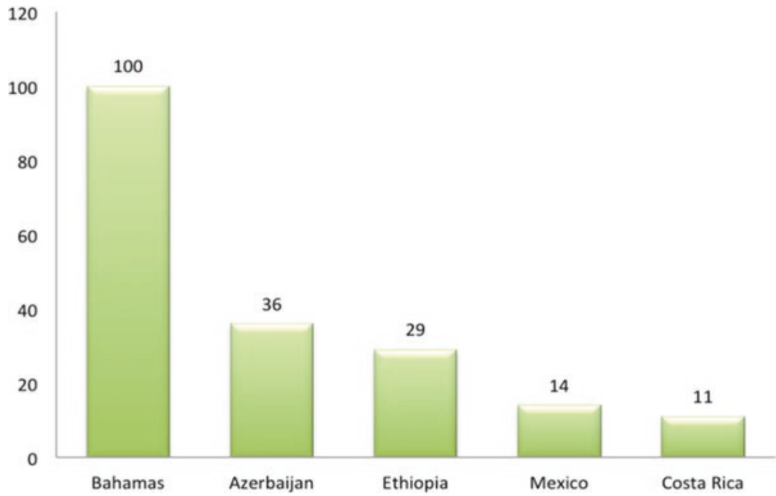


Fig. 3 Percentage of Public Education Institutions with Television-Assisted Instruction (TAI) in 2012 (*op cit.*)

If basic education levels are low in a country, television can be successfully deployed for learning, both in and out of school. However, a similar picture appears in the use of television-assisted instruction (TAI) in public schools in some countries. As Fig. 3 shows, high-income countries such as the Bahamas use TAI in 100% of the public schools, while lower income countries such as Ethiopia, Mexico and Costa Rica have relatively few public education institutions which deploy technology for secondary education.

There is also a significant lack of Internet content in local languages in a large number of countries that impairs the quantity and quality of digital public service delivery. Over 50% of the content is in English as the dominant global Internet language, though around 25% of Internet users are able to access it.[4] Local language and content is of particular importance for people who speak no other languages. Local languages are intrinsic to the local cultural context, and thus can be essential for finding and using appropriate public services, as well as understanding and participating in local policy issues. However, developing countries often adopt ICT hardware and software that are designed in the developed world (especially in English-speaking countries) and introduced to them through technology transfer programs, and this can become an important barrier to populations not skilled in such languages.

Given the potential trans-boundary and 24/7 reach of ICT, opportunities for e-learning provided by the private sector are globally abundant. However, lack of

[4] Internet language data is from "The Usage of Content Language for Website Survey" from W3Techs, http://w3techs.com/technologies/overview/content_language/all, retrieved February 2016; Internet user data is from "The Internet World User by Language Survey" from Internet World Stats, http://www.internetworldstats.com/stats7.htm, retrieved February 2016.

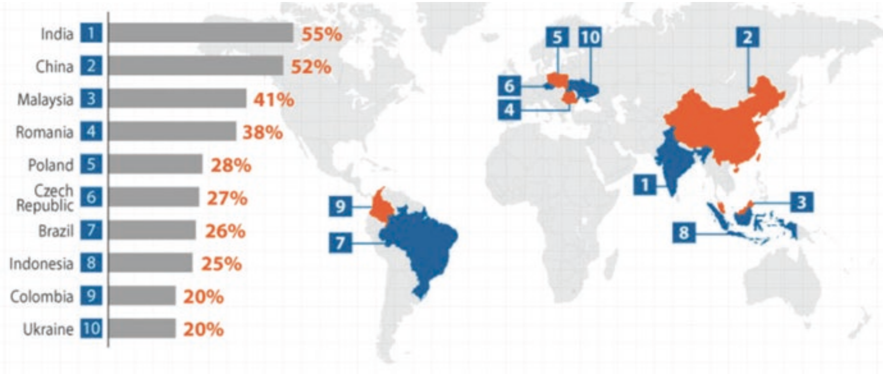


Fig. 4 Top 10 self-paced e-learning growth rates by country 2010–2015 (http://elearningindustry.com/elearning-statistics-and-facts-for-2015, Retrieved April 2016)

functional literacy restricts access to these as well. The global e-learning market was expected to reach $107 billion by 2015, with the global self-paced e-learning market component of this reaching $49.9 billion in 2015.[5] Although the largest global market share remains concentrated in developed countries, some emerging economies are now starting to grow much faster and to catch up (Docebo 2014). Figure 4 indicates that the top ten growing countries consist largely of such emerging economies, but again shows that Africa is largely missing from this development.

In terms of e-health, Fig. 5 shows the total global market size forecast for 2016 and, once again, underlines the dominance of developed countries and especially the USA. However, the sheer size of China with the rapid growth in demand for health and e-health services is also evident.

A large part of the lack of optimal use of new technologies for service delivery is digital infrastructure disparities, including factors such as the cost and quality of ICT connection and related services available to users. The comparison between different ICT infrastructures across types of countries in Fig. 6, shows significant gaps between developed countries on the one hand and developing and less developed countries on the other. However, this gap is least in relation to mobile cellular access given that demand here is strongest because of the very large price, convenience and ease-of-use advantages compared with the other infrastructures.

Technology Innovations in Public Service Delivery

As noted above, the innovative use of ICT is needed to fully meet the SDGs by 2030 as this makes it possible for millions more people in developing countries who previously had no access to basic public services to be able to do so, for example in

[5] http://elearningindustry.com/elearning-statistics-and-facts-for-2015, Retrieved April 2016.

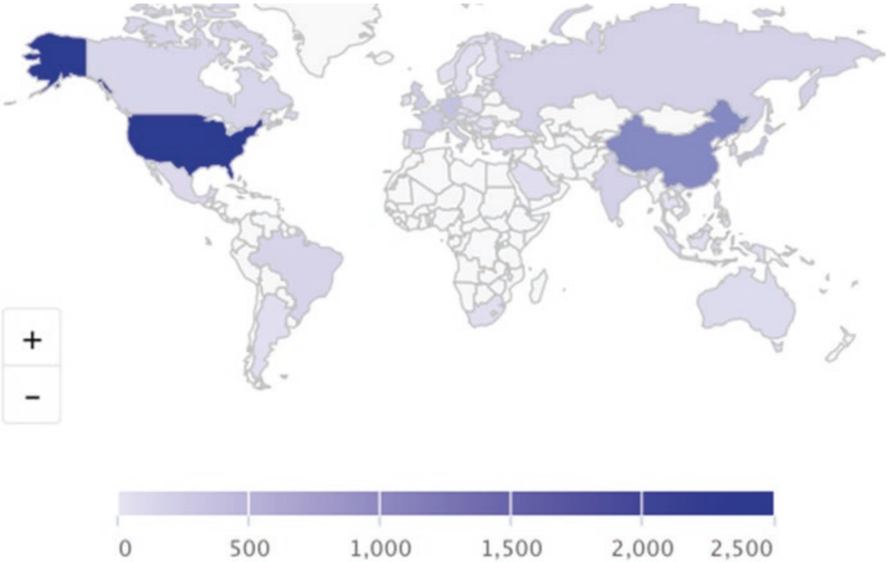


Fig. 5 E-health global revenue 2016 forecast $US million (https://www.statista.com/outlook/312/109/ehealth/united-states#market-global, Retrieved April 2016)

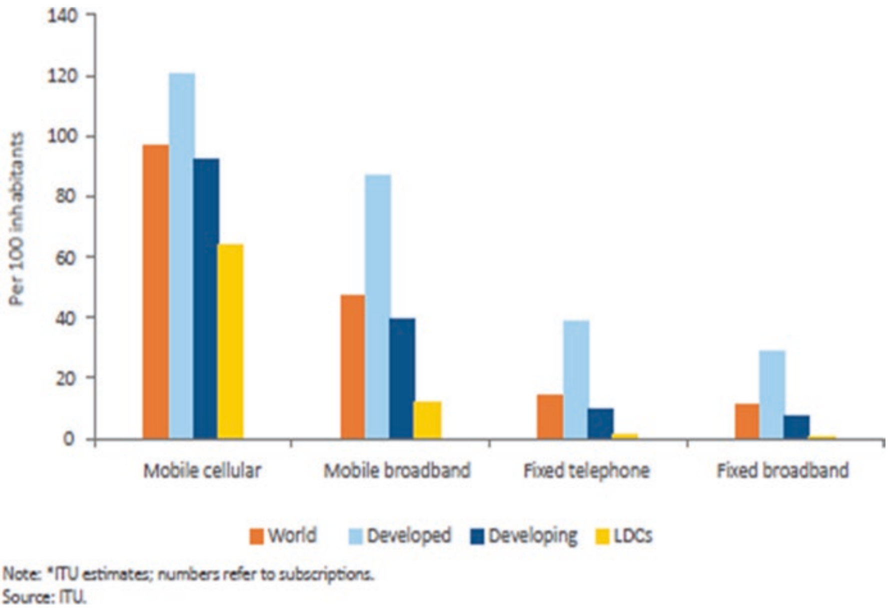


Fig. 6 ICT access by development status, 2015 (International Telecommunications Union 2015)

under-served areas like shanty towns or rural and remote locations.[6] "Leaving no one behind"[7] in this way has been a key feature of preparations for the SGDs and the 2030 Sustainable Development Agenda, and it is clear that the use of ICT is an important component of this objective.[8] For instance, in Tanzania, an innovative poverty mapping tool using GIS data has been developed to improve geographical identification of the poorest villages, which are beneficiaries of the country's social protection scheme.[9] ICT can also improve the speed and convenience of public services access through 24/7 availability, considerably reduce the cost of access, and in some cases provide completely new types of public services. As mentioned in section "Introduction", the use of ICT can also enhance and complement the continued use more traditional channels, such as over the counter, the postal service, telephone call centers, or TV and radio, where these remain more appropriate forms of communication and interaction with public officials or other service providers.

ICT can dramatically widen access to and the scope of education for anyone with a computing device and access to the Internet or mobile network. It can provide anywhere-anytime education, facilitate personalized education and new learning environments, as well as provide data for learning analytics which can be used to plan and monitor educational provision as well as precisely target services to specific needs and groups. ICT can also support crowd learning and citizen inquiry, and make education more attractive and appealing using gaming approaches. The Quest to Learn (USA)[10] is a collaboration between the Institute of Play, New Visions for Public Schools and the New York City Department of Education. It combines learning and gaming to meet the needs and interests of children who are anyway increasingly engaging in digital media platforms. The Professor-Why project in Poland[11] combines computer generated images with real images and introduces online students to the world of science to be explored both at school and at home, as well as supporting virtual experiments. The project has had significant impact due to dissatisfaction with the current form of chemistry education, and the lack of real experiments in schools which greatly impoverishes the study of chemistry.

[6] Text of speech of Mahmoud Mohieldin. Corporate Secretary and President's Special Envoy. The Independent Commission on Multilateralism, New York, United States at the 2030 Agenda for Sustainable Development and Addressing Climate Change. The World Bank. November 12, 2015. http://www.worldbank.org/en/news/speech/2015/11/12/as-prepared-for-delivery-the-2030-agenda-for-sustainable-development-and-addressing-climate-change-the-independent-commission-on-multilateralism

[7] http://www.una.org.uk/content/global-development-goals-leaving-no-one-behind

[8] https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9534.pdf

[9] Text of speech of Mahmoud Mohieldin. Corporate Secretary and President's Special Envoy. The Independent Commission on Multilateralism, New York, United States at the 2030 Agenda for Sustainable Development and Addressing Climate Change. The World Bank. November 12, 2015. http://www.worldbank.org/en/news/speech/2015/11/12/as-prepared-for-delivery-the-2030-agenda-for-sustainable-development-and-addressing-climate-change-the-independent-commission-on-multilateralism

[10] www.q2l.org

[11] www.professor-why.pl

The School of One project (USA)[12] deploys mass-customization techniques that use detailed data of each student and of the teaching curriculum to automatically personalize the pedagogy and the content to meet individual needs. Daily instructions are issued of how and what math skills to practice so as to meet each student's specific needs and abilities, as well as preferred ways of learning.

Traditionally, educational needs have mainly been met by very high cost physical buildings and top-down centralized institutions and, although these will remain highly important for the many situations in which face-to-face learning still provides advantages, education is being changed drastically by many forms of online education and e-learning. These developments are essential for being able to "leave no one behind", for example, there are huge potential advantages of so-called open educational resources consisting of course content, curricula and other support materials, made available by ICT.

MOOCs – Massive Open Online Courses: A Global Phenomenon[13]

MOOCs make available all types of educational courses and material for unlimited participation with typically free and open access for everyone connected to the internet anywhere in the world. They also directly address the need for lifelong education and learning as well as the up-skilling of the labour force. MOOCs offer a flexible, wide reaching and inexpensive way of meeting societies' need for education of all types through democratizing access and providing, in principle, no limits on the numbers participating. An example of a MOOC platform is Coursera (Coursera.Org), based at Stanford University in California, which is currently the biggest MOOC platform with over 600 free courses across multiple subjects and well over 7 million users. Coursera is working with a variety of business models, such as charging a fee for certificates, tuition fees for accredited courses, a 'career service' selling student information to potential employers and advertisers, fee-based assignment grading and making enterprises pay to run their own training courses.

ICT is of course critical to the success of MOOCs and is used by Coursera in both the learning and assessment process. Although there have been correspondence and open courses before, ICT provides the means for the massive expansion of this type of education, often through 'blended' learning where online channels are combined with offline and face-to-face channels. Like any other use of ICT by end users to benefit from public services, there are potential barriers in the form of often limited access to high speed networks and of digital literacy.

Source: United Nations (2015)

[12] http://izonenyc.org/ in New York.

[13] Yuan, L (2013). *MOOCs and Open Education: Implications for Higher Education.* CETIS; http://blog.coursera.org/post/29062736760/coursera-hits-1-million-students-across-196-countries; and http://www.nytimes.com/2013/11/01/education/us-plans-global-network-of-free-online-courses.html?hpw&_r=3&

Leaving no one behind in health care is also an area being revolutionised by ICT both through greater outreach, for example, by mobile phones, as well as in innovating public service delivery through service personalization and thereby more targeted high quality and convenient health services for individual patients, alongside traditional 'warm hands' interaction with public service staff. More sophisticated ICT is also becoming more mainstream in many countries, like body sensors to monitor a patient's condition, or the analysis of a patient's data over time in the context of large numbers of similar patients which can speed up diagnosis and make treatment more appropriate. The role of process, operational and organisational innovations supported by ICT is also very important, as well as the benefits of emulating innovations from commercial companies.

For example Ghana, with the support of international development organizations, is setting up an Integrated eHealth System to focus on developing foundational systems and outreach to underserved communities in the country Ghana Health Service 2016). The Patient Briefcase initiative in Denmark is a remote service connecting the patient in her/his own home with professional medical and care personnel through live video and audio channels over a broadband Internet link (European Commission 2013). It is the result of collaboration between the public and private sectors, originally supported by public innovation funds (both European and Danish), as well as private investment by the company involved itself, and today functions as a fully commercial operation. The service places strong focus on user-friendliness and making it easy for patients to be 'admitted to hospital' in their own homes. It is also an example of how the hospitals as service provider have been able to significantly change they way they work to fully exploit the technology by caring at a distance whilst routine aspects are automated. This frees up staff time to have more personal contact with patients who need it, as well as dramatically decreases transport costs and carbon emissions, whilst saving staff and patient waiting time.

The PatientsLikeMe service in the UK[14]is a free patient online network where people can connect with each other to better understand their diseases, share condition and treatment information, and get support from peers to improve their health. It is also a research platform for medical staff given that when patients report on their disease experiences, they provide real-world insight into diseases and long-term conditions based on their anonymized data. Those insights are shared with companies, government organizations and others who use them to continuously develop more effective products, pharmaceuticals, services and care.

More standard and inexpensive ICT can also have a significant impact on health issues. mPedigree is an African-based for profit company spun out of a non-profit organization founded by a Ghanaian social entrepreneur. Launched in 2007, it works with mobile operators and pharmaceutical manufacturers to provide a mobile phone-based drug verification system for addressing the issue of counterfeit drugs in pharmacies at the point-of-sale in Ghana, Kenya, and Nigeria. The mPedigree service is free to users and allows instant verification of whether a drug is real or counterfeit by sending a unique code via simple SMS and getting an automated response in appropriate language. The service relies on various partners across the

[14] www.patientslikeme.com

value chain, both private and public, while remaining simple to roll-out to new customers and easy to access for the end-user.[15]

All these uses of ICT illustrate the many different ways ICT can be used to meet the SDGs. There are also examples of how traditionally expensive and high cost healthcare can deploy ICT to support advanced technology in meeting the SDG for healthy lives and the promotion of well-being for all ages by providing cheap but very effective services through innovations on the provider side and in the value chain.

Cost Effective and High Quality Advanced Health Care in India

Narayana health is a multi-specialty hospital chain in India that, by April 2015, had become among the largest telemedicine networks in the world with 6,498 beds spread across 32 hospitals in 20 locations. Although operating like a commercial company, it reinvests its profits ethically and accountably in order to scale impact, typically collaborating with local and state governments as well as civil organizations. The objective is to make quality health care accessible and affordable using both economies of scale and process innovation, rather than product innovation, i.e. obtaining improvements that lower the cost of medical attention and make it more widely available.

Source: http://www.narayanahealth.org

One of Narayana Health's main specialities is cardiac care which only about 8% of the world's population can normally afford. In the US, cardiac surgeries can cost up to $50,000 compared to about $6000 in India, whilst Narayana health has reduced this down to less than $3000, irrespective of the complexity of the procedure. In serving the poor, Narayana health reaches out to patients through a network of rural clinics and via telemedicine facilities. Patients come to the Bangalore facility from more than 50 countries. The philosophy is that no one will be denied treatment due to a lack of funds. This dramatic reduction of costs has not reduced quality as the group has a mortality rate of about 2% and hospital-acquired infection rate of 2.8 per 1000. This favorably compares to the best hospitals across the world.

Source: United Nations (2015)

[15] http://www.eldis.org/go/topics/resource-guides/icts-for-development/icts-and-health&id=61115&type=Document#.Vw7UqKT2aAw

The Narayana Health case is an example of commercially driven operation with public and civil collaboration, but which specifically has a public value purpose as its overall vision. ICT can, in examples like this, enable process, operational and organizational innovations underpinning public service innovations in which the best and most suitable experience might be emulated from commercial companies. When focusing on delivering high quality but low cost public services specifically aimed at the poor, this is an example of 'frugal innovation' showing how much more can be done at much lower cost and with greater outreach, but without compromising quality. The prime purpose is to serve the poor and to do so ethically and accountably whilst drastically reducing costs through innovative business models.

Water and sanitation are vital for basic human health and quality of life and, although these are physical services, ICT can play a vital role in improving access, service delivery and governance. Water in particular is becoming an increasingly scarce resource as demand rises and pollution and climate change take their toll. ICT can, however, significantly enhance the identification, extraction and recovery of water supplies by providers, its efficient and effective access and use, as well as improve distribution and payment systems for users and especially the poor through, for example, mobile payment services (World Bank Group 2015).

There are a number of cases in developing countries where access to good quality water is often a serious challenge which can be addressed using ICT, including rural piped water schemes monitoring in Senegal, Mali, Benin and Niger. One example is Mwater is a mobile and web platform for the monitoring and regulation of 252 water schemes in small towns which typically rely on hand-pumps from piped systems operated by private companies. However, these providers traditionally have poor operational performance with a lack of knowledge about maintenance of the pipes or level of assets, and this can lead to high water tariffs and poor coverage without the use ICT. Data is now collected using mobile phones enabling providers to improve their operations and the regulators to monitor the performance of water schemes.[16] Finding and exploiting suitable water resources can also be significantly improved using ICT to show the reality of the situation on the ground using mobile devices. The data collected is used for decision making in order to establish and ensure the sustainability and quality of WASH[17] services. For example, so-called Water Point Mapping (WPM) in Rwanda has been very successful using mobile data collection in this way, and another example is in Ethiopia.

[16] ICT to improve water governance: World Water Week in Stockholm (2013): http://programme.worldwaterweek.org/event/changing-relationships-ict-2882.

[17] WASH is Water, Sanitation and Hygiene Services.

Government-led Water Point Mapping in Rural Ethiopia

Government-led monitoring in Ethiopia aims to meet the country's universal access plan 2015 to provide safe and sustainable water, sanitation and hygiene for all utilizing a WASH inventory monitoring tool. There is some district government access of water point data, but there is very limited capacity for analysis, interpretation, use and updating. Water point mapping (WPM) is undertaken using mobile phones and GPS, entering the data collected on a spreadsheet, linking this data to Google earth and then preparing maps of viable water resources. This enables decisions to be made about where investments are required, identifying the areas of greatest need or the main reasons for water point failure. It also allows districts to plan effectively, for example in both the north Achefer Woreda District in northern Ethiopia and in the Bonke Woreda District in southern Ethiopia, new water points are being constructed based on accurate and regularly updated data.

Source: ICT to improve water governance: World Water Week in Stockholm (2013): http://programme.worldwaterweek.org/event/changing-relationships-ict-2882

Using a combination of smart phone mapping and data analysis using ICT, provides valuable means to pinpoint precise water source locations, as well as the amounts and quality available. ICT also enables understanding of how these link together and can best be exploited and monitored in a sustainable manner to provide basic services. Both Water Point Mapping and monitoring of water delivery and quality typically take place through public-private partnerships between governments and local authorities, on the one hand, and commercial and/or donor agencies on the other providing both technology and expertise. Partnerships with civil society organizations are often also important through local volunteers undertaking the mapping and providing local knowledge and support on behalf of the community.

Infrastructures and utilities provide the basic physical and organizational facilities needed for the operation of society and for the services necessary for an economy to function, such as roads, water supply, sewers, power grids, and telecommunications. The goal needs to be to provide a universal service of such basic infrastructure, as in the Ethiopia example. ICT is itself an important basic infrastructure, but can also be used both to provide access and to deliver better quality utilities in order to leave no one behind, for example, smart power and water grids, road and congestion monitoring and coordinating public transport. For example, a study on the use of mobile devices in Kenya found that 25% of users could get more work and earn more money because they were more 'reachable' (Crandall et al. 2012). According to the eTransform Africa report (World Bank 2012), easier access via mobile and broadband "is quickly changing lives, driving entrepreneurship fuelled in part by collaborative technology hubs, and delivering innovation and home-grown solutions for Africa." The report focuses on eight key areas: agriculture, climate change, education, financial services, government, health, ICT competitiveness, and trade facilitation and regional integration. It emphasizes the need to build a competitive ICT industry to promote innovation, job creation, and boost the export potential of African companies. Part of this is the flowering of technology hubs across Africa – such as iHub and NaiLab in Kenya, Hive CoLab and AppLab in Uganda, Activspaces in Cameroon, BantaLabs in Senegal, Kinu in Tanzania or infoDev's mLabs in Kenya and South Africa. These hubs are creating new spaces for collaboration, innovation, training, applications and content development, and for pre-incubation of African firms (GSMA 2014).

Given the explosive growth of towns, and especially cities in developing countries, there is also an increasing importance of so-called smart cities using ICT to provide, interconnect and improve the efficiency and effectiveness of basic infrastructures.

Santiago, Chile: Ingredients for a Smart City

The smart city "Santiago of tomorrow" pilot development program starting in 2013 seeks to improve quality of life for its inhabitants by increasing access to energy, creating environmentally friendly smart homes, and emphasizing the use of sustainable energy. Santiago has a population of 5.12 million representing 40% of Chile's population, 85% of which lives in urban areas reflecting urbanization trends globally. The city was named the number one smart city in Latin America in 2013, based on a variety of projects. For example, business and innovation strategies in order to diversify the economy away from primary industries by attracting massive ICT infrastructure investments and inaugurating the "start-up Chile" program in 2010 to establish Chile as "the definitive innovation and entrepreneurial hub of Latin America." there is also a strong focus on energy and buildings supported by ICT infrastructures, with Chile ranked in the global top ten for the most sustainable buildings with investments in green infrastructure, including renewal energy. In terms of mobility, the metro network is based on ICT-based congestion pricing in a 3-tier system throughout the day, providing choices to local commuters, all supported by a central card payment platform. The ubiquitous network of bus routes provides 2 free daily bus arrival updates via text messaging. There is also a strong cycling community with separated bikeways, large public bike racks, and bike sharing programs based on smart phone apps. Similarly, a pilot electric vehicle car-sharing program, the first of its kind in Latin America, uses smart apps for real time information, booking and location updates.

Source: http://cityminded.org/santiago-chile-ingredients-smart-city-10307

In most developed countries, and increasingly in the emerging economies and developing countries, the smart city concept of urban development that integrates ICT solutions to govern, support and manage a city's assets, buildings, institutions, utilities, organizations and people is one of the world's most important development trends. For example, it aims to coordinate and thus optimize transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services. The overall goal is to improve quality of life by using technology to improve both the efficiency and effectiveness of services. ICT enables city officials to interact directly with each other as well as with citizens and businesses, and link these to city infrastructures to monitor what is happening in order to improve the management of urban flows and enable real time responses to problems arising. Through the use of sensors integrated with real-time monitoring systems, data is collected from both people and things, through the so-called Internet-of-Things. The data is then processed and analyzed for the purpose of enhancing the quality, performance and interactivity of urban services, and thereby reduce both costs and resource consumption.

Strengthening the Governance of Basic Services Through Innovative Technology Solutions

Challenges to Be Addressed

There is a significant lack of technology enabled governance in public service delivery. Good governance is essential to create the conditions for achieving better sustainable development outcomes when the public sector is accountable, effective, efficient, equitable, inclusive, participatory, responsive and transparent. ICT has indeed transformed governance in many developed countries over the past 15 years in many of these areas, inducing fundamental changes which are thought likely to increase in pace even more significantly in the future. ICT-enabled good governance is a key factor in a country's national development and underpins its efforts towards the successful achievement of the SDGs in the context of the 2030 Sustainable Development Agenda. It is the role of technology as an enabler, rather than as a stand-alone sector, that impacts development outcomes by increasing the added value in the provision of public services, efficient functioning of institutions, and participatory governance. ICT is also seen as a cross-sectoral enabler by joining up institutions and systems and making them function more efficiently (United Nations 2013).

Public service outcomes are determined by the interplay between decision makers in the public sector, often cooperating with civil society and private companies, as well as closely listening to, and co-creating with, citizens. All these stakeholders are interlinked through institutions, processes, resources, regulations and capacity endowments, each of which are impacted by ICT. However, despite good progress to date, there are wide disparities among and between regions and countries in the use of ICT in institutions, processes, and capacity building. Lack of transparency and accountability in particular continues to hamper public service delivery, impeding full access to services by people, and reflects inadequate governance environments and often weak public administration capacities. A survey of government efforts to control corruption indicates wide disparities. Figure 7 shows differences between selected countries in their perceptions of corruption which strongly reflect the levels of economic and social development in a given country.

A similar global mapping looks at good governance, as shown in Fig. 8, surveyed by the World Justice Project (WJP) through its open government index organized around the four dimensions of: publicized laws and government data; the right to information; civic participation; and complaint mechanisms.

Figure 8 maps the latest national benchmarks and clearly shows that the developed countries consistently score highest on these open government measures. However,

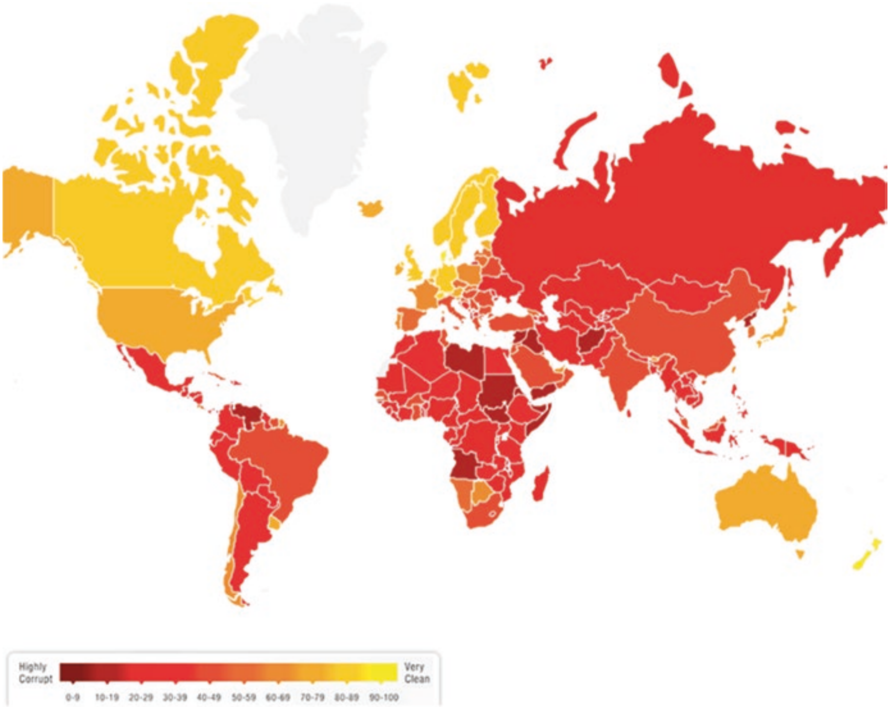


Fig. 7 Corruption perceptions index, 2015 (http://www.transparency.org/news/feature/corruption_perceptions_index_2016)

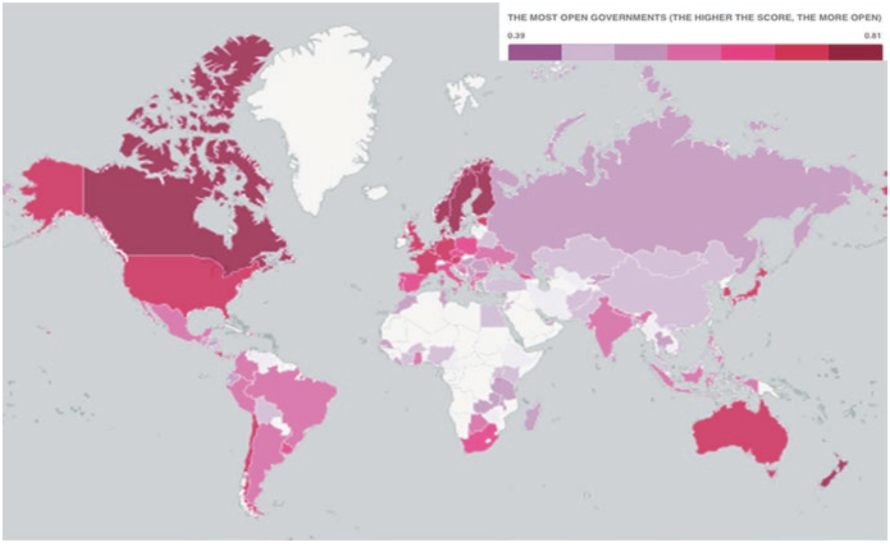


Fig. 8 The World Justice Project's Open Government Index, 2015 (http://worldjusticeproject.org/open-government-index)

as the World Justice Project report shows that, while in general, high-income countries attain higher Open Government Index 2015 scores, in developing countries there is no relationship between GDP per capita and open government. “This suggests that the level of government openness is not necessarily driven by economic resources”, and thus there is real opportunity for developing countries in particular to improve their open government performance without linking this directly to economic growth. And, as the WJP report points out, open government can itself be an important enabler of economic growth as it engenders trust in the ability to invest and do business. Both Figs. 7 and 8 show clear correspondence between measures of open government and the control of corruption, on the one hand, with disparities in digital infrastructures and services across countries and between global regions on the other.

Technology Innovations in Public Service Delivery

The innovative use of technology can directly support good governance through greater outreach, openness and effectiveness in the delivery of services. Such innovations can arise from enhancements in the capacity of governments to enable new technologies for a framework of good governance and public institutions that are efficient, effective, transparent, accountable, inclusive and participatory. ICT also provides a medium for building partnerships amongst all stakeholders for better service delivery. In recent years, so-called ‘open government’ has become an important feature of good governance and one of the main pillars of ICT-enabled public sector innovation and public service deliver in many countries through the opening up of government data, processes and services using ICT as an indispensable tool. The US administration launched the Open Government Partnership in 2011 based on the principles of transparency, participation and collaboration, and by early 2016 reached a total of 69 member countries from around the world.[18]

ICT can be used to increase social awareness, advocacy and feedback concerning the lack or poor quality of basic utilities and services, for example using social media and mobile devices. It can thereby help change the behaviour and attitudes of both citizens and service providers alike. If citizens can provide feedback to government about service delivery using the increasingly ubiquitous mobile channel, even in places with little or poor infrastructure, and rate the quality of specific programs, then government will have more information to prioritize services and should be more accountable to citizens. A project in urban India uses mobile technology to track how citizens experience water service delivery.[19] Citizen feedback is collecting and analyzed using innovative mobile applications, thereby providing a ‘reality check‘ on service levels from the citizens’ standpoint. It gives city managers more granular data at the sub-city level (ward/zone) which can facilitate improved monitoring and problem solving, and provides inputs into project planning processes for service providers. Most importantly, the project provides a suitable platform to

[18] http://www.opengovpartnership.org

[19] http://www.wsp.org/FeaturesEvents/Features/using-technology-track-how-citizens-experience-water-service-delivery-india

engage citizens in performance monitoring processes and encourages them to demand better services. The project was implemented in two cities of India during 2013 and is now being replicated in 20 more. Another project in Kenya is giving citizens a voice and active participation in their water supply services.

MajiVoice for Better Water in Nairobi, Kenya
Nairobi water is the biggest supplier of water in Kenya, supplying a city of 4 million inhabitants across 700 km^2. MajiVoice is software that aims to use technology to improve water services in Nairobi by making it easier for customers to report complaints. The case prioritizes five key attributes of good governance: Transparency, responsibility, accountability, participation and responsiveness to the people's needs.

Nairobi water had poor response times when dealing with customer complaints and it did not have strong, direct links with customers. Given there are at least 30 million users of mobiles in Kenya, the company now enables customers to report service exploitation and receive news updates on water supply using their mobile phone. Customers can be sent updates by text, including photos from engineers when they repair a leak. As a result, the number of reported leakages has doubled since the introduction of MajiVoice, so there has been a much improved service performance through greater accountability, which directly helps customers voice critical service issues more easily without needing to visit an office. This also enables staff to process and resolve complaints faster, and strengthens management and regulation through better data based on the collection of customer service data.

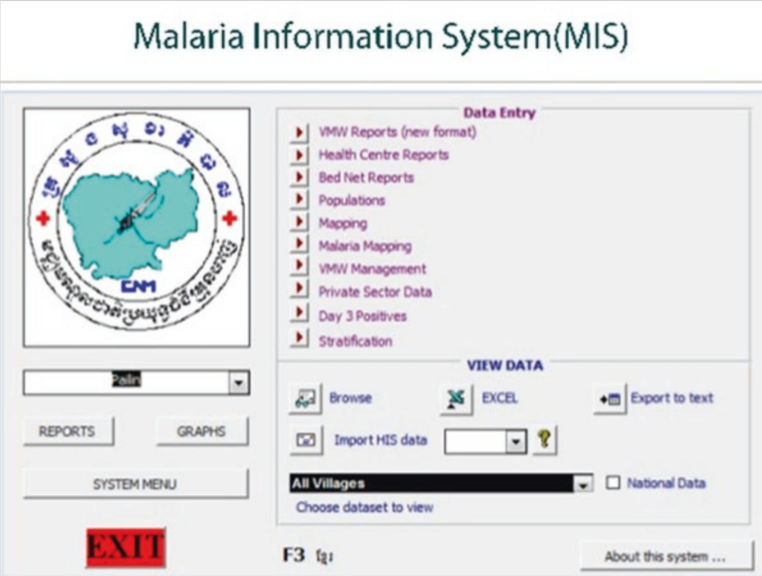
Source: ICT to improve water governance: World Water Week in Stockholm (2013): http://programme.worldwaterweek.org/event/changing-relationships-ict-2882

ICT is an excellent tool for collecting, analyzing and updating so-called big data in order to improve service efficiency and effectiveness, although it does rely on the data being representative and of good quality. Open data implies that big data is open to others to scrutinize and validate the data collected, for example, by governments or other service providers, as well as themselves to contribute to the data and use it for their own purposes. A health project in Cambodia combatting malaria is a good example of this.

Cambodia Malaria Information System (MIS)

Established in 2003, the malaria consortium is composed of national malaria control programs, research institutions plus commercial and civil society organizations, with the aim to share learning and discuss key issues. In Cambodia prior to 2009, malaria case data came from a national system which provided aggregate data at operational district level, but not down to village level. In 2009 the malaria information system (MIS) was developed by the malaria consortium, together with national program staff, to help process malaria data from village malaria workers and village health facilities using open source software for SMS reporting via mobile phones. This also provides a tool for district staff to manage their activities, such as mosquito net distribution and stratification at village level. The MIS also draws on other data, such as individual case data for all patients, mosquito net distribution data, demographic data on villages and data on the type and location of private sector outlets such as clinics and pharmacies. The MIS incorporates a 'drug stock out' system tracking drug stock levels in health centers and clinics around the country reported every 2 weeks or when levels drop below a set threshold.

A feature of the MIS is comprehensive data reporting and graphing. It allows exporting raw data and mapping of data using Google earth. The system is now decentralized to all 44 targeted operational districts in Cambodia, and also available for researchers and policy makers to improve malaria surveillance and cooperation with other countries.

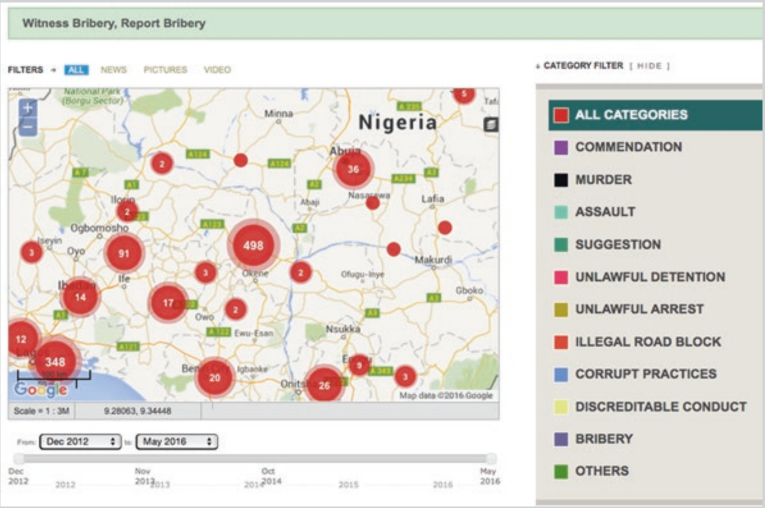


Source: Malaria Consortium (2013) Moving towards Malaria elimination: Developing innovative tools for malaria surveillance in Cambodia: http://www.malariaconsortium.org/media-downloads/257/moving-towards-malaria-elimination-developing-innovative-tools-for-malaria-surveillance-in-cambodia

ICT technology is also becoming a powerful tool in fighting corruption related to service provision, both in the public and private sectors. For example, in Montenegro the Citizen Involvement in the Fight against Grey Economy initiative has been launched to enable citizens to participate in reporting corruption (UNDP Montenegro 2014) The initiative focuses on business wrongdoing as well as the collection of funds for socially beneficial projects, such as buying equipment for healthcare or educational centers, and the reconstruction of health-care centers for children. Citizens can fight against the grey economy by reporting incidents, and the government invests half of each fine issued on socially beneficial projects. Through a web page, a mobile application, and a phone channel, citizens are able to report the issue of non-fiscal receipts, violation of labor regulations, breach of consumer protection legislation, and irregularities regarding recreational beaches and resorts. The initiative facilitates two types of citizen participation, first, crowdsourcing instances of violation to economic rules, and second voting on the use of funds raised through their participation.

Stopthebribes, Nigeria

Stopthebribes is a crowdsourcing platform for accessing public feedbacks on the conduct of Nigeria police force personnel. The platform receives complaints through multiple channels, including mobile, SMS, twitter, Facebook, email and direct reporting onto the website. Stopthebribes therefore promotes inclusive policing by involve members of the public in oversight of the police, thereby engendering public accountability and transparency.



Reports on the platform are closely monitored and acted upon by the Nigeria police force responsible for ensuring internal accountability. The platform is operated by the Nigeria police force and thus eliminates bureaucracies and limitations that hitherto characterized making complaints or observations on police conduct.

Source: http://www.stopthebribes.net/page/index/7

Another case, started by an NGO in India as a bottom-up citizen-driven initiative, has now also spread to many other countries.

I Paid a Bribe, India

Ipaidabribe.Com is a website, set up by non-profit organisation Janaagraha in 2010, to harness the collective energy of citizens to tackle corruption in public services across India. The site collects citizens' reports about the "nature, number, pattern, types, location, frequency and values of actual corrupt acts" in specific locations. Citizens can contribute in a number of ways. They can provide reports about bribes they paid, bribes they resisted and instances where they received a public service without paying a bribe, that is, when they encountered 'honest officers'. There is also a 'bribe hotline' for people to ask advice about rules and regulations, how to avoid paying bribes, how to deal with corrupt officers, and so on. Together, these reports provide ongoing snapshots of bribery and corruption in a particular locality.

The information collected through the site is then used to advocate changes in governance and accountability processes, as well as to tackle particular incidences of corruption. For example there are numerous instances where government rules and procedures have been changed as a result, including in Department of Transport in the government of Karnataka in Bangalore. About twenty senior officials were issued with warnings. Similarly, changes were made to registrations of land transactions at the Department of Stamps and Registration in Bangalore.

The success of the I paid A bribe concept and the ICT tools that enabled it, has led to it being emulated in many other countries, including Ghana, Greece, Kenya, Zimbabwe, Pakistan, Azerbaijan, South Africa, Ukraine, and Tunisia. It has also inspired similar initiatives elsewhere, for example in Romania through an online service that allows citizens to share their experiences of bribery when interacting with public services, including sharing information on the amount of money they paid.

Source: http://www.ipaidabribe.com

The above examples demonstrate the clear benefits of close cooperation between civil society and the public sector in improving public service delivery using ICT. However, ICT can be a double-edged sword as it can also be used by corrupt government officials who have access to databases and applications in government back offices. Without adequate supervision and a robust code of conduct, they can manipulate ICT systems for their own benefit. In order to increase awareness of this challenge, a report and checklist has been prepared by the EU-supported Regional School of Public Administration in the Western Balkans (ReSPA 2013).

ICT provides the communication tools for service users to directly participate in the design and delivery of services, as many of the above examples have also demonstrated. Another prominent example is participatory decision-making and budgeting, an approach that allows citizens to discuss and vote on how some parts of a government's budget should be used. The archetypal example at Porto Alegre in Brazil is recognized internationally as a ground-breaking initiative at the local level where the state government has engaged over one million residents in its multi-channel (online and offline) participatory decision-making in the provision of a whole range of public services and utilities.[20] There are also examples of participatory decision-making using mobile technology for public services in Cameroon[21] and in South Kivu in the Democratic Republic of the Congo.[22] In the latter example, communities were given the chance to voice their basic service needs which the government responded to. As a result, tax collection rates increased as people have come to believe that their government can actually deliver valuable services, and this may demonstrate one way to increase tax collection in developing countries, where such rates are notably low. Another case from the Basque Country in northern Spain shows how the government is using ICT to take the initiative in involving citizens in decision making.

The Irekia Open-Government Portal

The Irekia open-government portal provides citizens with an open window to learn, comment and express opinion on the initiatives of the Basque Government, through two collaboration spaces. First, for citizen petitions where they can take the initiative in formulating a petition to the government as well as to other citizens to argue and vote in favor or against each petition. Second, for the government and government agencies to initiate proposals and draft laws by providing supporting information, and for citizens to express their comments and debate the issues. The portal provides a direct channel for two-way communication between citizens and government. This enables citizens to request services they think government should deliver, as well as to express their opinion on government decision-making processes, so the government can respond directly to citizens' needs.

Source: http://www.irekia.euskadi.eus/

Both in the Porto Alegre and the Irekia examples, the government has itself taken the initiative to use digital technology to make it possible for citizens and users of public services to become involved in policy and decision making. Like the other cases presented above, the use of the technology in this way, directly supports many of the aspects of good governance as defined in chapter "European Strategies for e-Governance to 2020 and Beyond" of this report, including accountability and control of corruption, openness and transparency, efficiency and effectiveness, as well as participation and collaboration.

[20] http://odta.net/post/technology-drives-citizen-participation-and-feedback-in-rio-grande-do-sul-brazil-0

[21] http://odta.net/post/participatory-budgeting-cameroon

[22] http://blogs.worldbank.org/ic4d/mobile-enhanced-participatory-budgeting-in-the-drc

Meeting the Social Needs of Target Populations

Challenges to Be Addressed

The social needs of target populations are directly reflected in the SDGs, ranging from education, health, basic infrastructures, water and sanitation, as well as challenges such as poverty, food, housing and employment. All of these need innovative public service delivery if targets are to be achieved by 2030. However, the provision of public service is increasingly challenged by the diversity of social needs across different locations and segments related to, such as ageing societies, digitally-savvy 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.[23]

For example, there are important gender disparities between male and female Internet usage which are much greater in developing and less developed countries than in developed countries, as shown in Fig. 9.

Region	Gap 2013 (%)	Gap 2015 (%)
Developed	6.3	5.4
Developing	15.6	15.4
World	11.0	11.1
LDC	29.9	28.9
Africa	20.7	20.5
Arab States	15.5	14.4
Asia & Pacific	17.7	17.6
CIS	7.5	7.0
Europe	9.4	8.2
The Americas	-0.4	-0.7

Note: *The gap represents the difference between the Internet user penetration rates for males and females relative to the Internet user penetration rate for males, expressed as a percentage.
Source: ITU.

Fig. 9 Gap in Internet usage between males and females and by development status, 2013 and 2015 (ITU 2015)

[23] Global Development Network (2009). Varieties of Governance : Effective Public Service Delivery Concept Note.

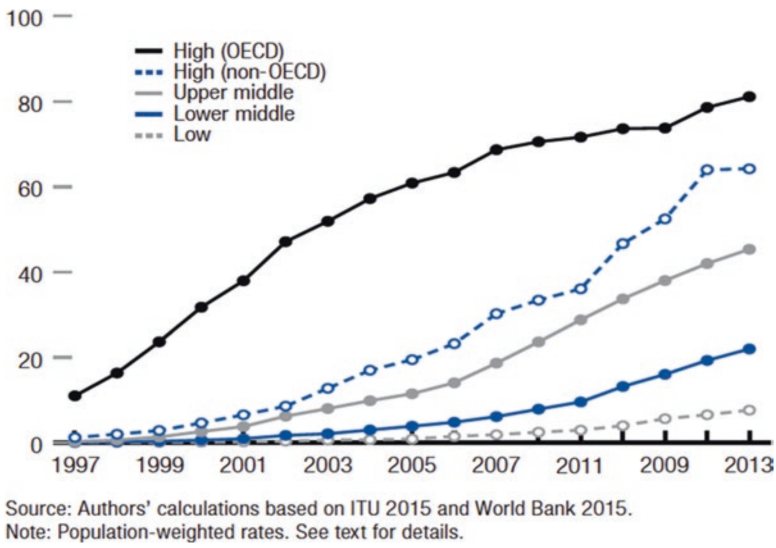


Fig. 10 Percent of individuals using the Internet by income group, 1997–2013 (World Economic Forum 2015)

Figure 9 also shows that, although this gap generally fell between 2013 and 2015, it tended to reduce more slowly in the developing and less developed countries, indicating that progress is slower here. Such gender differences are important for the use of ICT-enabled public services given that women, as prime users of basic services in their role as mothers and caregivers, are often more severely affected than men by poverty, lack of employment, lack of water, inadequate maternal child health care and lack of education opportunities.

Household surveys by Research ICT Africa, conducted in 12 African countries in 2011, also reported a close relationship between Internet access differences by gender, level of income, level of education, extent of disability and other variables (Dean-Swarray et al. 2013). That income differences mark a sharp diversification in usage of the Internet, is depicted in Fig. 10, which also shows that the lowest income groups generally increase their take-up of the Internet more slowly than higher income groups.

Furthermore, as depicted in Fig. 11, there are stark differences between urban and rural dwellers in most countries as exemplified by mobile 3G coverage, generally necessary for the operation of smart as opposed to dumb phones and thus access to more sophisticated services and data. Even though global urban inhabitants surpassed 50% of the total population for the first time in 2009, the size of the rural population will remain large for many years, and indeed there are important sustainable development reasons for keeping as many people in these areas as possible. Appropriate infrastructures and services outside of towns and cities are necessary to achieve this goal, and indeed ICT provides relatively efficient and effective means of doing so.

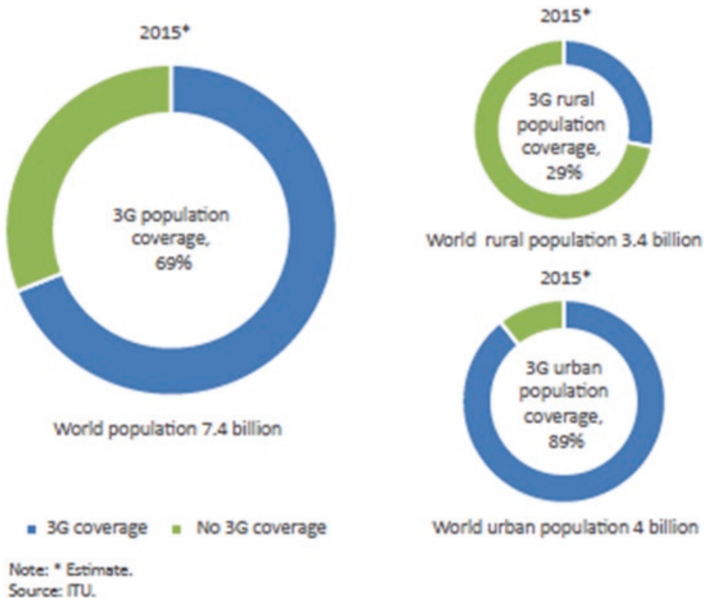


Fig. 11 Population coverage by 3G networks, urban and rural areas, 2015 (ITU 2015)

Technology Innovations in Public Service Delivery

Overcoming the challenges discussed above requires in public service delivery that:

- creates and maintains an eco-system of government agencies, businesses, non-profit organizations, universities, citizens and other actors that participate in the provision, consumption and intermediation in public service delivery brings services closer to the consumers through, e.g. the provision of multi-service centers and the use of diverse delivery channels
- learns about public service provision locally and from around the world and adapts the knowledge to the local contexts digitizes public services, tailors them to individual needs, and delivers them through various digital channels using new social and organizational innovation models.[24]

When meeting these challenges and to achieve the 2030 Agenda for Sustainable Development, especially in relation to poor and marginalized individuals and communities, new types of innovation are beginning to be deployed that are beyond but build on conventional technology and top-down driven innovation. These prioritize collaboration, diversity and a range of voices, skills, competencies and resources, across all types of public sector activity, and especially for public service delivery.

[24] OECD (2015b). The OECD Innovation Strategy 2015. Retrieved November 14, 2015, from https://www.innovationpolicyplatform.org/sti/oecd-innovation-strategy-2015

Many of the new innovation forms are typified as ‘open innovation’ (Chesbrough 2003) in which all can be involved, where there are no supposed monopolies of innovation talent and potential, and where the solutions become owned by as many people as possible, which results in greater acceptance, trust and impact, such as through co-creation. A specific variant of open innovation has being shown to be highly relevant to public service design and delivery, i.e. ‘social innovation’, which is becoming well embedded and recognized in many developed countries. This is meeting a social need (for example for an education or health service) in a new way that also involves collaboration with, and the empowerment of, the service user or beneficiary. It works with them rather than just doing something to them as passive recipients, thereby also developing their own capabilities around, and ownership of, the service and thereby transforming their social relations and improving their access to power and resources. In other words, social innovations are social both in their means and in their ends (Millard et al. 2016). Many social innovations explicitly target the otherwise excluded, for example by adapting or developing a public service which ensures they are not left out. It directly targets the needs of the low-income or the base-of-the-pyramid (BoP) population (Prahalad 2004).

Social needs are highly diverse, so the public services designed to meet them must respond accordingly. Different social groups require different types of public services and these should be addressed in different ways depending on their unique social needs. One size fits all public services, not tailored to specific needs, can miss their mark and thus both waste public resources as well as prove ineffective. ICT is a powerful tool enabling this to happen, both when used and initiated by the government and other service providers, as well as when utilized directly by the users themselves. For example, a highly successful initiative in Bangladesh supports people with low incomes and low educational levels learn English.

BBC Janala: Free Interactive English Lessons for Low Income People in Bangladesh

BBC Jamala provides interactive English language lessons to Bangladeshis in accessible format over multiple platforms – Mobile, web, television and newspapers – At affordable rates and completely free when necessary. The service is delivered by the BBC world service trust to provide comprehensive English language learning opportunities to Bangladeshis across multiple economic and social strata. Starting in November 2009, the service has received over 10 million calls from 3.8 million people with over 170,000 mobile internet lesson downloads since launch, in addition to 20 million television and newspaper users. The use of multiple ICT and other media platforms for stand-alone lessons designed with hundreds of hours of testing (input and feedback regarding Bengali language, accents, dialect, and currently specific references), innovatively removes barriers to entry for low-income and low-education users. Leveraging and coordinating the different platforms has led to widespread use and high market saturation in a short period of time.

(continued)

BBC Janala has proved that the so-called bottom-of-the-pyramid (BoP) population[25]is willing to pay for English classes via mobile phones, reaching millions of clients at a cost of less than $4 per person. Yet it does not currently collect any revenues of its own, all revenues accruing to mobile operators. The project will continue to be funded by the UK's Department for International Development until 2017 during which time the BBC will explore whether parts of the project – Including mobile – Can become independently commercially viable.

Sources: http://www.bbcjanala.com; Leveraging Information and Communication Technology for the Base of the Pyramid ICT for development in education, health, finance and agriculture

http://www.eldis.org/go/topics/resource-guides/icts-for-development/icts-and-health&id=61115&type=Document#.Vw7UqKT2aAw

The BBC Janala case show shows a multi-channel approach, largely based on relatively cheap ICT in the form of mobile phones as well as more traditional media like TV, radio and newspapers. It can be hugely successful, also on a semi-commercial basis if the business model is right, but in this case also relies on support from a developed country aid budget. In some contrast, the Mondey project in Germany[26] aims to improve early fostering and diagnosis of very young children with retarded development by supporting parents, pedagogical staff and scientists with monitoring and documentation of everyday situations. It provides advanced training for pedagogical personnel and parents in diagnostic skills using a blended educational approach consisting of the Internet, tablets and face-to-face contact by professionals and experts. It is an open and free educational service which uses standard tools, so that parents, pedagogical personnel and experts can monitor and diagnose the development of the children in their care. They can choose to document the development of a child for themselves offline or use the interactive online database.

Developed by a social entrepreneur, the Buddy app case in the UK[27] aims to improve patients' mental health so they feel less dependent on the therapist in the clinic by using text messaging between therapy sessions. The dotHIV initiative in Germany[28] generates money to support HIV patients, raise awareness of the global threat of HIV/AIDS and de-stigmatise HIV-positive people. It is an innovative approach for raising awareness for a social problem, whilst also generating income from sales of .hiv domain products and services that are forwarded to support projects

[25] The Bottom-of-the Pyramid (BoP) population is the largest, but poorest socio-economic group globally, at about 3 billion people who live on less than roughly $2.50 per day. (See 2004).

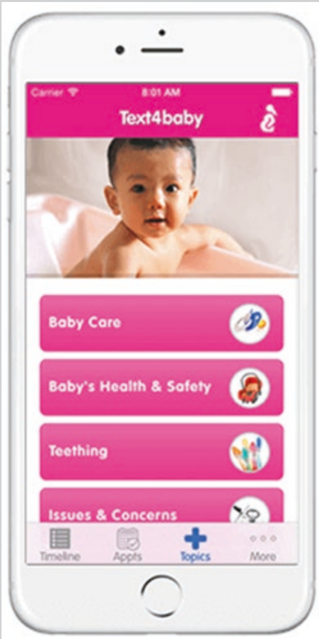
[26] www.mondey.de

[27] www.buddyapp.co.uk

[28] https://click4life.hiv/de

and organizations addressing the condition. ICT is used both to raise awareness and collect and allocate funds. A ground-breaking project in the USA has had a large impact on expectant and young mothers from disadvantaged backgrounds.

'Text4Baby': SMS Support Service for New and Expectant Mothers Aimed Largely at Those from a Disadvantaged Background (USA)
Text4Baby provides information to expectant and new mothers about how to take care of themselves and the baby while pregnant and during the first year of the baby's life. Given that the women most at risk usually came from a disadvantaged background and thus have limited access to the internet, but are likely to have access to a mobile phone, the program sends relevant information in either English or Spanish once a week to women who signed up by texting Text4Baby on their mobile phone. Marketing and outreach aims at all mothers but it is mainly women who are low-income and African-American or Hispanic who are signed up.



A 2011 study showed "very high satisfaction with the service, increase in users' health knowledge, improved interaction with healthcare providers, improved adherence to appointments and immunizations, and increased access to health resources." (National Latino Research Center 2011) participants rated text4baby as an 8.5 out of 10 overall, and indicated that 81% have an annual household income under $40,000, 65% are either uninsured or enrolled in California's Medicaid program, and 75% said they learned and followed up on a medical warning sign they didn't know previously.

Source: https://www.text4baby.org

The Text4Baby initiative is a highly successful partnership between the US government Center for Disease Control and a number of non-profit and other government organizations, including National Healthy Mothers and the Healthy Babies Coalition consisting of over 700 partners supporting text4baby. It is thus a very good example of collaboration between the public and civil sectors deploying simple but highly effective technology used by the target group.

The Drishtee education supply chain project uses ICT to provide key web-based services and distribute so-called fast moving consumer goods to remote locations in rural India. It is a for profit organization which has developed a rural network of franchises and partnerships capable of providing access to basic services and goods to the rural population. It provides access to web-based services through a network of 2000 village kiosks and on this basis also distributes Fast Moving Consumer Goods (FMCGs) to 13,000 rural shops which supply 10–15 million villagers in Assam, Bihar and Uttar Pradesh. Drishtee's uniqueness lies in its original use of ICT to foster development in remote communities by combining access to ICT-based services and the physical availability of essential goods.[29]

An example from the Bahamas illustrates how the challenge of an island state and disadvantaged groups can be addressed.

E-Government Serving Remote Islands, Poor People and Unemployed Youth in the Bahamas[30]

Embedding public service delivery into ambitious national development plans is important for their long-term impact on sustainable development and particularly to ensure that the poor are specifically targeted. After 42 years of independence, despite great development strides, the Bahamas still has basic challenges due to its more than 630 inhabited islands, each one requiring the replication of public services, and an over-populated capital city. Many public policies and systems have not changed for more than 50 years, and much still takes place on paper in the context of strong cultural resistance to change, so the transformation of public services is urgent. Another top priority is the need to find new sources of employment, particularly for the youth. Efforts to support such change since 2015 are focused on promoting dignity and empowerment in order to break the cycle of poverty. A 'safety net' system for poor people has been established with money placed in bank accounts accessible by a smart card for those in need.

---

[29] Leveraging Information and Communication Technology for the Base Of the Pyramid ICT for development in education, health, finance and agriculture: http://www.eldis.org/go/topics/resource-guides/icts-for-development/icts-and-health&id=61115&type=Document#.Vw7UqKT2aAw

[30] E-Government as a driving force for institutional integration and effective service delivery in the Bahamas. Presentation by Rowena Bethel, Director and CEO, The national Insurance Board/The Bahamas Government; and D. Shane Gibson, Minister of the Public Service, Labour and National Insurance, The Bahamas, at the Expert Group Meeting "Innovating Public Service Delivery for Sustainable Development", Medellin, Colombia, 23–26 June 2015.

To deliver these and other goals, institutional integration enabled by ICT is taking place. For example, focus is on training the middle cadre of civil servants in modern government using ICT in close cooperation with the political opposition to ensure cross-party support and the long-term continuity of transformation policies. ICT has already increased the efficiency of public services through process reengineering and increased access by citizens. Effective service delivery is being promoted through multi-channel delivery options (face-to-face, traditional, mail services, online, mobile access, television, telephone and SMS), ensuring access is anytime, anywhere and anyhow. Kiosks, internet cafes and 'satellite' service centers offering one-stop access are being established on many of the islands where internet penetration and/or mobile penetration is insufficient to support the widespread use of online interaction.

Source: United Nations (2015)

Enhancing the Policy and Strategic Framework for Basic Services

Challenges to Be Addressed

Access to, and the quality of, public services can be vastly improved by appropriate policies and strategic frameworks enabling the use of new technologies, both within the public sector and between the government and citizens or businesses, and thereby enable innovations in the delivery of public services. One of the biggest challenges in this context is legacy policies, strategies and legal and regulatory systems, which often reflect a pre-ICT period when all government business took place on paper or in-person. Without changes making the use of new technologies possible, and which can promote responsible innovation, the use of ICT will be severely curtailed.

In turn, the lack of formal legal and regulatory structures can retard necessary changes in informal working and administrative cultures within the public sector, and reinforce the often already embedded resistance to change. The entrenchment of a 'risk adverse culture' and 'business as usual procedures' remains strong within many government at all levels, creating an inherent obstacle to the introduction of new processes, products, services and good governance that ICT enables.

Although issues like political will, leadership and resources are important in effecting needed changes, the lack of relevant regulation frequently hampers the adoption and use of new technologies in basic services like education health, water and other infrastructure initiatives. Figure 12 shows that the global top 25 nations in terms of laws related to the use of ICT, such as delivering online services, electronic commerce, digital signatures and consumer protection, are almost only developed countries. The only exceptions are two Gulf countries, the United Arab Emirates and Qatar, plus Malaysia, each of which has invested heavily in ICT in government

Fig. 12 Laws relating to ICT: top 25 countries (World Economic Forum 2015, p. 269)

and has enacted appropriate laws and regulations in support of both public and private use of new technology. In contrast, the bottom 25 countries all comprise developing countries, with the exceptions of Argentina and Venezuela as emerging economies (World Economic Forum 2015, p. 269).

Technology Innovations in Public Service Delivery

In order to meet the challenge of an effective enabling environment for technology in public service delivery, strong focus is needed on a clear and long-term policy and strategic framework. Such a framework for public service delivery provides the overall setting, direction and importance given to public services in support of sustainable development within a specific legal and regulatory jurisdiction, whether this is local, municipal, regional or national. The national level tends to be dominant, but there are also strong trends towards the decentralization of public service responsibility and design to lower tier entities and especially cities. Trans-national jurisdictions can also be important, as in the European Union where there is a long history of cooperation and agreement on public services, especially related to e-government. Many countries today have also entered into formal and informal learning and peer exchange relationships with neighbouring, similar or lead nations, given that many of the challenges are the same although contexts vary widely.

In order to meet the 2030 Sustainable Development Agenda and the SDGs, Ericsson and the Earth Institute (2016) conclude that governments need to ensure that the entire public sector, including service delivery in health, education, and infrastructure, is fully supported by high-quality ICT infrastructure. This includes: broadband connectivity of all public facilities; ICT training of all relevant public officials and service providers; ICT-based delivery systems for healthcare, education, and infrastructure; deployment of the Internet of Things (remote sensing and control of connected devices) for the public infrastructure and environmental management; encouraging universities to scale up education and incubation of ICT solutions, including through partnerships with the business sector; Public-Private Partnerships (PPPs) for ICT-enabled systems; and deployment of an ICT-based SDG information system that connects public services, public facilities, the business sector, and the public. The accelerated uptake of ICT-based services is the key to achieving the SDGs, not only because ICT empowers other technologies and services, but because it itself is also one of the technologies that can accelerate uptake.

Public services delivery is one of the most expensive aspects of any government's budget, so it is extremely important to have the right policies and legal frameworks for the specific context a jurisdiction finds itself in.

Innovation and Modernisation of Public Service Policies and Strategy in Portugal

The modernization of public services in Portugal since the late 1990s has had a policy focused both on efficiency and cost reduction, on the one hand, and high quality services and their multi-channel delivery on the other. Portuguese policies and strategies for public service modernization emphasize three issues: How to reach every citizen; focusing on the core public sector functions; and rationalizing costs and the use of resources, including civil servants, given that technology cannot replace the need for people to deal with people in complex or highly personal situations. One-stop-shops are one of the flagships of this policy as an innovative concept of public service delivery bringing together in the same space several public and private entities. This involves the local public administration collaborating with local partners and citizens who best know the needs of the population and the area. There are now more than 100 such physical multi-service centers as part of a national

(continued)

network utilizing ICT to set up citizen spaces for the provision of digitally delivered services, with in-person assistance if required. This addresses the fact that digital literacy is not at the same level everywhere in the country.

Portugal is also moving towards shared services as a means to improve public service delivery through better use of resources. Pilots are in progress in five action areas: Financial shared services integrating budget, property and logistics; human resources management and the integrated system of management and performance appraisal in the public administration; public procurement; management of the state's car fleet; and sharing the means and resources for developing information systems and the rationalization of ICT infrastructures. Shared services provide a win-win: For citizens who can access public entities more simply and solve minor problems faster and in a more personalized way; and for the public administration that will be able to dedicate its own resources to its core functions whilst benefitting from the common shared resources which all entities need.

Source: United Nations (2015)

The Portuguese case demonstrates that fully embracing the digital revolution can enable a new vision and provide better tools for service delivery, but should also go hand-in-hand with understanding that the human element remains essential. In order both to save money and resources as well as provide better quality services, sharing across the public sector is needed, both of good practices and ideas but also in terms of human, organizational and physical assets. Multiple service delivery channels supported by the local authority as well as by local organizations and citizens provide both better tailored and contextual services as well as improve the inclusion of everybody. Blending physical, digital and voice channels addresses the need for convenience and time saving, but also provides physical outreach to people where they live. Human and organizational capacity building is essential for both routine service delivery but also for promoting creativity, experimentation and innovation in a continuous search for improvement.

Malaysian National Telecommunications and E-Government Policy

In Malaysia, electronic government and general ICT policies are undertaken by the Malaysian government as part of a 25-year ambitious plan from 1994 to 2020 incorporated into the country's National Telecommunications Policy (NTP). In mid 1996, this was supplemented by the multimedia super corridor (MSC) strategy running south from the capital Kuala Lumpur to the border with Singapore, and aimed at attracting large scale international investment by ICT and related companies, creating jobs and growth, becoming a regional hub, helping to reduce the digital divide, and boosting e-government

(continued)

initiatives. Legal and regulatory frameworks were put in place to support these strategies over the long term. These included a number of so-called cyber laws enacted in 1997, such as the digital signature act, the computer crimes act, the copyright amendment act and the telemedicine act, followed up by the communications and multimedia act of 1998, and the personal data protection act of 2004.

This legislation and the strategies it supports also laid the basis for ICT-supported public services for both citizens and businesses as part of the broader goal to reinvent how the government works. Given this early start in the mid-1990s laying the foundations for an ambitious long-term and consistent strategy, Malaysia is recognized as a developing nation role model that accomplished a major challenge: Connecting its e-government implementations with clear development targets. The country has thereby evolved into an exemplary case featuring project developers "who by effort of visionary policy and nurturing of critical conditions have realized tremendous growth which can be demonstrably attributed to proactive ICT-related initiatives" (John et al. 2005).

Source: Mohsin Bin Hj Ahmed (2007)

The Malaysian national policy and strategy for ICT and e-government is an example showing the importance of the long-term development of the legal basis for using ICT in e-government generally and public service delivery in particular (Malaysia Government, undated). This is one of the reasons the country scores so high in laws relating to ICT, as shown in Fig. 12. The case shows how policy, strategy and a sound legal basis are a means for institutional capacity reinforcement for transforming public services. It also illustrates how political will and resources, sanctioned from the top are important, and how this also depends on long-term and consistent commitment transcending changing political conditions.

Conclusions and Lessons Learnt

Basic services like education, health, water and sanitation, as well as infrastructures and other utilities, are essential for sustainable development strategies and for improving people's quality of life and prosperity. They need to be delivered universally in order not to leave anyone behind, as this is the only way that the SDGs can be achieved by 2030. New technologies and ICT are essential to ensure this can happen, both through enabling the significant widening of access as well as by providing large beneficial impacts for service users, at the same time as provider costs can be reduced.

The transformational and facilitating power of ICT is enabling a paradigm shift in the public sector and its role in society as a whole. This is driven by three trends: first, the need to address ever increasing and complex societal challenges; second, the acceptance that, although the public sector is normally the biggest and most powerful actor it does not have a monopoly on resources or on the ability to innovate; and third, the increased capacities, tools and willingness possessed by other state actors as well as civil society and the commercial sector, to participate alongside the public sector in addressing societal challenges ranging from the local to the global. This conjuncture is further enabled by the emergence of open and collaborative governance systems, underpinned by ICT and promoting transparency, participation and collaboration. Although such systems are typically led or sanctioned by the public sector and its governments, they consist of dynamically adapting constellations of a range of actors with changing roles and relationships addressing specific challenges in specific contexts at a variety of scales (Millard 2015b).

Improving Access to Basic Public Services Using Innovative ICT

New technology has the potential to assist in moving towards universality in the access, reach, intensity and quality of basic public service delivery. The innovative use of ICT can enable people to find and use basic public services in cases when access was previously denied to them, for example in under-served areas like shanty towns or rural and remote locations. It can also improve the speed and convenience of public services access through 24/7 availability, considerably reduce the cost of access, and in some cases provide completely new types of public services.

ICT can also enhance and complement the continued use of more traditional channels, such as over the counter, the postal service, telephone call centers, or TV and radio, where these remain appropriate forms of communication and interaction with public officials or other service providers. The technology can lead to new types of services based, for example, on the personalization of service offerings through interaction with the service interface or direct with the service provider.

In many cases, close cooperation is beneficial with the private sector providing investment and technical expertise as well as civil society organizations which are close to service users both geographically in in terms of understanding their real situation. Public, private and civil partnerships often provide good opportunities for dramatically extending basic services to large numbers of people, as long as the oversight and regulation are appropriate.'

The main lessons in summary are:

1. ICT enabled service delivery on a large scale can significantly reduces costs, widen access and result in increased sustainable development impacts. ICT and other technology innovations are necessary enablers and can be game changers, but organizational, human resource and process innovations are also necessary, the best and most suitable of which might be emulated from commercial companies or civil organizations.

2. Simple and relatively cheap technology such as mobile phones is a very flexible tool that maximizes reach, is generally personalizable to the individual user and enables two or multi-way interaction with the service provider as well as between users themselves.
3. On a larger scale, more sophisticated and powerful ICT systems can knit together other infrastructures and utilities, for example by deploying high capacity Internet, sensors and databases to dramatically reduce costs and increase service integration and impact in real time, for example in smart city or smart neighborhood initiatives. This can enhance the quality, performance and interactivity of services as well as strengthen coordination through innovative technology solutions.

Strengthening Governance Through Innovative Technology Solutions

New technology has the clear potential to directly support good governance through greater outreach, openness and innovations in the speed and delivery of services. Such innovations can arise from enhancements in the capacity of governments to enable new technologies for a framework of good governance and public institutions that are efficient, effective, transparent, accountable, inclusive and participatory. ICT also provides a medium for building partnerships amongst all stakeholders for better service delivery.

ICT can increase accountability and strengthen the fight against corruption in public service delivery. Citizens can report and compare their experiences on a website, via mobile phones or social media, bypassing official channels when these are not responsive. Bottom-up pressure can be applied and collated through responsible intermediaries like civil society organizations or local government agencies if these are open, cooperative and prepared to listen and be responsive.

One of the main ambitions of ICT-enabled good governance is to ensure that public policy and public services focus on becoming more open and innovative as well as efficient and effective, and indeed it is clear that these attributes are complementary. It is becoming clear that the public sector cannot successfully tackle service delivery challenges entirely on its own, but also needs to collaborate with other actors, and especially the private and civil sectors, and a powerful tool in this context is ICT.

The main lessons in summary are:

1. Data from service providers, users as well as other legitimate sources can be used and made available as big and/or open data (as long as individual privacy is protected) to increase the efficiency of public service delivery through the use of ICT by highlighting where costs are incurred and whether processes can be rationalized or eliminated.
2. Data can also be used together with ICT tools to improve the effectiveness of public service delivery by enabling the service provider to specifically target a service to precise user requirements, and so that users themselves can personalize a service to her/his own situation.

3. New technologies like social media, mobile phones and other interactive ICT can enable service provides to obtain feedback from users and the wider society concerning corruption and mis-management, about specific services as well as public policy issues more generally. These tools can also be used unilaterally by users to address service providers and governments concerning a wide range of legitimate public policy issues. It is important that the public sector listens, learns and responds to these new forms of communication.

Meeting the Social Needs of Target Populations

The social needs of people, communities and locations are highly diverse, so the public services designed to meet them must be inclusive and respond according. Different social groups require different types of public services and need to be addressed in different ways depending on their unique social needs. One size fits all public services, not tailored to specific needs, can miss their mark and thus both waste public resources as well as prove ineffective. ICT is a powerful tool enabling personalization to happen, both when used and initiated by the government and other service providers, as well as when utilized directly by the users themselves.

Often different needs can be precisely tailored by using a multi-channel approach consisting of different combinations of both ICT and traditional means. Especially when targeting mainly poor people or those suffering from a range of disadvantages, relatively cheap ICT in the form of mobile phones as well as more traditional media like TV, radio and newspapers are highly effective. Such approaches can be hugely successful, also on a commercial basis, if the business model is right.

The main lessons in summary are:

1. Collaboration both between the public and civil sectors and the public and private sectors, or all three, is often highly productive as each can bring specific competencies and assets to the table. However, the public interest, and especially the specific needs of the users and their social needs must be constantly prioritized in an open and transparent manner.
2. Mobile technology is typically the most powerful tool to reach poor and disadvantaged people and provide them with high impact basic services. For example, through the two-way collection of information and data from service users which service providers can then analyze and actively use as a management tool to organize and deploy their own resources, and to react rapidly to changing circumstances or emergencies.
3. ICT infrastructural policies should be directly embedded in broader national or regional sustainable development policies and plans to meet the public service needs of different societal groups. Often this will mean adopting a multi-channel approach consisting of both ICT and more traditional channels to deliver basic services and provide a safety net for the poorest and most vulnerable.

Enhancing the Policy and Strategic Framework for Basic Services

A strong focus is needed on a clear and long-term policy and strategic framework in order to meet the challenge of an effective enabling environment for technology in public service delivery. This will need to provide the overall setting, direction and importance given to public services in support of sustainable development within a specific legal and regulatory jurisdiction, whether this is local, municipal, regional or national. Public service delivery is one of the most expensive aspects of any government's budget, so it is extremely important to have the right policies for the specific context a jurisdiction finds itself in. In particular, lack of relevant legal provision and regulation hampers the adoption and use of new technologies in basic public services. Developing a long-term strategy for ICT enhanced public service design and delivery, underpinned by a sound legal basis, together with consistent political will and resources, is critical.

The main lessons in summary are:

1. It is important to fully embrace the digital revolution and develop a new vision around it which can provide better tools for service delivery, but also to recognize the challenges and potential dangers this might reveal, for example in relation to security and privacy issues, as well as the uneven digital access and skills people posses.
2. An ICT strategy should also go hand-in-hand with understanding that the human element remains essential. Human and organizational capacity building is important for both routine service delivery but also for promoting creativity, experimentation and innovation in a continuous search for improvement.
3. In order both to save money and resources as well as provide better quality services, ICT-enabled sharing across the public sector is needed, both of good practices and ideas but also in terms of human, organizational and physical assets. Multiple service delivery channels supported by the local authority as well as by local organizations and citizens provide both better tailored and contextual services as well as improve the inclusion of everybody.

References

Broadband Commission (2014) Means of transformation: harnessing broadband for the post-2015 development agenda, a collaboration between UNESCO, ITU and Ericsson. http://www.broadbandcommission.org/documents/reports/tf-post2015-advocacy-2014.pdf

Chesbrough HW (2003) The era of open innovation. MIT Sloan Manag Rev 44(3):35–41

Crandall A, Otieno A, Mutuku L, Colaço J (2012) Mobile phone usage at the Kenyan base of the pyramid. iHub Research, November 2012. https://blogs.worldbank.org/ic4d/files/ic4d/mobile_phone_usage_kenyan_base_pyramid.pdf

Dean-Swarray M, Gillwald A, Morrell A (2013) Lifting the veil on ICT gender indicators in Africa. Research ICT Africa. https://www.researchictafrica.net/publications/Evidence_for_ICT_Policy_Action/Policy_Paper_13_-_Lifting_the_veil_on_gender_ICT_indicators_in_Africa.pdf

Docebo (2014) E-Learning market trends & forecast 2014–2016 Report, March 2014. https://www.docebo.com/landing/contactform/elearning-market-trends-and-forecast-2014-2016-docebo-report.pdf. Retrieved April 2016

Ericsson and the Earth Institute (2016) How information and communications technology can accelerate action on the sustainable development goals. http://www.ericsson.com/res/docs/2016/ict-sdg.pdf

European Commission (2013) Study on business and financing models related to ICT for ageing well. DG CONNECT, Danish Technological Institute, Ernst & Young. https://ec.europa.eu/digital-single-market/en/news/study-business-and-financing-models-related-ict-ageing-well

Ghana Health Service (2016) Integrated national ICT for health and development forum, Millennium Promise. http://1millionhealthworkers.org/files/2016/09/ICT_REPORT.pdf

Global Opportunity Network (2016) Global opportunity report 2016. Published by DNV GL AS, the United Nations Global Compact, and Monday Morning Global Institute. http://www.globalopportunitynetwork.org/report-2016/#.V0LvqTY-KqA

GSMA (Mobile Enabled Community Services) (2014) The synergies between mobile, energy and water access: Africa. http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2014/04/MECS_Synergies-between-Mobile-Energy-and-Water-Access_Africa.pdf. Retrieved April 2016

International Telecommunication Union (2013) Measuring the information society. Geneva. http://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2013.aspx; and The ITU World Telecommunication/ICT Indicators database. http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx. Retrieved April 2016

International Telecommunication Union (2015) Measuring the information society report 2015. Geneva. http://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2015.aspx; and The ITU World Telecommunication/ICT Indicators database. http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx. Retrieved April 2016

John JK, Nair MS, Selvanthan PJ, Kuppusamy M (2005) Using ICT as a catalyst for sustainable development: the role of national policy. In: Rahim RA, Waldburger D, Muinde GS (ed) Access, empowerment and governance: creating a world of equal opportunities with ICT. Global Knowledge Partnership, Kuala Lumpur

Malaysia Government (undated) The national telecommunication policy of Malaysia (1994–2020)

Millard J (2015a) The digital divide and the post-2015 development debate. In: Andreasson K (ed) Digital divides: the new challenges and opportunities of e-inclusion. Taylor and Francis Publishing Group, Abingdon

Millard J (2015b) Open governance systems: doing more with more. Gov Inf Q, 12 Sept 2015. http://doi.org/10.1016/j.giq.2015.08.003

Millard J, Weerakkody V, Missi F, Kapoor K, Fernando G (2016) Social innovation for poverty reduction and sustainable development: some governance and policy perspectives. In: Proceedings of the 9th international conference on the theory and practice of electronic governance (ICEGOV2015–16), The ACM Press, Montevideo, 1–3 March 2016

Mohsin Bin Hj Ahmed (2007) Implementation of electronic government in Malaysia: the status and potential for better service to the public. Public Sect ICT Manage Rev 1(1)

National Latino Research Center (2011) Text4baby preliminary study. California State University and the University of California, San Diego

Prahalad CK (2004) The fortune at the bottom of the pyramid: eradicating poverty through profits. Pearson Prentice Hall, New York

Regional School of Public Administration (2013) Abuse of Information Technology (IT) for corruption. ReSPA, Danilovgrad

UNDP Montenegro (2014) Increasing citizens' engagement by using social innovation and social media to enhance government's transparency and accountability. Retrieved from https://info.undp.org/docs/pdc/Documents/MNE/Pro Doc Citizen Engagement signed.pdf

United Nations (2013) Governance, public administration and information technology for post-2015 development. United Nations Department of Social and Economic Affairs New York. http://workspace.unpan.org/sites/Internet/Documents/Governance_PA_Report.pdf. Retrieved April 2016

United Nations (2015) Innovative public service delivery: learning from best practice. United Nations Department of Social and Economic Affairs New York. http://workspace.unpan.org/sites/Internet/Documents/EGM%20Report%20on%20Innovative%20Public%20Service%20Delivery%20Learning%20from%20Best%20Practices.docx.pdf. Retrieved April 2016

World Bank (2012) eTransform Africa – the transformational use of information and communications technologies in Africa. The World Bank and the African Development Bank with the support of the African Union, Washington, DC. www.eTransformAfrica.org. Retrieved April 2016

World Bank Group (2015) Unlocking the potential of information communications technology to improve water and sanitation services. Water and Sanitation Program, Washington, DC

World Economic Forum (2015) The global information technology report 2015: ICTs for inclusive growth. World Economic Forum and INSEAD, Geneva. http://www3.weforum.org/docs/WEF_Global_IT_Report_2015.pdf. Retrieved April 2016

Jeremy Millard is Director of the consultancy Third Millennium Governance, as well as having senior research positions at the Danish Technological Institute in Denmark and Bradford University in the UK. He has over 40 years' global experience on issues ranging from governance, ICT, open and social innovation, participation, sustainable and socio-economic development, tackling poverty and exclusion, the new economy, urbanization and nature-based solutions for growth, and has published extensive in these and related fields. His many clients include governments, the European Commission, United Nations, OECD and World Bank, as well as many non-profits and companies around the world. Recent assignments in the area of e-government include on-going support to both the United Nations regarding their biennial eGovernment Survey, and the European Commission regarding e-government research and innovation, as well as a survey on back-office developments in support of user-centred e-government strategies for the OECD. He has also worked with the UN on ICT and governance issues for the 2030 sustainable development agenda, and with ESCWA on integrated service delivery across the Arab Region.

Blockchain as a Next Generation Government Information Infrastructure: A Review of Initiatives in D5 Countries

Adegboyega Ojo and Samuel Adebayo

Abstract Blockchain or distributed ledger technology; a distributed and open data infrastructure enabling secure transactions without centralised trust party on the Internet, is considered to have disruptive potentials comparable to that of the Internet. This technology innovation is driving major strategic and policy actions in several economies around the world and particularly in the Digital 5 (D5) countries which include United Kingdom, United States, Estonia, New Zealand and Israel. This chapter provides some background to the new technology and reviews flagship blockchain related initiatives in the D5 countries. It concludes with recommendations for policymakers on emerging governance topics that require investigation in order to realise the full potentials of blockchain innovation in public administration and the government domain.

Introduction

Blockchain could be described as a distributed information infrastructure or an open, distributed database on the internet (Ølnes 2008). Blockchain technology maintains continuous update of all transactions occurring across large fully distributed or peer-to-peer network, that are either private or public (Srisukvattananan 2016). The technology enables secure and private transactions among involved parties without the need for any intermediary to guarantee trust (Kosba et al. 2016).

The technology has triggered interest from all industry sectors due to its capability to store the history of every transaction sent and confirmed over the network, including information included as a part of those transactions (Kaye 2016). One of

A. Ojo (✉)
Insight Centre for Data Analytics, National University of Ireland Galway,
Lower Dangan, Galway, Ireland
e-mail: adegboyega.ojo@insight-centre.org

S. Adebayo
Insight Centre for Data Analytics, National University of Ireland Galway (NUIG),
IDA Business Park, Lower Dangan, Galway, Ireland
e-mail: Samuel.Adebayo@insight-centre.org

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_11

the motives for adopting this technology is that it affords transparent real-time transaction settlement and auto-executing so-called smart contracts with business logic encoded into the ledger (Wyman 2016). Another significant motive for the adoption of this innovation is its extended capabilities to provide significant impacts to different economics and social activities in the society (Taylor, 2016)

Blockchain according to findings can be used to address inefficiencies in current systems and increase the effectiveness of public service activities (Drucker 2016). It can also create a data network platform where citizens, private companies, and governments can access for the verification of information (Oscar 2016). The adoption of Blockchain in the public sector is expected to reduce the cost of operations particularly by eliminating fraud, error in payments, providing greater transparency of transactions between government, other agencies and citizens. It strengthens citizens data protection and encourages data sharing among entities (Taylor, 2016). In general, government entities can perform the following activities on the Blockchain[1]: (1) verification of documents such as licenses, proofs of records, transactions, processes or events such as birth of a child, (2) movement of assets such as transferring money from one entity to another after some work conditions are met, (3) asset ownership registers such as land registries, property titles and other types of ownership of physical assets and (4) management of identities like e-identities for citizens and city residents.

Interestingly, while there is growing literature on Blockchain applications in the private sector, the literature on possible applications of this new generation information infrastructure in the government domain are few (Ølnes 2008). This chapter addresses this knowledge gap by examining some of the flagship Blockchain initiatives in leading five digital champion (so-called D5) countries including United Kingdom, United States, Estonia, New Zealand and Israel.

The rest of the chapter is organized as follows: section "Background" provides a brief background on Blockchain and Distributed Ledger technology. The approach for the study is presented in section "The Digital 5 Countries as Innovators" while the case studies selected from the D5 countries are laid out in section "Cases". We provide some analysis of these initiatives in section "Discussion" and conclude in section "Conclusion".

Background

The blockchain is a digital ledger and a "database that can be shared across a network of multiple sites, geographies or institutions" (Taylor 2016). It could also be described as a database of secure transaction ledgers only accessible to all parties involved in a distributed network. It has the capacity to record and save every transaction which occurs in the network and also create an irrevocable and auditable transaction history (Finextra 2016). Other authors consider the Blockchain as

[1] http://observer.com/2016/09/why-the-Blockchain-is-perfect-for-government-services/

consensus-based, tamper-proof data structure that delivers a shared public ledger open to all connected parties (Capgemini 2016).

The goal of the Blockchain innovation is to create trust, enhance transparency and eliminate unnecessary intermediate parties among involved parties in digital transactions (Wyman 2016). The technology supports basic payments (including micropayments), decentralised exchange, token earning, digital asset transfer, as well as smart contract issuance and execution (Froystad and Holm, 2016). Smart contracts are specific programs used by users of blockchains in order to decide whether a specific operation, say a given payment or transfer of digital asset should be permitted or not (Pilkington 2016).

According to (Froystad and Holm, 2016), there are different types of blockchains implementations available today since the first Blockchain developed based on the Bitcoin protocol. The Bitcoin protocol is what really enables secure transactions to be carried out on the Internet without the need for a trusted third-party or intermediary (Ølnes 2008). Other blockchain and distributed ledger implementations include Ethereum,[2] Gridcoin,[3] and Ripple[4] (Pilkington 2016).

According to (Wyman 2016), The *blockchain innovation* is built on the three complementary solutions namely encryption, mutual consensus verification, and smart contracts. The encryption component protects the sensitive data exchanged on the bitcoin network. The mutual consensus verification element is the network protocol which ensures the integrity of the bitcoin ledger or database by approval or denying changes made to the database after verifying that the overall state of distributed ledger remains accurate at all times without any interference from external or central governing authority. This element is central to preventing malicious manipulation and failures. The third component called the smart contracts provide the mechanism for automating governance of transactions among bitcoin users. Smart contracts are implemented as codes written in a special language and stored on the bitcoin ledger the same way data are stored (Wyman 2016).

From the perspective of authors of (Crawford et al. 2016), blockchain provides the users a more secure, decentralized transactions through common access to a ledger that has a secure audit trail. This enhances support for non-repudiation, governance, fraud prevention and reporting. From a technical standpoint, it allows users to recognize the opportunity to integrate an ecosystem of trusted third parties for the purpose of reducing the costs of their global platforms, advance customer and market reach and develop new propositions (Crawford et al. 2016).

Network security provided by Blockchain is also a benefit because of the use of cryptographic and decentralized protocols. This reduces the risk of a brute force hack or an accidental instance of two users generating the same private key (Kaye 2016).

While the blockchain innovation comes with many attractive benefits, there are however some drawbacks associated with it. These drawbacks have been highlighted by (Shrier et al. 2016) as follows: the platform is relatively complex and not

[2] https://www.ethereum.org/

[3] http://www.gridcoin.us/

[4] https://ripple.com/

user-friendly and transactions made on the blockchain are not reversible, so genuine errors cannot be corrected by any administrator.

The popularity of the blockchain technology is driven by a number of factors (ODI 2016) including: (1) The capabilities of the platform to store data that is very robust in nature and that cannot be tampered with; the highly distributed nature of Blockchain platform comprising of nodes managed by different parties making collusion to compromise the infrastructure difficult. Another driving factor of the Blockchain technology is the optimization of cost and time efficiency in both public and private sectors. For instance, it is now faster through this innovation to move funds between two different institutions and geographical zones without any interference of intermediaries (Probst et al. 2016).

Finally, the Blockchain technology has potential to impact any industry or product line that relies on the storage and verification of information or value. Blockchain technology's programmable aspects can also facilitate the development of independent governance systems, contracts and legal constructs (e.g., "smart contract") or the ability of interrelated devices to interact with and even pay each other in the "Internet of Things" (Kaye 2016).

The Digital 5 Countries as Innovators

We have chosen to review some past and ongoing Blockchain innovation in Digital countries due to the strong commitment that these countries have for undertaking digital transformations and serving as innovators and early adopters with respect to emerging technologies. The Digital 5 or D5 is a networking group of leading digital government countries with the objective of strengthening the digital economy. There is a promise among the members to be open while they aim at how to transform government's relationship with technology through the espousal of open standards and open source software and also increasing the effectiveness of digital government. Furthermore, these countries are also working towards encouraging digital skills in-house and also short-term contracts with small and medium business suppliers (Wikipedia 2016).

This network group was founded on the 9 December 2014. The founding members of the group are Estonia, Israel, New Zealand, South Korea and the United Kingdom. These countries possess mutual agreement to create this network group and develop a platform where best practice will be shared and also collaborate on common projects that will provide support in growing digital economies. Some of the goals of the D5 countries according to (Palo et al. 2015) are:

- *User needs* – provide citizen-centric public services taking into consideration specific needs of different segments of the citizenry.
- *Open standards* – employ technologies that are interoperability and show a clear commitment to a credible royalty free open standards policy.
- *Open source* – ensure that future government systems, tradecraft, manuals, and standards are created as open resources and shareable among members.

- *Open markets* – ensure true competition for companies regardless of size in government procurements, promote and support start-up culture as well as economic growth through open markets.
- *Open government (transparency)* – be a member of the Open Government Partnership and use open licences to produce and consume open data.
- *Connectivity* – develop an online population through comprehensive and high-quality digital infrastructure.
- *Teach children to code* – show commitment to offer children the opportunity to learn to code and acquire next generation skills.
- *Assisted digital* services– show commitment to supporting all its citizens to access digital services.
- *Commitment to share and learn* – commit to work together to help solve each other's issues wherever they can.

Our study examined public sector innovation activities of these countries related to the use of blockchains through exploratory desktop research. Information was consolidated from scholarly and online articles and news on Blockchain technologies. We outline the identified initiatives in section "Discussion" and discuss them in section "Conclusion".

Cases

In this section, we describe some of the major innovations in D5 countries in which the blockchain technology has exploited for improving the delivery of public services. In all 13 initiatives are described across the five countries with a summary of the initiatives presented in Table 1. Information on these cases were collected and analysed largely between May and December 2016.

Estonia Estonia is one of the countries with very high E-Government Development Index. Specifically, it ranks in the 13th position globally based on the 2016 UN Global E-Government Index (United Nations Department of Economic and Social Affairs 2016). It also ranks as one of the most innovative countries in the world; ranking at 24th position out of the 128 countries surveyed in the 2017 edition of the Global Innovation Index report (Cornell University, INSEAD, and WIPO 2016). Since 2014, the topic of Blockchain innovation has gained significant popularity among private and public institutions in Estonia. Several prototypes and concepts involving Blockchain technology have been announced by the government of Estonia. Three notable cases of these innovations involving management of access to health records, provision of notary services to e-residents and authentication of shareholders for e-voting in meetings are briefly described below.

- *Migration of government data to Blockchain* (Oscar 2016): The initiative aimed at securing access to over 1 million public health records to eliminate unauthorised access to the records without the need of a centralised trust party in or outside government. The initiative relies on the technology developed by Guardtime;

Table 1 Summary of blockchain related initiatives across D5 countries

No.	Initiative	Participants	Goal	Strategy	Other stakeholders	Sector
1	Migration of government data to Blockchain – *Estonia*	Estonian e-Health Authority, Information System Authority & Guardtime (SME)	Solution for securing access and integrity of public health records using Blockchain technology	Integration of guardtime's keyless signature infrastructure into Oracle database engine of the health sector	Citizens, third-party private companies that require access to health records	Health sector
2	Public notary to e-residents (Estonia)	e-Residency Programme, Bitnation	Giving citizen the right to exercise notary act regardless of their geographical location and set up businesses in Estonia	Leveraging Bitnation digital nation platform and providing public key infrastructure card (PKI) to both residents and non-residents to access services	Government agencies and private sector organizations (e.g. banks) interested in making services available to e-residents	Economy
3	e-Voting Scheme (Estonia)	Tallinn Stock Exchange, Nasdaq, e-Residency Programme	Giving the Estonia citizens that are shareholders in firms listed on Tallinn Stock Exchange the opportunity to vote securely online in shareholders meetings	Using the Estonia e-residency platform to authenticate e-resident shareholders in shareholders meetings	US stock market, shareholders, Estonia e-residents and Estonia citizens	Economy
4	Joint research with Commonwealth Bank of Australia (Israel)	Israel ministry of economy, Commonwealth Bank of Australia	Exporting blockchain expertise to other countries (Australia) and establish the country as the knowledge hub for blockchain.	Provision of research grants to attract researchers in the areas of disruptive technology including Blockchain	Other global firms like Microsoft, General Electric, Procter and Gamble.	Finance

5	The Israeli Blockchain Ecosystem (Israel)	Blockchain start-ups, Deloitte	Develop a critical mass of the Blockchain start-up and attract investors to create a strong and viable blockchain ecosystem	Foster collaboration among global consulting firms, other private sector organizations and Blockchain start-ups	Start-up firms, potential investors	Economy
6	Improving the agriculture sector through Blockchain (New Zealand)	Food Agility, Ministry of Agriculture and Forestry	To acquire knowledge on how Blockchain can be used to improve Agricultural sector	Funding long-term research initiatives to identify how Blockchain technology can be used to provide high-value products with solid provenance	Farmers and citizens	Agriculture
7	Energy and the Blockchain in New Zealand	P2 power	Providing a platform for the sale, purchase and distribution of energy via Blockchain platform	Using Blockchain technology to deliver a peer-to-peer grid of green energy.	Citizens, Energy Providers	Energy
8	Blockchain for Local Community Voting (South Korea)	Gyeonggi-do, Blocko	Enable direct participation of community residents in determining community initiatives to fund	Leveraging Blocko's blockchain based voting system to supporting both online and offline voting.	Community residents	Governance

(continued)

Table 1 (continued)

No.	Initiative	Participants	Goal	Strategy	Other stakeholders	Sector
9	Blockchain-based financial innovation (South Korea)	Investment banks	Enable innovation in the financial technology arena through blockchain technology.	Government facilitating the use of blockchain for managing asset ownership and settlement in the financial technology sector	Blockchain start-ups, Citizens, Businesses	Finance
10	Distributed ledger gross settlement system (UK)	Bank of England	Replacement of its aging real-time gross settlement (RTGS)	Use of Blockchain to revamp the RTGS	Bank of England, Financial Institutions	Finance
11	Blockchain for benefit payment (UK)	Department of Work and Pensions, Barclays, Npower, University College London, GovCoin	Improve welfare payment system and track payments made to claimants	Creation of a mobile app and a Blockchain that records payments sent and received by claimants	Claimants, Citizen	Welfare and Social Security
12	Monitoring research grants (UK)	Paymaster general office, government,	Solving the monitoring complexity of research grants	Use of Blockchain to manage the distribution of grants given to researchers	Researchers	Education
13	Blockchain-as-a-Service for the Public Sector (UK)	Credits	Making Blockchain services available to public agencies	Allowing credits Blockchain-as-a-service platform to be accessible through the Digital Marketplace to reduce the barrier to access.	Government agencies	Public service

a Blockchain start-up. The solution is based on Guardtime's *Keyless signatures* technology which can establish the integrity of any data without the use and exchange of the traditional private and public keys. The *keyless signature infrastructure* (KSI) Blockchain will be integrated with the e-Health Authority health (Oracle) database for "real-time visibility" into the state of patient records. This initiative is expected to significantly improve the process used in recording and updating health records in terms of efficiency (including cost) and effectiveness. The use of Blockchain technology will provide the creation of a secured and trusted care records into electronic chains of events while preserving the provenance and integrity of those health records. The solution will also enable strong identity proofing by preserving immutable records of the declared identities of both patients and healthcare professionals. Equally important, the initiative will empower patients through the recording of consent decisions and patient directives within the secured healthcare record.
- *Public notary to e-residents* (Ian 2015): In late 2014, Estonia made history by becoming the first country to offer electronic residency to people located both in and outside the country. This was regarded by the Estonian government as a step towards "the idea of a country without borders. It is essentially a transnational digital identity, available to anyone in the world interested in operating a location-independent business online. The project was developed in partnership with Bitnation; a distributed governance and blockchain-based virtual nation project. The platform has been used for providing emergency identity and registry services. The platform enables Estonia to provide its residents a public key infrastructure (PKI) card, which grants access to over 1000 electronic government services. Non-residents are also able to apply for a PKI card, which is issued by the state. The card comes with a four digit pin number, which authorises digital signatures for online documents, which is considered legally binding throughout the EU. This initiative provides some validation for Bitnation is an open source protocol and sovereign entity. With applications over 9,200 from over 127 countries, about 291 companies have been opened through the e-residency programme as at February 2016 (Kalev 2016). This initiative involves several government agencies and private organizations willing to make their services available to e-residents through the Bitnation's platform.
- *E-voting for E-Resident Shareholders* (Kalev 2016): the US stock-market firm Nasdaq in collaboration with the Estonian e-residency programme aims to provide e-Residents and Estonian citizens who are shareholders in firms listed on the Tallinn Stock Exchange an opportunity to vote securely online in shareholder meetings. The Estonia's e-residency platform will be used to authenticate e-resident shareholders while the Nasdaq's Blockchain technology will be employed to record votes securely. The agility and size of Estonia coupled with its robust Information Society created the favourable environment for the Nasdaq-Estonian Government collaboration in piloting the e-voting programme.

Israel Israel currently ranks in the 20th position in the UN E-Government Development Index (United Nations Department of Economic and Social Affairs 2016) and 21st in the global innovation index (Cornell University, INSEAD, and WIPO 2016). It is a country that is driven by a strong defence industry, technological military units, and world-class academic institutions. Israel is also developing a reputation as a hub for innovation and technology. The country's unique experience in Fintech, cybersecurity and cryptography makes it a hotspot for Blockchain innovation. Notable examples of Blockchain-based initiatives in public sector in Israel include:

- *Israel joint research with Commonwealth Bank of Australia* (Marine and Chloé Gueguen 2016): Israel is currently working jointly with Australia to achieve a goal of making Australia as a leading hub in Asia pioneering global initiatives in Blockchain, cybersecurity, international settlement and big data. To make this goal a reality, Commonwealth Bank of Australia (CBA) has signed an agreement with the Israel government to access Blockchain related technology and innovation developed by Israel's flourishing start-up ecosystem. The initiative will also benefit from the support of global firms such as Microsoft, General Electric, and Procter & Gamble are the sources in the area of funding. However, the bank, other firms and the Ministry will provide research grants in the areas disruptive technologies in Blockchain and related areas of Internet of Things and Big Data Analytics.
- *The Israel Blockchain Ecosystem* (Amit 2016): In addition to enabling Blockchain-based innovation in other countries, Israel has successfully built an ecosystem of Blockchain. At least eleven Blockchain start-up firms are already in operations in the country. The thrust here is to employ Blockchain as an information infrastructure for digital, chronologically updated, distributed and cryptographically record of data. By digital, we understand that almost all types of information can be expressed in digital format and referenced later through a ledger entry. The chronological order enables verification and authentication through permanent time stamping. These start-ups are employing blockchain technology to secure online purchases, protect digital rights to songs, enable the conversion of cryptocurrencies to bills at ATM, send cryptocurrencies as messages, operate decentralised organizations, buying bitcoin over credit card transactions. These technology companies are collaborating with global technology consulting firms like Deloitte and banks in and outside Isreal to realise these innovations.

New Zealand The country ranks 8th in the E-Government Development Index and 17th in the Global Innovation Index. Over 40 top financial institutions and a growing number of businesses are experimenting with Blockchains in the country as a way of doing business. A few of the Blockchain-based government initiatives that are also under development include:

- *Improving the agricultural sector through Blockchain* (Corner 2016): The Government of New Zealand aims to attract leading entrepreneurial researchers to the country to increase knowledge in the key areas that can contribute to the economic and environmental needs of the country. One of the strategies of the government is to build capabilities which will enable the country to stay at the forefront as the digital revolutions by leveraging emerging technology such as the Blockchain. This technology is specifically targeted at the agriculture sector to provide food products with solid provenance. This will enable consumers to determine where a food item is produced, its freshness, safety and quality.
- *Energy and the Blockchain technology in New Zealand* (Phillippa 2016): A private energy firm (P2 power) is working with the government to provide a platform for the sales, purchase, and distribution of energy via Blockchain innovation. In April 2016, the firm launched a platform which enables the production of up to green energy delivered from a peer-to-peer grid. It is estimated that consumers will save about 4c per kWh buying from the peer-to-peer network. Currently, it takes 30 min to scan the networks for excess power generated by those who are part of it and when that is unavailable, energy will be provided by local power stations. The planned migration to the 'Ethereum' blockchain is expected to deliver a better experience in terms of speed for the peer-to-peer matching.

South Korea The country is well known for its global leadership in the area of technological innovation. It currently ranks 3rd in the E-Government Development Index and 11th on the Global Innovation Index. South Korea has in the past few years been actively involved in the development of Blockchain technologies. On 28 February 2015, the government opened its doors becoming a common ground for Korean Blockchain enthusiasts. Among the government initiatives in this space is the organization of weekly bitcoin trading programming classes. The government is also supporting the hosting of the bitcoin start-up competition where five companies participated. Two notable blockchain initiatives in the country are:

- *Using Blockchain for Local Community Voting* (Keirns 2017): In collaboration with Blocko, the provincial government of Gyeonggi-do employed a voting solution for community funding. Specifically, the blockchain- and smart contract-based voting platform enables members of the community and local residents to propose and vote on community aid initiatives. Over 9,000 votes were submitted by residents through online and offline channels resulting in the selection of 527 projects by the provincial government. The blockchain-based solution according to provincial government allowed the possibility of complementing traditional representative democracy with direct democracy. The collaborator in this initiative; Blocko, is a blockchain research and services start-up in Korea and the developer of the CoinStack platform.
- *Blockchain-based financial innovation* (Buntinx 2016): the South Korean Government is looking to provide venture capital opportunities to SMEs involved in blockchain related innovation. The strategy employed by the government is to

invest in financial technology and an ICT-based start-up that can develop creative ideas on innovation and change project based on the Blockchain technology. The government and its partners have identified Blockchain innovation as a tool that can be used for asset ownership and settlement management. The government also believes that Blockchain will pave the way for new technologies and solutions in the Fintech industry.

United Kingdom The country ranks in 1st position in the 2016 E-Government Development Index and the 3rd place in the 2016 Global Innovation Index. UK Government through its Office of Science published a report on Distributed Ledger Technology: Beyond blockchain (Taylor 2016). The report expressed the transformational potential of distributed ledger and also advanced a number of technology, governance, security and privacy, and trust and interoperability related recommendations. Furthermore, the UK government believes that it stands in a good position to leverage the benefits and address the challenges related to the use of distributed ledgers in the public service and economy because of the digital capability, innovative financial services, the effective research community and growing private service. Some of the ongoing blockchain based initiatives in the UK include:

- *Distributed ledger based Gross Settlement System* (Peter 2016): the Bank of England is currently working on replacing its current real-time gross settlement (RTGS) system to be ready for future demands. Specifically, the future system must address the following strategic RTGS requirements: (1) capability of responding to the changing structure of the financial system; (2) recognising that payment system users want simpler and more resilient pathways for their payments; (3) capability of interfacing with a range of new technologies being used in the private sector, including distributed ledgers, if/when they achieve critical mass; (4) to remain highly resilient to the increasingly diverse range of threats to continuity of service, and (5) develop capacity to support the future evolution of regulatory and monetary policy tools. From the bank point of view, the new system will change a lot of features between the existing system which was built in 1996 and its successor. Some of these changes will include and enhanced security, which could be provided through the use of distributed ledger/blockchain solutions.
- *Blockchain for benefit payment* (Lynsey 2016): the government is currently test-running a blockchain based social welfare payment mobile app. Claimants in receipt of this payment are advised to download the app on their phones which will enable them to receive and spend their benefit payments. With their consent, their transactions are being recorded on a distributed ledger to support their financial management. This initiative focuses on adding an additional layer of richer data and identity onto payments so that a deeper and more effective relationship can be established between the government and claimants. The aim of this project is to identify the possibility for welfare payment to citizens to be sent through a secure app and also to see if people reliant on welfare payments would benefit from this approach. This new system consists of a mobile app and a Blockchain system that records payments sent

and received by beneficiaries. This initiative is a joint effort of the Department of Work and Pensions, Barclays, Npower, University of London and UK-based blockchain start-up GovCoin.

- *Paying research grant through Blockchain* (Hopping, 2016): Monitoring and controlling the use of grants is incredibly complex. The government considers that a blockchain accessible to all the parties involved might be a better way of solving that problem. The government presently is looking into any sort of Blockchain technique, Bitcoin is one of those. Furthermore, it is open to all ideas because of the fact that there are a number of areas Blockchains can be used, including government grants which can be used to track the money and it gets taxpayers a better deal, potentially. The government is currently exploring future technologies so that new ways of doing old things can be identified to reshape the state through the best use of modern technology.
- *Blockchain-as-a-Service for Public Sector* (Hopping, 2016): The government in collaboration with Credits; a distributed ledger or blockchain service provider are working to provide *Blockchain-as-a-service* on the Government Digital Services' Digital Marketplace – UK Government's official platform for public agencies to access cloud and digital services. The initiative will enable central and local government, devolved administrations, health, education, emergency services, defence, and not-for-profits will all be able to take advantage of Credits' platform to build applications and services on a Blockchain. Delivering blockchain service on the Digital Marketplace provides public agencies some flexibility in accessing the service. Based on the framework agreements signed with suppliers of services on the Digital Market, public sector organizations can buy services without needing to run a full tender or competition procurement process. Access to Credit's Blockchain platforms–as-a-service will allow the public agencies to build robust Blockchain-based systems that address the challenges in establishing provenance, authentication service participants, reconciliation of transactions service in addition to seamless and secure interoperability with legacy and other Blockchain systems.

Discussion

We have reviewed 13 blockchain-related initiatives across five leading innovation and e-government countries; D5 countries. These initiatives span the Finance, Economy, Welfare & Social Security, Energy, Governance and Public Services sectors (summary in Table 1). In these cases, blockchain technologies have been deployed as secure information management and provenance infrastructure, authentication and validation infrastructure, financial settlement infrastructure, and transaction governance infrastructure. In all these cases, blockchain start-ups in the different countries have played pivotal roles in realizing the different initiatives.

These cases have also revealed some emerging patterns on the role of governments in developing blockchain applications. In most cases, government agencies have simply leveraged the infrastructure and services provided by local blockchain start-ups to realise pilot initiatives. In other cases, the governments have sought to focus on developing the blockchain ecosystems (e.g. Israel) by facilitating the interaction of local start-ups and investors.

In addition to the various type of goals that emerged from the cases and described in Table 1, blockchain and distributed ledger technology could help in the specific area of governance including (Hopping 2016): traceability of government spending, protecting critical infrastructure, registering assets such as intellectual property, wills, and health data as well as reducing waste resulting from benefit fraud.

To further develop and mature blockchain initiatives, the UK Government Chief Scientific Office provided some recommendations in advancing blockchain innovations in government and society, which include (Taylor 2016): (1) establishing a ministerial level leadership to ensure that government provides the vision, leadership and the platform for distributed ledger technology within government; (2) that the research community invest in the research required to ensure that distributed ledgers are scalable, secure and provide proof of correctness of their contents; (3) that government supports the creation of distributed ledger demonstrators for local government that consolidates all the elements necessary to test the technology and its applications; (4) government should put in place the necessary regulatory framework for distributed ledger; (5) that government works with academia and industry to ensure that standards are set for the integrity, security and privacy of distributed ledgers and their contents which should be reflected in both regulations and software code; (6) that government works with academia and industry to ensure the most effective and usable identification and authentication protocols are implemented for organizations and individuals.

Similar recommendations have been advanced in other sources[1]. For instance, it was recommended that Government leaders need to familiarise themselves with the potentials and benefits of the blockchain as a digital transformation technology before committing to exploring its potentials; and 3) commence experimentation with blockchain technology via proofs of concepts and small projects.

As indicated in many of the recommendations above, government's close collaboration with academia is critical to advancing research in blockchain and distributed ledger technology. From the different cases reviewed, we observe that a number of interesting concepts are emerging from the interaction of blockchain technology and governance. Some of the concepts that could redefine governance and definitely worth examining further include (James et al. 2016): "Do-it-Yourself" Governance, Decentralised Autonomous Organization, Decentralised Citizen Engagement,[5] Provably Secure Governance, Provable Transparency, and Collaborative management of jointly owned digital assets.

[5] http://netfutures2016.eu/wp-content/uploads/2016/05/1-Project-presentation-net-futures-.pdf

Conclusion

This chapter has directly contributed to addressing the paucity of scholarly literature on the application of blockchain and distributed ledger technology in the government domain as highlighted in (Ølnes 2008). We have reviewed several initiatives across the Digital 5 countries in which government has played various roles in blockchain initiatives. While some of the reviewed initiatives show great promise, most of these initiatives are far from operating at scale. At the same time, there are a number of legal, regulatory, ethical as well as technical barriers that must be addressed to fully harness the potentials of the blockchain and distributed ledger technology in government.

References

Amit H (2016) Israel: a hotspot for blockchain innovation
Buntinx J (2016) Korea to boost investments in fintech, blockchain startups. Korea Herald
Capgemini (2016) Blockchain: a fundamental shift for financial services institutions, p 16
Cornell University, INSEAD, and WIPO (2016) The global innovation index 2016
Corner S (2016) How blockchain can help Kiwi farmers. Computerworld
Crawford S, Meadows I, Piesse D (2016) Blockchain technology as a platform for digitization. EY, p 16
Drucker P (2016) Blockchain applications in the public sector
Froystad P, Holm J (2016) Blockchain: powering the internet of value, p. 50
Finextra (2016) Banking on blockchain: charting the progress of distributed ledger technology in financial service, p 28
Ian A (2015) Bitnation and Estonian government start spreading sovereign jurisdiction on the blockchain. IB Times
James S, Tennison J, Wells P, Fawcett J, Harrison S (2016) Applying blockchain technology in global data infrastructure
Kalev A (2016) Why ripples from this Estonian blockchain experiment may be felt around the world
Kaye S (2016) An introduction to bitcoin and blockchain technology, p 13
Keirns G (2017) Local Government in South Korea Taps Blockchain for Community Vote. Coindesk. [Online]. Available: http://www.coindesk.com/south-korea-blockchain-community-vote/. Accessed 14 Apr 2017
Kosba A, Miller A, Shi E, Wen Z, Papamanthou C (2016) Hawk: the blockchain model of cryptography and privacy-preserving smart contracts. IEEE S&P, p 31
Lynsey B (2016) The government has quietly been testing blockchain technology for benefits payments
Marine and Chloé Gueguen (2016) Landscaping the Australian fintech ecosystem
Palo U, Katribas U, Dunne, P, Jong-Sup C, Maude F (2015) D5 Charter, pp. 5–6
Hopping C (2016) Credit becomes first G-Cloud blockchain PaaS
ODI (2016) Applying blockchain technology in global data infrastructure, p. 26
Ølnes S (2008) Beyond bitcoin enabling smart government using blockchain technology. In: Scholl HJ, et al. (eds) EGOV 2016, LNCS 9820, 5184(2006):253–264
Oscar W-G (2016) Estonia is using the technology behind bitcoin to secure 1 million health records
Peter S (2016) Bank of England wants next payment system to be blockchain-ready
Phillippa W (2016) Peer to peer energy trading to be trialled in NZ

Pilkington M (2016) Blockchain technology: principles and applications. In: Elgar F, Olleros X, Zhegu M, Elgar E (eds) Research handbook on digital transformations. Edward Elgar, Cheltenham, p 39

Probst L, Frideres L, Cambier B, Martinez-Diaz C (2016) Business innovation observatory: blockchain applications & services. European Union, p 16

Shrier D, Iarossi J, Sharma D, Pentland A (2016) Markets and marketplaces, pp 1–19

Srisukvattananan Y (2016) Overview of blockchain and possible use cases in the Thai payment system. Massachusetts Institute of Technology, pp 1–172

Taylor S (2016) Distributed ledger technology: beyond block chain

United Nations Department of Economic and Social Affairs (2016) UN E-government survey 2016. E-government in support of sustainable development. New York

Wikipedia (2016) Digital 5

Wyman O (2016) Blockchain in capital markets: the prize and the journey. Euro Clear

Dr. Adegboyega Ojo is Senior Research Fellow at the Insight Centre for Data Analytics, National University of Ireland Galway (NUIG). He leads the E-Government Group at Insight Centre and serves as Adjunct Lecturer at the College of Engineering and Informatics. His current research interests include data driven innovations in government, Open data policies and Infrastructures, data analytics and governance of smart cities. He is a member of the Editorial Boards of the Government Information Quarterly and International Journal of Public Administration in the Digital Age.

Samuel Adebayo a research assistant at Insight Centre for Data Analytics, NUI Galway. Samuel's research interests include Open Data, Social media and emerging technologies in government. He joined the e-Government unit at Insight Centre in April 2015. Samuel holds a bachelor degree in Business Management from University of Wales and a master's degree in Information System Management from National University Ireland Galway. His area of expertise includes project management, requirement life cycle management, analysis and design, solution evaluation, testing and quality engineering.

Governance, Transparency and the Collaborative Design of Open Data Collaboration Platforms: Understanding Barriers, Options, and Needs

Michael Hogan, Adegboyega Ojo, Owen Harney, Erna Ruijer, Albert Meijer, Jerry Andriessen, Mirjam Pardijs, Paolo Boscolo, Elena Palmisano, Matteo Satta, Jonathan Groff, Michael Baker, Françoise Détienne, Lukasz Porwol, Vittorio Scarano, and Delfina Malandrino

Abstract Developments in open data have prompted a range of proposals and innovations in the domain of governance and public administration. Within the democratic tradition, transparency is seen as a fundamental element of democratic governance. While the use of open government data has the potential to enhance transparency and trust in government, realising any ideal of transparent democratic governance implies responding to a range of sociotechnical design challenges.

M. Hogan (✉) • O. Harney
National University of Ireland, Galway, Ireland
e-mail: michael.hogan@nuigalway.ie; o.harney2@nuigalway.ie;
http://www.linkedin.com/in/owenharney

A. Ojo
Insight Centre for Data Analytics, National University of Ireland Galway, Lower Dangan, Galway, Ireland
e-mail: adegboyega.ojo@insight-centre.org

L. Porwol
Insight Centre for Data Analytics, National University of Ireland, Galway, Ireland
e-mail: lukasz.porwol@insight-centre.org

E. Ruijer • A. Meijer
Utrecht University, School of Governance, Utrecht, The Netherlands
e-mail: H.J.M.Ruijer@uu.nl; A.J.Meijer@uu.nl

J. Andriessen • M. Pardijs
Wise & Murno Learning Research, Den Haag, The Netherlands
e-mail: jerry@wisenmunro.eu; mirjam@wisemunro.eu

P. Boscolo • E. Palmisano
Comune di Prato, Prato, Italy
e-mail: p.boscolo@comune.prato.it; elena.palmisano@pin.unifi.it

M. Satta
Issy-Média and Ville d'Issy-les-Moulineaux, Issy-les-Moulineaux, France
e-mail: Matteo.Satta@ville-issy.fr

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_12

In order to address these design challenges it is essential to adopt an interdisciplinary and stakeholder-engaged approach to research and innovation. In the current study, we describe a contextualist approach to the design of an open data collaboration platform in the context of an EU innovation project, focused on enhancing transparency and collaboration between citizens and public administrators through the use of open government data. We report on a collective intelligence scenario-based design process that has shaped the development of open data platform requirements and ongoing system engineering and evaluation work. Stakeholders across five pilot sites identified barriers to accessing, understanding, and using open data, and options to overcome these barriers across three broad categories: government and organisational issues; technical, data, and resource issues; and training and engagement issues. Stakeholders also expressed a broad variety of user needs across three domains: information needs; social-collaborative needs; and understandability, usability, and decision-making needs. Similarities and differences across sites are highlighted along with implications for open data platform design.

Developments in political philosophy, science, technology, and open data information systems have prompted a range of proposals and innovations in the domain of governance and public administration. Within the democratic tradition transparency is seen as central to democratic governance (Ghaus-Pasha 2007) and has been a central focus of research and innovation in recent years (Meijer 2015a, 2015b). Advocates of open government and transparency have long argued that citizens should have the right to access the data, documents and proceedings of the government to allow for effective public scrutiny and oversight and to support increased public participation and collaboration (Habermas 1962; Bertot et al. 2008). Whether citizens are focused on monitoring government policy and the consequences of policy, deliberating and discussing policies and shaping the policy decision making process, or participating directly in policy development and public value creation, the use of open data which are available through platforms has the potential to enhance transparency and trust in government. The internet revolution and wide adoption of e-government across different parts of the world has made computer-mediated transparency a popular strategy for transforming transparency relationships between government and citizens towards greater co-creation and trust (Meijer 2009; Bannister and Connolly 2011). There are well over 8,000 datasets available on the European Union Open Data Portal (Ojo et al. 2016). This is in addition to

J. Groff • M. Baker • F. Détienne
CNRS – Telecom ParisTech, Paris, France
e-mail: jonathan.groff@telecom-paristech.fr; michael.baker@telecom-paristech.fr; francoise.detienne@telecom-paristech.fr

V. Scarano • D. Malandrino
University of Salerno, Fisciano (Salerno), Italy
e-mail: vitsca@unisa.it; dmalandrino@unisa.it

hundreds of open data portals provided at different levels of government to enhance transparency and spur data-driven innovation.

While the availability of reliable open data on an open data platform can inform policies and practices in democratic societies, realising any ideal of transparent democratic governance implies a range of sociotechnical design challenges. These design challenges may vary depending on the political and social context and specific scenario of usage where open data is being used by stakeholders to address specific questions or problems. However, research on challenges and barriers to open data adoption has not focused much attention on specific scenarios or contexts of usage (Janssen et al. 2012; Attard et al. 2015; Meijer 2015a). The current study advances research in the area by adopting a collective intelligence scenario-based design approach to investigating the barriers to accessing, understanding, and using open data and the specific information, social-collaborative, and decision-making needs of stakeholders across a range of different open data usage scenarios. As part of an ongoing EU innovation project focused on the design of an open data collaboration platform, the current study presents the results of a series of collective intelligence scenario-based design workshops that have shaped the development of system requirements and ongoing system engineering and evaluation work. The results highlight a range of barriers to accessing, understanding, and using open data and a range of user needs that platform designers must consider based on specific scenarios across five pilot cases involving Local Authorities across four EU countries. Based on our results and experiences using the collective intelligence scenario-based design process, we argue that it is feasible to design open data platforms through a collaborative design process that engages key stakeholders. We further argue that open data platforms engineered this way will better meet stakeholders' needs in the context of real-world political and social scenarios.

Approaching Design for Transparency: The Case for Contextualism

Transparency is generally seen as a fundamental element of democratic governance (Ghaus-Pasha 2007). It is commonly associated with an entity's revelation or disclosure of information about its own decision processes, procedures, functioning and performance to external actors (Grimmelikhuijsen and Welch 2012). When transparency is conceived as a means to an end, transparency initiatives can have different goals ranging from limiting abuses of power, to tackling corruption, encouraging improved institutional performance and stimulating open innovation (Hilgers and Ihl 2010; Fox 2007).

Over the years, perspectives on, as well as treatment of transparency as a concept have evolved. Historically, two distinct eras of transparency have been identified – transparency in an era of representative democracy and transparency in an era of participatory democracy (Meijer 2015b). While representative democracy is founded on the principle of elected officials representing a group of people, with the potential for people to monitor and discuss policies and policy outcomes, participatory democracy is a process emphasizing the broad participation of citizens and public administrators in the direction and operation of political systems and the co-creation of public value. The era of participatory democracy is associated with widespread availability of government documents and data on websites and open data portals (Meijer 2015b), which opens the potential not only to monitor government activity, but also deliberate and discuss policies in an informed manner, and participate and collaborate in the formulation of policy and the co-creation of public value.

Research and innovation in the area of transparency enhancing technologies emerges in parallel with different perspectives and conceptualisations of transparency. Different approaches to conceptualising transparency may influence open data platform and software design. Consistent with the collective intelligence design methods developed by Warfield (2006), which emphasise a stakeholder-driven approach to design, and consistent with the principles of scenario-based design (Caroll 2000), which emphasises the importance of understanding specific scenarios of usage in the technology design process, our view is that understanding the context of technology usage and the specific problems stakeholders are trying to resolve in context is important for the design of transparency-enhancing technologies. As such, we advocate contextualism as an orienting philosophy for conceptualising transparency and for understanding the technology-mediated activities that support transparency in context. In general, we believe that conceptualisations of transparency can be understood by reference to different worldviews, or ways of understanding reality, and different worldviews can influence the development of different frameworks shaping research, design, and innovation (Hayes et al. 1988). Drawing upon Pepper's (1942) distinction between formism, mechanism, organicism and contextualism, below we will briefly describe these worldviews in turn, and the rationale for adopting contextualism as an approach to technology design in the current project.

Formism, as defined by Pepper, involves the identification of forms, or aspects of reality, that share common or similar characteristics. Heald (2006) highlights a variety of different forms of transparency. For example, Heald (2006) draws a distinction between *nominal* versus *effective* transparency. While a *nominal* form of transparency might imply the *availability* of data on an open data platform, an *effective* form of transparency might involve data that is *effectively used* to shape valued outcomes (Heald 2006). Similarly, Heald (2006) distinguishes between forms of transparency that are based on an analysis of historical data (i.e., transparency in *retrospect)* and forms of transparency that are based on an analysis of data that reflects the current state of a system (i.e., transparency in *real-time)*. As noted by Pepper (1942) identifying different forms, or aspects of reality, can be an important precursor to the development of more complex models, for example, mechanistic models that describe causal relationships between different aspects of reality. Similarly, formism may shape design thinking. For example, in the context of the design and innovation of an open data platform, formist conceptualisations of transparency may support design thinking in relation to specific aspects of technology design, related to specific forms of transparency. For instance, drawing upon a distinction between transparency in *retrospect* and transparency in *real-time,* a technology design team might include platform features that allow for a distinction to be made between current data and historical data, and possibly add prompts that help users to make these distinctions. At the same time, formist conceptualisations of transparency may limit design thinking in certain respects. While it might support design thinking in relation to specific forms of transparency, a formist approach to analysis does not generally emphasise a dedicated focus on activity in context. As such, a formist approach to understanding transparency may neglect key aspects of the context of transparency-related activities, or specific problem situations that involve interactions between stakeholders who analyse, discuss, and make use of open data in an effort to support transparency-related activities. In the absence of this more contextual focus distinctions between different forms of transparency may have limited value for the overall design of transparency-enhancing technologies.

In Pepper's (1942) scheme, a mechanistic worldview may build upon formist accounts by specifying how components parts of a system (or machine) work together. From this view, different forms of transparency may be viewed as different components of a system of interdependencies. For example, a mechanistic model may be developed to explain how components of transparency work together to produce trust in societies (Meijer 2009; Mei and Dewan 2014). Specific components of transparency such as *visibility* (the degree to which information is complete and easily located) and *inferability* (the degree to which information can be used to draw verifiable inferences) may in turn be influenced by other components of a system, and a mechanistic model of transparency may become increasingly complex as more components of reality are identified and modelled. For example, studies report that increased demand drives up *visibility*; and demand is strongest for issues that represent acute concerns of citizens, such as finance, health and security (Piotrowski et al. 2011). Although complex mechanistic models of transparency describing many component interdependencies can be developed to shed light on specific issues relevant for transparency-enhancing technology design, by virtue of their mechanistic structure, and the defined set of variables and components in the model, mechanistic models may constrain the ability of a design team to consider the varied actions and needs of users across different scenarios and contexts.

According to Pepper (1942), distinct from mechanism as a worldview is organicism. From the perspective of organicism transparency would be viewed as part of a living system that actively develops through various stages of maturity or functional complexity. For instance, the *Transparency Maturity Model* (Cappelli et al. 2013) characterises five levels of transparency – opaque, disclosed, comprehended, reliable, and participative. At the lowest level of maturity, the *opaque* level, the organization provides information access to the external environment in a non-systematic fashion. In the *disclosed* level, the organization provides information access to the external environment, but not necessarily in a way that is easily comprehended or responsive to feedback from external stakeholders. The *comprehended* level enables access to understandable information and thus facilitates a higher level of transparency and engagement. At the *reliable* level, the organization allows for auditability of the information provided. Finally, at the *participative* level the organisation allows for ongoing dialogue with the external environment about the information provided. As a worldview orientation, Pepper (1942) notes that organicism is linked to idealism, in the sense that there is an assumption that a system has the potential to develop toward a more ideal state of functioning. However, these idealist assumptions may not be aligned with the activity in context and thus by adopting organicism as a worldview, designers of transparency-enhancing technologies may neglect the problems and activities of technology users in context and thus fail to develop technologies that are well suited to the problems users are working to resolve.

As an approach to analysis and design, Pepper (1942) notes that contextualism emphasises a focus on activity in context. Contextualism allows for different strands of enquiry in relation to different activities in context, each of which may be important for successful workings, or the resolution of a specific problem in context. For example, a contextualist might consider the activities of key stakeholders seeking to access, understand, and use open data – the key barriers they face and the specific information, social-collaborative, and decision-making needs they have across different problem solving scenarios. In a participatory democracy scenario, where there is a focus on collaboration over open data in response to a specific political and social problem, one strand of contextualist enquiry might focus on the qualities of data, such as accessibility, usability, understandability, informativeness and auditability of the data (Cappelli et al. 2013). A related strand of analysis might focus on the social and organisational context within which data is sourced, including who the information holders are, the relevance of different types of public sector information, the availability of the information, and the distribution channels of information (Deloitte 2013). An analysis of these and related issues may be essential to the success of the participatory democracy group working together in the local problem situation. Notably, according to Pepper (1942), adopting the contextualist approach to research and innovation implies a focus on the specific purpose or goal(s) of actors in the problematic situation, and success is determined by the extent to which their purpose or goal(s) are achieved.

Given our focus on the design of a new open data platform, and our focus on developing system requirements that were matched to the context or scenario of usage identified across our pilot sites, we adopted a contextual and collective intelligence scenario-based approach to transparency research and innovation. Specifically, in the current study, we draw upon the collective intelligence scenario-based design thinking of stakeholders to define the scope of our analysis of open data transparency and our approach to the design of a new open data platform that may help to overcome barriers to accessing, understanding, and using open data and fulfil the key needs of stakeholders working across a variety of scenarios.

Transparency Design and the Route-to-PA Project

The research findings reported in this paper emerge as part of an ongoing EU innovation project, the "Route-to-PA" project (http://routetopa.eu/). Route-to-PA is focused on the design and evaluation of an open data collaboration platform that can be used by citizens and public administrators across a wide variety of usage scenarios. As the goal of the project is to design user-friendly transparency-enabling technologies for public administrations across a range of EU countries categorised by the Open Data Barometer (2015)[1] as *high capacity* (UK, France, and the Netherlands) and *emerging and advancing* (Italy and Ireland), it was important to understand the varied political and social contextswhere our design and innovation is to be realised. This involved an analysis of the open data readiness of each country, and a mapping of the local open data context for specific usage scenarios that reflect ongoing priorities of citizens and public administrations in each country (see http://routetopa.eu/wp-content/uploads/2016/07/D7.1_Market_analysis.pdf/). To maximize the socio-technical capabilities and vision of the design team, it was essential to engage with key stakeholders and users in each pilot site to understand the barrriers to accessing, understanding, andusing open data, options to overcome these barriers, and the key needs and requirements of users across a range of monitorial, deliberative, and participatory democracy scenarios. Furthermore, as the goal of the Route-to-PA project is the design of a flexible open data collaboration platform that allows for a range of democratic activities, up to and including collaboration and co-creation of public value, it was essential that the range of needs stakeholders specified in response to scenarios include not only information needs, but also social-collaborative and decision-making needs. In order words, the open data platform needed to allow for collaboration, shared learning, and decision making in the context of accessible, usable, understandable open data. As such, we approached our contextual analysis and system design work using an integrative collective intelligence scenario-based design approach. Below we describe our approach to system design in more detail and present the results of our study, highlighting in particular the range of barriers, options, and needs our stakeholders identified and how we have grounded our open data platform design in this collective intelligence work.

Advancing Our Knowledge and Innovation Potential Using Collective Intelligence Scenario-Based Design

While it is widely recognised that open data platforms can foster democratic processes by promoting transparency (Lourenço 2013; Dawes and Helbig 2010; Janssen 2011), researchers have identified a range barriers that hamper effective service design and the full potential of open data innovations. Barriers to effective service design in the area of open data include limited organizational resources and budget, legislative challenges, poor information quality, lack of usability and technical issues (Janssen et al. 2012; Attard et al. 2015; Meijer 2015a). In working to overcome these barriers researchers have proposed a range of generic user requirements (Lourenço 2013; Jaeger et al. 2012; Van Velzen et al. 2009) and assessment frameworks for open data portals and policies (Sandoval-Almazan and Gil-Garcia 2012; Zuiderwijk and Janssen 2014; Lee and Kwak 2012). These approaches either

[1] Open Data Barometer (January 2015) – http://barometer.opendataresearch.org/

take users (both citizens and government) or open data portals as point of departure for analysis. However, the unique context and scenarios of usage and the unique perspectives of stakeholders in relation to information, social-collaborative, and decision-making needs are less often considered in the literature and open data platform design process (Dahlander et al. 2009). Focusing on specific scenarios of usage and the specific needs of users may be important for adoption, uptake and use of open data and open data platforms.

At a basic level, effective computer-mediated transparency implies that external or receiving parties are capable of processing information that has been made available (Heald 2006). However, platforms for open-data enabled transparency are often limited in this regard. Literature on open data portal software shows that social media features are limited on existing or first generation open data portal software or platforms (Alexopoulos et al. 2014). Specifically, these platforms do not provide beyond features for sharing information about datasets on major social media platforms, thus limiting the potential use of open data in participatory democracy scenarios. In addition, features for checking compliance with metadata standards and good practices (Greiner et al. 2015) are very limited, thus limiting feedback from users to data providers that may enhance the quality of data published online. Understanding the unique perspectives of stakeholders and their unique scenarios of usage is critical for the design of platforms and platform software features that are responsive to user needs.

Central to our design work in the Route-to-PA project is the combination of collective intelligence (Warfield 2006) with scenario-based design (Caroll 2000) and agile user story (Cohn 2004) methods. Collective intelligence methods ensure input from a diverse range of representative stakeholders in the design process and the use of scenario-based design methods ensures that identified needs and requirements of users are grounded in an understanding of specific political and social scenarios that are relevant to stakeholders. Finally, the use of agile user stories allows for the specification of user needs, and reasons for those needs, at a level of detail that allows for agile software development of specific functionalities. Working across four EU countries and five pilot sites, we used these methods in a series of carefully designed workshops, one in each pilot site, for the purpose of developing a comprehensive set of user needs, as proposed by key stakeholders.

Each workshop brought together experts, academics, industry specialists, open data practitioners, representatives of governments, open data researchers, and potential users (including citizens, representatives of citizens and social service institutes, various stakeholder groups, and journalists) to reflect on (a) barriers to accessing, understanding and using open data, (b) options to overcome specific categories of barriers, and (c) specific user needs and requirements necessary for consideration in the design of the Route-To-PA platform. More specifically, based on John Warfield's (1994) science of design, in the first phase of each workshop, we used collective intelligence methodologies to understand barriers to accessing and using open data, and options to overcome these barriers. Participants then worked to develop scenario-based user needs (Rosson and Carroll 2002), which involved profiling user needs in light of the barriers and options and high level scenarios of open data usage. This included a separate focus on (1) information needs – what kinds of data do stakeholders want?; (2) social and collaborative interaction needs – how do stakeholders want to use and interact with the data?; and (3) understandabilty, usability and decision-making needs – what kinds of decisions do stakeholders want to make with the data and how would they like to use the data? High level scenarios including multiple users were used to prompt idea writing and discussion in relation to user needs. The scenarios addressed various contextual issues, relevant to each workshop site, and aligned with the primary case focus and societal issue in each pilot site. For example, the Dublin workshop focused on *community networking and opportunity creation;* the Groningen workshop focused on the challenge of *population decline;* the Den Haag workshop focused on *employment and opportunity creation*; the Prato workshop focused on *local policy and budget issues*; and the workshop in Issy-les-Moulineaux focused on the facilitation of *start-up companies and the digital economy*. The research team conducted a meta-analysis of barriers, options, and needs across all sites and used this analysis to inform the specific use-case models and system requirements for the Route-to-PA platform. Below we describe these methods and our results in more detail.

Method and Results

Scenarios and Pilot Sample Details

A total of 83 workshop participants across the five sites participated in the study. Participants represented a broad variety of stakeholders with stakeholder representation distributed evenly across sites. Participants included representatives of stakeholder groups, business representatives, NGO representatives, public administrators and other government representatives, data experts, developers, and researchers. See Fig. 1 for a breakdown of stakeholders across sites.

Workshops

Each pilot site ran a workshop following a common method. The workshop began with a collective intelligence (CI) analysis of barriers to accessing, understanding and using open data, followed by an analysis of options that may overcome these barriers. Based on Warfield's (1994) science of generic design, the CI process is a facilitated problem solving methodology that helps groups to develop outcomes that integrate contributions from individuals with diverse views, backgrounds, and perspectives. Established as a formal system of facilitation in 1980 after a developmental phase that started in 1974, CI was designed to assist groups in dealing with complex issues. The CI approach carefully delineates content and process roles, assigning to participants responsibility for contributing ideas and to the facilitator

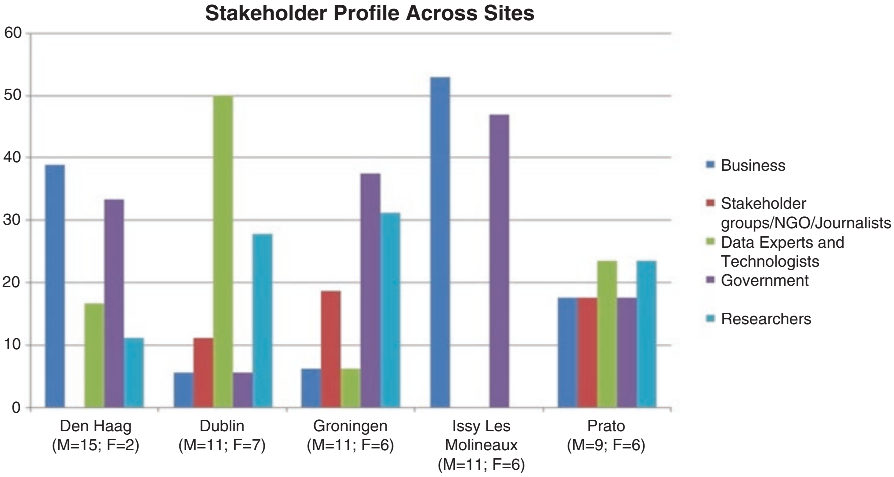


Fig. 1 Stakeholder profile across sites

responsibility for choosing and implementing selected methodologies for generating, clarifying, structuring, interpreting, and amending ideas. Emphasis is given to balancing behavioural and technical demands of group work (Broome and Chen 1992) while honouring design laws concerning variety, parsimony, and saliency (Ashby 1958). CI has been applied in a variety of situations to accomplish many different goals, including assisting city councils in making budget cuts (Coke and Moore 1981), developing instructional units (Sato 1979), designing a national agenda for paediatric nursing (Feeg 1988), creating computer-based information systems for organizations (Keever 1989), improving the U.S. Department of Defense's acquisition process (Alberts 1992), promoting world peace (Christakis 1987), improving Tribal governance process in Native American communities (Broome and Cromer 1991), and training facilitators (Broome and Fulbright 1995). CI has also been recently used in a variety of basic science applications, for example, to design a national well-being measurement system (Hogan et al. 2015), to understand the adaptive functions of music listening (Groarke and Hogan 2016), and to design a student-centred conceptualisation of critical thinking (Dwyer et al. 2014).

CI utilizes a carefully selected set of methodologies, which may include the nominal group technique, ideawriting, interpretive structural modelling, and field and profile representations. The methodologies are matched to the phase of group interaction and the requirements of the situation. For the purposes of idea generation in our workshops, the ideawriting technique was used, along with categorisation or field representation of ideas. Ideawriting is a method that utilizes relatively small groups of 4–6 persons each, formed by dividing a larger group into several working teams, for the purpose of developing ideas and exploring the meaning of those ideas through open discussion (Warfield 1994). Ideawriting involves five steps: (a) presentation of a stimulus question to participants; (b) silent generation of ideas in writing by each participant working alone; (c) exchange of written sheets of ideas among all group members, with opportunity for individuals to add ideas as they read others' papers; (e) discussion and clarification of unique ideas; and (f) an oral report of the ideas generated by each working group in a plenary session. In this plenary session, duplicate ideas across the working groups are eliminated from the set and new ideas are added; the resulting set of ideas is then ready for use in the next stage of the group's work.

In the current application of CI, workshop participants first engaged in ideawriting in response to the question:

"*What are barriers to accessing, understanding and using Open Data?*"

Each workshop generated a set of barriers, which were thematically arranged into categories using a paired comparison method to create a field representation of clusters of related ideas (for more details, see RezaeiZadeh et al. 2017; Warfield 2006). Next, workshop participants engaged with these categories to generate options for overcoming barriers. This was done by means of another round of ideawriting and discussion. In the third phase of the workshop, participants documented scenario-based user needs, by means of agile user stories. This involved profiling user needs in light of the barriers and options and high level scenarios of open data usage (see Table 1 for an overview of scenarios; see appendix 1 for sample scenarios). This included a separate focus on (1) information needs, (2) social/collaborative interaction needs, and (3) understandabilty, usability and decision-making needs. Idea writing was used for each cluster of needs. High level scenarios including multiple users were used to prompt thinking in relation to user needs. All the agile user stories generated by participants were generated in the form:

As User Type _______, I want ______, so that I can ______

Participants were asked to consider the roles and needs of the different actors in each scenario, and generate a list of needs for each actor. Ideas were subsequently discussed by sub-groups and all ideas and handouts were then gathered and collated by the workshop facilitation team. Each pilot site facilitation team conducted an analysis of needs by categorising related needs within each of the three domains (i.e., information, social/collaborative interaction needs, and understandabilty, usability and decision-making) and documenting the frequency of needs in each category. These analyses are reported in detail in an EU report published online here: http://routetopa.eu/wp-content/uploads/2015/06/D2.3_-User_stories_on_Open_Data_and_Transparency-v1.0.pdf. The research team engaged in a further meta-analysis of barriers, options, and needs across all sites. The results of this analysis are reported below.

Barriers to Accessing, Understanding, and Using Open Data, and Options for Overcoming These Barriers

Figure 2 below presents the results of a relative frequency analysis of barriers to accessing, understanding, and using open data across sites, with the total number of barrier statements in each category noted in the legend. A set of 12 categories were

Table 1 Scenarios

Pilot	Context	Actors involved	Use of open data in scenarios
Dublin	Deliberative Democracy; Participatory Democracy	• Public Administrator • Entrepreneur • Citizen • Local Activist • Local Group Coordinator • Civic Hacker	• Societal Issues • Improved Govemment financial efficiency • Business development • Community building • Citizen–Government communication
Groningen	Deliberative Democracy; Participatory Democracy	• Principal • Public Administrator • Community Activist • Entrepreneur • Local Business Community • Local Community Members	• Government actions monitoring and collaboration • Business community collaboration
Den Haag	Deliberative Democracy; Participator Democracy	• Public Administrator • Business Owner • Citizen • Unemployed • Entrepreneur • Disabled Job Seeker	• Social problem solving – unemployment of disabled
Prato	Monitorial Democracy, Deliberative Democracy;	• Public Administrator • Student • Citizen • Community Activist • Journalist • Accountant	• Citizen–Government communication • Inclusive policy making • Citizen collaboration and co-creation • Service improvement • Government actions monitoring
Issy-les-Moulineaux	Deliberative Democracy, Participatory Democracy	• Entrepreneur • Local Community Members • Businesses • Public Administrator • Domain Expert	• Social problem solving-ecology, technology, and mobility services

identified by two interdependent coders using the paired comparison method (Warfield 2006). These included a number of categories of barriers related to government and organisational issues, such as: *Conflict and Cooperation; Government and Organisational: Resistance to Open Data Initiatives; Government and Organisational: Fear of Losing Control of Data; and Privacy and Security.* Another set of barrier categories were linked to technical, data, and resource issues, specifically: *Data Applications; Data Management/Policies; Data Quality, Accessibility,*

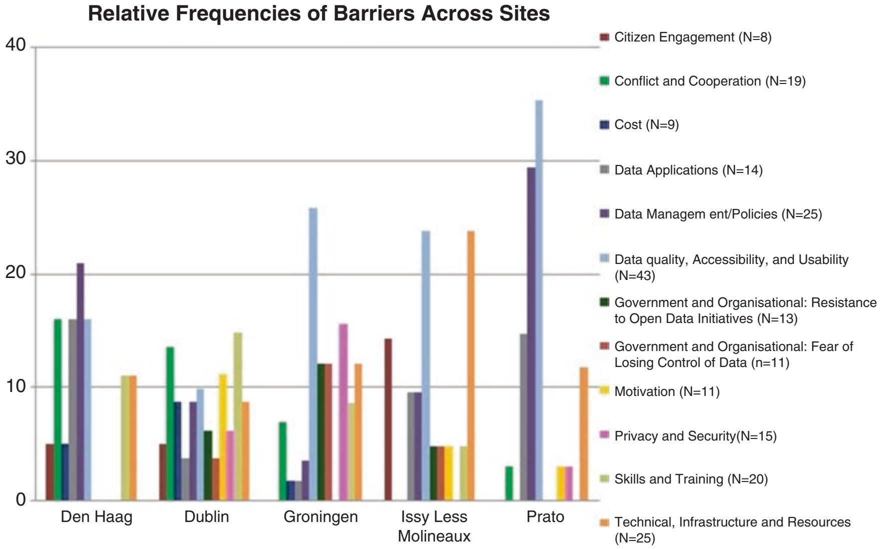


Fig. 2 – Relative frequencies of barriers across sites

and Usability; Technical, Infrastructure and Resources; and *Cost.* Finally, a set of barrier categories related to training and engagement issues, including: *Citizen Engagement; Skills and Training*; and *Motivation.* Table 2 presents a sample of barriers from each category.

The frequency analysis – that is, an analysis of the number of barrier statements generated by each site across the 12 categories, controlling for the total number of ideas generated in each site – allows for comparison of the relative weight stakeholders in each pilot site placed on the various barrier categories. Looking at Fig. 2, it can be seen, for example, that 35% of all barriers generated in Prato related to *Data Quality, Accessibility, and Usability*. As such, this category accounted for the highest percentage of total barriers generated by stakeholders in Prato. Looking across the pilot sites, it is also evident that the category *Data Quality, Accessibility, and Usability* accounted for the highest or joint-highest percentage of total barriers in Groningen, Issy-les-Moulineaux, and Den Haag.

Options to Overcome Categories of Barriers

Table 2 also presents a sample of options generated by participants, linked to specific barriers. Notably, a large proportion of options across sites related to efforts to respond proactively and positively to government and organisational resistance, which may be seen as central to enhancing overall open data infrastructures and practices. Furthermore, a large portion of options across sites focused on the need for skills and training, citizen engagement, and efforts to enhance data quality and usability.

Table 2 – Categories of barriers and options across sites, including samples

Categories of barriers	Sample barriers	Sample options
Citizen Engagement	Failure by government departments to advertise that datais available to the public	Open a channel for the public to communicate with governments
	Minimal publicity about data available leading to lack of awareness of its existence	Put good examples in the limelight (competent citizens)
Conflict and Cooperation	Conflict between wanting to share data and the data being used as criticism	Establish an open data training officer or advisor within an organisation
	Conflict between privacy and openness	Encourage a code of conduct that allows fair discussion and not vindictive trolling
Cost	Inadequate finances to fund the sustained collection and sharing of open data	Data creation should be driven by user demand
	The cost of accessing data may be prohibitive	Centralize streamline formats license metadata for all datasets from all sources
Data Applications	Lack of examples available for smart use of open data	Make a connection with education
	Scarce effectiveness of research tools: queries are not tailored on real users needs	More complete platform for better search ability of data
Data Management/Policies	Lack of information about the circumstances of data production	Set up good information management practices across all public bodies – data co-ordinates
	Lack of data maintenance	Regulate Transparency from all sides (policy making, showcase it. budgets): reward it
Data Quality, Accessibility, and Usability	Data is published but cannot be found and does not have a user-friendly format	Involve users in the development of the platform
	Insufficient data description	Be clear about what is what: when collected, by whom. how. and so on
Government and Organisational: Fear of Losing Control of Data	Fear of how transparency via open data might affect the organisation Fear of misuse of data	Explain what open data is Facilitate a culture change: it is ok to make mistakes, political backup for management

(continued)

Table 2 (continued)

Categories of barriers	Sample barriers	Sample options
Government and Organisational: Resistance to open data initiatives	Failure to understand the organisational benefits of releasing open data It will take a lot of effort to convince people to use open data	Demonstrate the business case to local governments through case studies, feedback and further innovation outcomes Support and drive organisational change programs; Organisational change management is essential.
Motivation	Failure to understand the benefits that Open Data can offer	Identify and publish data that is relevant and engaging
	Data publishing is not perceived as a "mission" in administration's point of view'	Promote the benefits of an open data portal and give good examples
Privacy and Security	Personal information accessed by public canlead to data protection infringement	Very clear data protocol and guidance
	Some data is commercially sensitive	Profiling of platform members could support their research without violating personal information or property rights
Skills and Training	Inadequate technical expertise to produce data in a usable format	Provide information, training and education, for all government agencies on the benefits of an open data portal
	Users lack the skills to process data and translate into information	Provide open data FAQs for basic users
Technical, Infrastructure, and Resources	Data is spread over different organizations and departments Inadequate institutional capacity to provide open data services, to develop standards and to provide expertise	Pooling of public sector resources Better curation and maintenance of data quality

As was the case with regard to barriers, there were also differences in the relative frequencies of options across sites. For example, while the *Technical, Infrastructure and Resources* category accounted for a high percentage of total options generated in Den Haag and Issy-les-Moulineaux, fewer options were generated in response to this category in the other sites. Similarly, while *Citizen Engagement* received a high

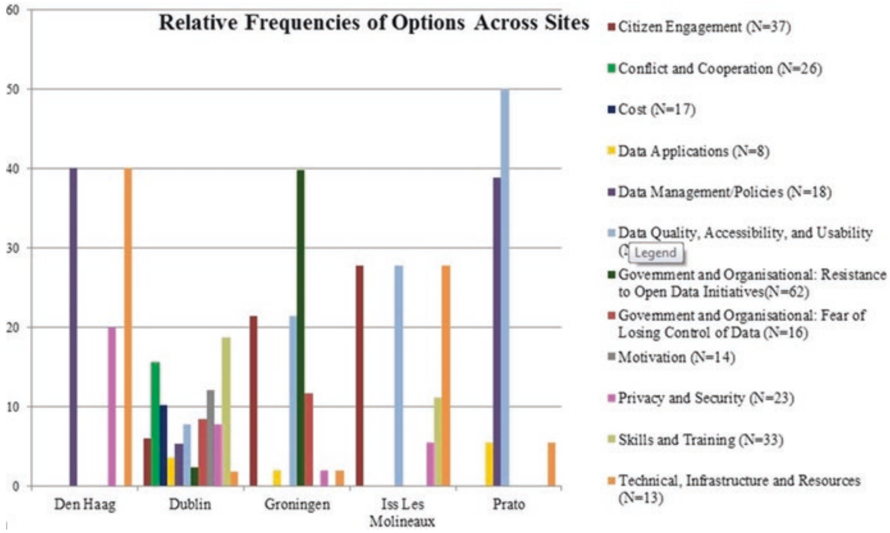


Fig. 3 Relative frequencies of options across sites

percentage of generated options in Groningen and Issy-les-Moulineaux, it received less attention in the other sites. Also, whereas options in Dublin were spread across all categories, options were more focused on a smaller set of specific categories in Den Haag and Prato. This suggests that, from the perspective of stakeholders, these pilot sites, at least in their initial evaluation of the problem situation, have identified a particularly strong need for options to overcome barriers for a select number of categories (Fig. 3).

User Needs

1. *Information Needs*

Stakeholders also highlighted specific needs of users in light of specific scenarios of usage. Table 3 presents sample information needs for each category.

Given the range of scenarios, the user information needs generated across sites were numerous and diverse, allowing for interesting comparisons (see Fig. 4). For example, while the focus of the Den Haag workshop was on employment and opportunity creation, resulting in a high proportion of information needs being developed under the category *Jobseekers Information*, the Dublin workshop, which focused on community engagement and planning generated information needs across a much wider range, including: *Community Information; Planning Information; Services, Amenities and Event Information; Business and Financial Information*; and *Child and Education-related*. Also of note, for example, is the high percentage of needs devoted to *Business and Financial Data*, in two pilot

Table 3 Sample information needs across sites

Categories of information needs	Sample needs
Broadband Data	It is important to know where broadband internet is available if you want to start up your own business Fast internet to know whether I can work from home
Business and Financial Data	Access to economic data To find out about local business rates in the area
Child and Education-related	Projection of the amount of students for the coming 10 years Knowing what the future of the school will be so that I can make plans for the future of the children
Community Information Needs	A list of community groups and different types of communities in the city Data to provide me with new insights on mv community
Contact Information	Where and with whom can I talk about e.g. education policy Contact with government
Demographic Information	Birth rates and migration rates Population statistics
Government Role/Transparency	To know what the government and city are doing about population decline in education To get information about Open Data set traceability
Health Data	Available data about health services in my village Information regarding health services and support facilities
Jobseeker Information	Overview of regulations Standardised CV templates
Legal and Policy Data	Information about laws and regulations, like zoning Data on European community legislation
Market Developments: Housing Data	Information of the last 20 years to examine whether there is indeed a housing dip Housing value data
Planning Data	Information relating to developmental programmes Local news, planning applications: Events in neighbourhood, Road works, Environmental projects
Services, Amenities, and Issues	Information about opening times for parks, libraries, etc.
	Information about cultural heritage sites
Social Issues and Information	To see and ‘up to date’ list of volunteers in my community with skillset and reputation information
	Datasets on citizen demographics
Transport and Parking	Data Journey planning information for people with disabilities
	Location of electric charging station for electric cars

sites – Issy-les-Moulineaux, and Prato – two sites that have a focus on business and local budgeting scenarios, respectively. It is likely that the information needs across sites will develop further as each pilot site works to realise their scenarios by reference to the key open data that allows for effective collaboration between citizens and public administrators.

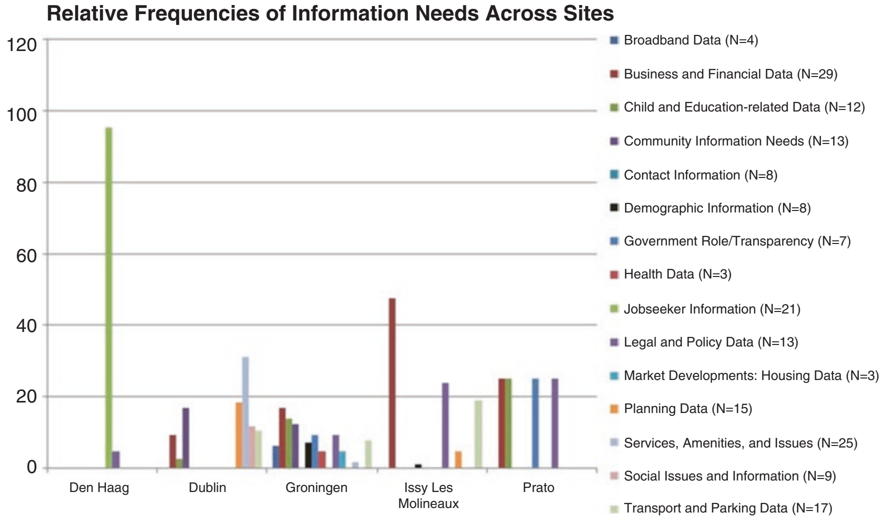


Fig. 4 Relative frequencies of information needs across sites

2. *Social-collaborative needs*

Table 4 presents the category analysis for social-collaborative needs across sites. Participants identified a range of social and collaborative needs, highlighting a number of forms of interaction for use over Open Data, as well as various considerations and capabilities which would enhance the impact and appeal of the platform. Participants highlighted the need for coaching and support, dialogue and discussion spaces; feedback, moderation and maintenance of these spaces; platform tool capabilities for interaction; varied forms of interaction over the data; and sharing and requesting data.

Analysis of the relative frequencies of social and collaborative needs (see Fig. 5) revealed that the *Forms of interaction* category accounted for a high percentage of the total social and collaborative needs in three pilot sites: Den Haag, Dublin, and Groningen. *Coaching and support* received the highest weighting in Issy-les-Moulineaux, and it also received a high weighting in Den Haag (along with *Forms of interaction*). *Platform Tools and Capabilities for Interaction*, which had the highest weighting in Prato, also received high relative weighting in Issy-les-Moulineaux and Dublin. Examples from the three categories highlighted above emphasise, for example, the need for flexibility of interaction: “there must be multiple modes” (*Forms of interaction*); the need for support tools to be in place to “help users to select the relevant data” (*Coaching and support*); and the ability to easily share data analyses with others: “To be able to easily share graphs and reports obtained by TET on social networks” (*Platform Tool and Capabilities for Interaction*).

3. *Understandabilty, usability, and decision-making needs*

Participants also used their scenarios to generate a set of understandabilty, usability, and decision-making needs (see Table 5). Categories of needs here include:

Table 4 Sample social and collaborative needs across sites

Categories of social and collaborative needs	Sample needs
Coaching and Support	Learn to use functionalities Expert facilitation
Contact Information	Identify players in the field, personal contact Personal contact regarding quality improvement
Dialogue and Discussion Space	Somewhere both PA and locals can see a shared conversation To rank suggestions from participants to the discussion
Feedback	A forum rich with feedback from politicians Share feedback received from Public administrators
Forms of Interaction	To share graphics and visual reports obtained via SPOD/TET on Social Network App on mobile phone
Moderation and Maintenance	To have a moderator associated to a discussion To ensure group-specific communication
Personalisation	The ability to share my profile To be able to moderate my portal
Platform tool and capabilities for interaction	Notifications on the evolution of specific societal issues (e.g. distribution of public subsidies) Make data searchable
Sharing and requesting data	The ability to share data on social media To request new datasets
Standardised Protocols	A set of standardised forms and feedback response e.g. forms and Disqus Requests to follow a set format (e.g. when reporting a flood – send a photo)

certification tools; decision-making support tools; guidance and support tools; ability to visualise and personalising data, and data analysis and reporting tools.

A relative frequency analysis of Understandability, Usability, and Decision-making Needs (see Fig. 6) shows that, in four out of five pilot sites (Den Haag, Dublin, Groningen, and Prato), the category *The Ability to Visualise and Personalise Data*, generated the highest percentage of needs. This category included affordances which would help users to understand and use open data, by allowing a degree of flexibility and personal control over the way data is presented. Ideas in this category referred to the need, for example, to “Filter data to my neighbourhood/interests”, to “Return all data about my local area and visualize”, and “To be able to aggregate geographic data belonging to different data sets on a new map”. Similarly, the category *Data Analysis and Reporting Tools* included a high percentage of overall needs across four pilot sites (Dublin, Groningen, Issy-les-Moulineaux, and Prato). This category includes a number of needs which are important for deeper analysis of open data, including: “Modelling tools that I can use with open data and citizens”, “Data mining tools”, and the need “To build in real time graphics and visual reports using Open Data”.

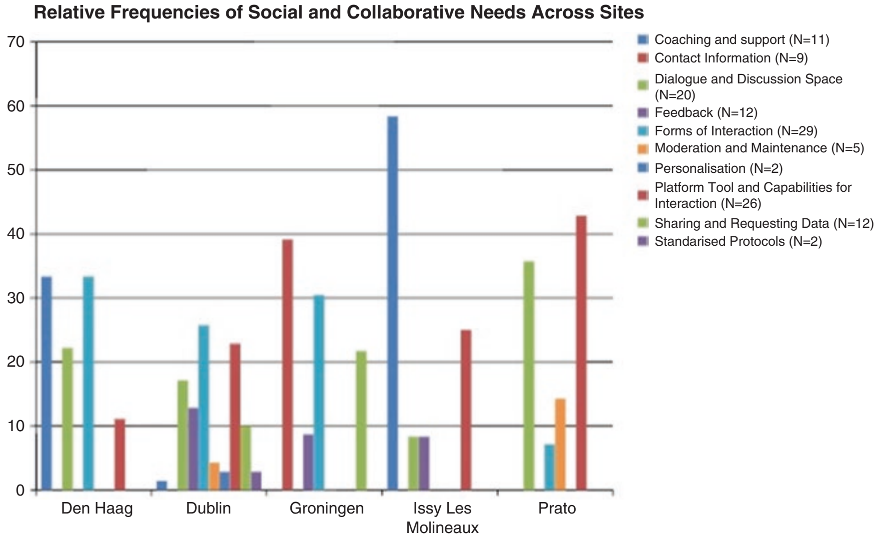


Fig. 5 Relative frequencies of social and collaborative needs across sites

Table 5 Sample understandability, usability, and decision-making needs across sites

Categories of understandability, usability, and decision-making needs	Sample needs
Certification Tools	To certify a published data set or report To be able to demonstrate that a Data set or a report in my possession has been produced by the platform
Data Analysis and Reporting Tools	Better labelling and contextual information on data Data merge and wrangling tools
Decision-Making Support Tools	Mapping platform that gathers public opinion on local area plans A tool to discuss an issue and add data elements to complement discussion
Guidance and Support Tools	Example of successful use app Knowing which people use app
Partner Websites	Complementary information on other websites A support to optimize functionalities
Profiling	Find similar entrepreneur profile on other open data websites Find comments which match with my own issues
The Ability to Visualise and Personalise Data	Filter data to my neighbourhood/interests Modifiable maps and customisable dashboards

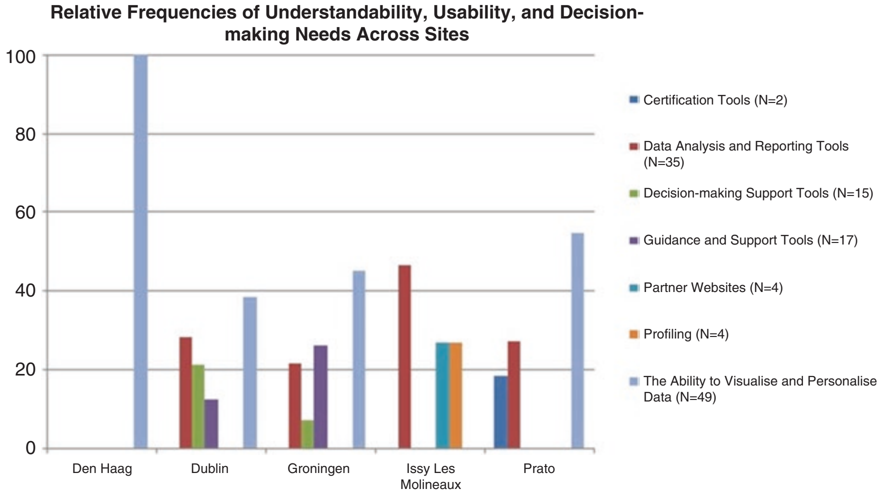


Fig. 6 Relative frequencies of understandability, usability, and decision-making needs across sites

Discussion

Research and innovation focused on the design of open data platforms has the potential to foster democratic processes by promoting transparency (Lourenço 2013; Dawes and Helbig 2010; Janssen 2011). A range of barriers have been identified that hamper effective service design and the full potential of open data platforms, including poor information quality, lack of usability and technical issues, limited organizational resources, and legislative challenges (Janssen et al. 2012; Attard et al. 2015; Meijer 2015a). A range of generic user requirements have been proposed to overcome barriers to effective open data platform design and service delivery (Lourenço 2013; Jaeger et al. 2012; Van Velzen et al. 2009), but the unique scenarios of usage and the unique needs of stakeholders are less often considered in the open data platform design process (Dahlander et al. 2009).

The current study reflects a contextualist approach to conceptualising transparency and open data platform design, drawing in particular on the collective intelligence scenario-based design ideas of stakeholders across five pilot sites in an effort to analyse barriers to accessing, understanding, and using open data, options to overcome these barriers, and the specific needs of open data platform users working across a variety of scenarios. This research was conducted as part of an EU innovation project, the Route-to-PA project. A primary goal of the project is the design of an open data collaboration platform that can be flexibly used by citizens and public administrators across a wide variety of usage scenarios that reflect a range of monitorial, deliberative, and participatory democracy activities. It was important for the platform design team to understand the varied political and social contexts where the open data platform is to be used, and the key needs of stakeholders. By using a combination of collective intelligence (Warfield 2006), scenario-based design (Caroll 2000) and agile user story (Cohn 2004) methods, we were able to achieve a number of goals in the current study. First, we received design input from a diverse range of representative stakeholders. Second, we identified needs and requirements of users that were grounded in an understanding of specific, relevant political and societal challenges they face. Third, we generated a set of user needs specified at a level of detail that allow for ongoing agile software development of specific functionalities.

Using these methods, we identified 12 categories of barriers to accessing, understanding, and using open data. These include two categories which relate to government and organisational barriers: *Resistance to Open Data Initiatives*, and *Fear of Losing Control of Data*. In relation to *Resistance to Open Data Initiatives*, stakeholders noted barriers such as, failure to understand the organisational benefits of releasing open data; resistance due to the fact that "It will take a lot of effort to convince people to use open data", and a refusal by politicians to transfer knowledge or power. Similarly, in relation to the category *Fear of Losing Control of Data,* stakeholders highlighted barriers such as: fear of loss of data ownership once data is released in an open format, and fear that the government will lose its reputation if it pursues the path of openness and transparency. Consistent with these findings, it has been argued that government departments will likely resist releasing precious information assets that define their political status and bargaining power vis-à-vis other government departments and stakeholders (Peled 2011). Increased cooperation across government departments may be essential in efforts to promote transparency into the future.

Notably, all EU countries represented in the current study are largely defined by systems of representative democracy, which means that passing over control to citizens to access and analyse open data relevant to political and societal issues may continue to be a challenge as governments seek to negotiate participatory democratic or networked governance arrangements. At the same time, a range of options were proposed in response to these two categories barriers, including: increased effort in providing enjoyable and intuitive interfaces for local government staff to publish data as open data; celebrating open data innovation leaders in organisations to highlight the importance and value of their work; and providing information, training and education for all government agencies on the benefits of an open data portal.

Stakeholders identified two additional categories of barriers that are closely related to the government and organisational barriers described above, specifically, *Privacy and Security* and *Conflict and Cooperation*. In the *Privacy and Security* category, which Janssen and colleagues call the legislation barriers (Janssen et al. 2012), stakeholder's barrier statements highlighted issues such as: personal information accessed by the public can lead to data protection infringement; some data are commercially sensitive; and privacy and security may be compromised by conflicting roles and interests between politicians, management, and the public. Options for overcoming barriers in this category included: efforts to organise multi-level training on how to use data safely; initiatives showcasing good practice; and research examining how potentially sensitive data is used in an open environment in other countries.

In relation to the *Conflict and Cooperation* category, stakeholders generated barriers such as: conflict and lack of progress in the development of open data initiatives due to contrary interests; and lack of cooperation between government and public. Stakeholders suggested a range of options in response to this category of barriers, including efforts to introduce procedures to standardise/simplify data release; establish the practice of asking and having to justify "why not" around data release; and establish a data review board for an organisation to help individual public administrators with data release decisions.

The four categories of barriers discussed above all relate to government and organisational issues. Moving beyond these types of barriers, stakeholders also identified a number of categories of barriers which were more closely related to technical or resource issues. This is in line with the findings of Attard et al. (2015), and Janssen et al. (2012), who identified technical barriers as impediments to open data platform service delivery. In the current study, five categories of barriers emerged that were related to technical, data, and resource issues, specifically: *Data Applications; Data Management/Policies; Data Quality, Accessibility, and Usability; Technical, Infrastructure and Resources;* and *Cost.*

With regard to *Data Applications*, stakeholders highlighted barriers such as: lack of examples available for smart use of open data; and issues with the effectiveness of research tools, whereby queries are not tailored to real user's needs. Options generated in response to barriers in this category included: making a connection with education, to provide examples; and providing a more complete platform for better searchability of data.

Stakeholders also generated a significant number of barriers focused on data management and policies. Barriers in this category included: lack of information about the circumstances of data production; and lack of data maintenance. As a means to overcoming such barriers, stakeholders suggested the implementation of "good information practices" within public bodies. It was also suggested that the regulation of transparency activities, incentivised with rewards, would address barriers in this category.

Stakeholders also generated a related category of barriers: *Data Quality, Accessibility, and Usability.* This category represented the largest set of ideas across sites and includes barriers such as: data may be published but not easily found; data does not have a user-friendly format; and insufficient data descriptions. In response to these barriers, stakeholders suggested the involvement of users in the development of data platforms, and that clear descriptions should provide information about when the data was collected, how it was collected, and by whom.

These barriers resonate with data challenges identified by other scholars, including challenges associated with exploration, extraction, and formatting, cleaning, and ungrounding (or rawification) of data (Denis and Goeta 2014). Similarly, Bertot et al. (2008) note that e-government services are often limited by challenges associated with organisation, structure, search, metadata, and other factors.

As well as data-specific barriers, stakeholders generated a category of barriers relating to *Technical, Infrastructural, and Resource Issues*. Barriers in this category include: data is spread over different organisations and departments; and inadequate institutional capacity can often limit the provision of data services, the development of standards, and the provision of necessary expertise. Stakeholders suggested that pooling of public sector resources, and better curation and maintenance of data quality, could help to alleviate barriers in this category.

The final technical or resource based category developed by stakeholders related to *Cost*. Stakeholders noted that a lack of adequate finances often negatively impacts the sustained collection, and sharing of open data. Similarly, stakeholders noted that the cost of accessing open data can often be prohibitive. In order to address these, and other cost-related barriers, stakeholders suggested that data creation should be driven by user demand. Stakeholders also suggested that the creation of funds to commercialise open data projects could alleviate some of the cost-related barriers.

Finally, three categories relating to training and engagement issues were developed by stakeholders. These categories are as follows: *Citizen Engagement; Skills and Training*; and *Motivation*. These categories are in line with what Janssen et al. (2012) call use and participation.

Specifically in relation to *Citizen Engagement*, stakeholders referred to barriers such as: minimal publicity of open data leading to lack of awareness of its existence; and failure by government departments to advertise that data is available to the public. Stakeholders proposed a range of options to overcome these barriers including, for example, promotion programmes aimed at the public to create not just awareness of data availability but also uses and benefits of open data; and the opening of channels for the public to communicate with governments. In relation to *Skills and Training*, stakeholders noted a number of barriers relating to lack of open data skills on the part of data providers and users, including both public administrators and citizens. For example, stakeholders noted that inadequate technical expertise to produce data in a usable format is a significant barrier to usage, as well as users' lack of skills to process data and translate open data into information. In response to these and similar barriers, participants suggested that government agencies should be provided with training on the benefits of an open data portal, and that platforms provide detailed frequently asked questions sections to assist users.

Finally, in relation to *Motivation*, stakeholders referred barriers such as: open data publishing is often not perceived as a priority by administrators, and the lack of understanding of the benefits that Open Data can offer. In order to overcome these barriers, stakeholders suggested options including: promotion of the benefits of an open data portal, the provision of good examples, and publishing data that is identified by users as relevant and engaging.

As noted, overall, barriers associated with *Data quality, Accessibility, and Usability* represented the largest portion of the total set of barriers generated across sites. Similarly, barriers associated with both *Data Management and Policies* and *Technical, Infrastructure and Resources* represented a large portion of the total number of barriers generated. This is consistent with previous research which has highlighted poor information quality, lack of usability and technical issues, limited organizational resources and budget as major barriers to achieveing the full potential of open data platforms (Janssen et al. 2012; Attard et al. 2015; Meijer 2015a) .

Analysis of the relative frequencies of barriers across sites provided insight into the relative weight stakeholders in each pilot site placed on the various barrier categories. For example, the high frequency of barriers in the Data Quality, Accessibility, and Usability category overall reflected the fact that this category accounted for a high percentage of total barriers generated by stakeholders in Prato, Groningen, Issy-les-Moulineaux, Den Haag, and Dublin. Barrier statements in this category were also phrased similarly across sites. For example, “Information is not presented in a user friendly manner” (Den Haag); “Lack of user-friendly file-formats” (Dublin); and “Data is published but cannot be found and does not have a user-friendly format” (Groningen).

However, a number of differences were also observed across sites. For example, the relatively stronger focus on data application barriers in Prato and Den Haag could reflect the fact that both of these pilot sites and stakeholder groups are relatively new to working with open data platforms. By contrast, Dublin, which has an active open data platform, emphasised less data application barriers but highlighted more barriers linked to skills and training. It may be that certain barriers and needs (e.g., associated with the skilled used of platforms) will only arise after stakeholders have had experience working with an evaluating existing platforms and services. A key goal of the Route-to-PA project is to build upon existing platforms and provide coaching and training in the use of key functionalities, working directly with stakeholders in each pilot site. Work is ongoing to evaluate user experience of key functionalities and the specific training needs that will be required as new platform users are introduced to the platform. It is noteworthy that all pilot sites in the current study emphasised technical, infrastructure, and resource barriers. Overcoming these barriers may be essential to ensuring sustainable inputs in terms of quality data, iterative design of platforms to enhance functionalities, and ongoing skills training to increase the data competencies and collaboration skills of stakeholders and open data platform users engaged in governance networks.

The different focus across sites is also evident in the absence of categories of barriers in certain pilot sites. For example, *Skills and Training* is represented in all pilot sites except Prato. Similarly, neither *Resistance to Open Data Initiatives* nor *Fear of Losing Control of Data* are represented in the barrier categories in Den Haag or Prato. The lower representation of barriers across categories in Prato is not surprising, given that 79% of their total barriers fell into the three data-related categories: Data Quality, Accessibility, and Usability; Data Management/Policies; and Data Applications. This suggests that stakeholders in Prato are primarily focused on data-related barriers at this stage of their work together, and may not yet have encountered organisational or training related barriers to the extent that other pilot sites have.

There were also differences across pilot sites in the number and types of options generated in response to barriers. For example, while *Citizen Engagement* received a high percentage of generated options in Groningen (e.g. ask citizens which information they find useful) and Issy-les-Moulineaux (e.g. allow citizens to make recommendations on the mode of data collection, the quantity of data and the presentation format), it received relatively less attention in the other sites. Also, whereas options in Dublin were spread across all categories, options were more focused on a smaller set of specific categories in Den Haag and Prato. This suggests that stakeholders in Den Haag and Prato, at least in their initial evaluation of the problem situation, have identified a strong need for options in response to a select number of barrier categories. Similarities and differences across sites provide useful insights for the design team in terms of the possible focus of attention across pilot sites when open data platform innovations are fully operational. They also highlight key areas where flexible design of platform features needs to be combined with broader strategies of political and social engagement with stakeholders and user groups to ensure uptake and continued use of open data platform innovations.

Each pilot site in the current study focused on unique scenarios that reflect local political and social priorities and thus stakeholders in each site had unique needs. This was clearly reflected, in the first instance, in the range of open data information needs across sites. For example, while the scenario in Den Haag focused on employment and opportunity creation, resulting in a high proportion of *jobseekers information* needs, the Dublin scenario, which focused on community engagement and planning, generated information needs across a much wider range, including *community, planning, services, amenities, business*, and *education* information. It is likely that the information needs across sites will develop further as each pilot site works to realise their scenarios and promote effective collaboration between citizens and public administrators.

More generally, essential for the future success of open data portals is that more varied high-quality open data is made available to stakeholders in an increasingly accessible, understandable and usable manner. Societal challenges or problems, including those that stakeholder focused on in the current study, are invariably complex. A key goal of networked governance is to enhance our overall capacity to collaboratively resolve societal problems. However, as noted by Warfield (2006), understanding societal problems always involves an effort to identify how problems in the problem situation interact. Failure to recognise potential interactions between problems in the problem situation can result in unexpected and often undesirable outcomes. To the extent that networked governance arrangements involve collaboration over open data in efforts to resolve societal problems, having access to sufficiently varied, usable and understandable open data matched to the complexity of the problematic situation will be a core requirement of effective governance into the future. Ongoing work by the Route-to-PA team has involved profiling the extent to which open data is available, matched to, and useful for, the scenarios of interest to stakeholders in each pilot site. This profiling of data is being used to feedback to public administrators and key data providers to highlight some of the key gaps in the data.

Stakeholders across pilot sites in the current study also highlighted a range of social and collaborative needs, in particular, the need for different forms of interaction over open data, including dialogue and discussion spaces, moderation and maintenance of these spaces, feedback, sharing and requesting data, and also coaching and support in the use of social-collaborative affordances. To date, the Route-to-PA team has designed a number of key social-collaborative affordances, including a dialogue and collaboration platform that allows for sharing and discussion of data visualisations, awareness of network connections and levels of engagement between users collaborating on shared projects, and the capacity to create dedicated collaboration spaces focused on specific issues.

Furthermore, the current study identified a variety of understandability, usability, and decision-making needs of users, including the need for certification tools, guidance and support tools, data visualisation and personalisation tools, and data analysis and reporting tools. The ability to search, filter, aggregate, visualise, modify, customise, and analyse data were identified as central needs across pilot sites. More advanced data analysis and reporting tools were also seen as central for decision-making, including data mining tools, modelling tools, metadata tools, data merging tools, data wrangling and labelling tools, among others. A key challenge for the Route-to-PA design team moving forward is to design affordances that support understandability, usability, and decision-making needs in a way that both citizens and public administrators can readily learn to use without advanced training in statistical data analysis techniques. This presents a major challenge as a reasonably high level of data competency may be needed to match the complexity of the societal issues collaborative groups are working on. One potential solution to this challenge is to design collaborative groups that include stakeholders with a range of skills, including a sub-group who specialise in more advance data analysis and visualisation work that supports the deliberation and decision-making of the larger team.

Limitations and Directions for Future Research

There are a number of limitations to the current study. First, while reflecting the different scenarios and contexts of usage identified as the starting point for the Route-to-PA project, there was considerable variation in the stakeholders who participated in the collective intelligence sessions across the different sites in the current study. For example, Issy-les-Moulineaux was focused on a local enterprise development scenario and thus the major citizen group in this context was stakeholders in the business sector. The study results, and the range of information needs identified across sites in particular, also vary as a function of the scenario and the participants in the scenarios that stakeholders in each pilot site were using to support idea generation at their respective workshops. At the same time, these scenarios reflected the types of problems that stakeholders in each pilot site were seeking to address, and thus the variation across sites is consistent with our contextual approach to open data platform design. Future research should seek to examine the barriers, options and needs of different user groups across a range of different scenarios, to further our understanding of the range of barriers, options, and needs that will need to be considered in the future, in efforts to design increasingly flexible and adaptable open data platforms that support the goals of stakeholders across a range of different scenarios of usage. We speculate that perceived barriers to accessing, understanding, and using open data, and options to overcome these barriers, may show greater similarities across different contexts, when compared with the range of information, social-collaborative, and decision-making needs of users, as these barriers may reflect underlying political and social-organisational challenges that are fundamental to the broader societal challenge of supporting transparency and collaboration over open data. Furthermore, our conclusions regarding the specific needs of users are a function of the specific methods we used, and future research should seek to combine our collective intelligence scenario-based design methods with other user-centered methodologies to provide more insight into the specific barriers, options, and needs of open data platform users. For example, the use of remote user testing may be particularly useful in the iterative design of open data platforms as they evolve and develop further.

Conclusions

In line with the approach adopted in the current study, Ojo and Mellouli (2016) note that governments are increasingly engaging private sector organizations, civil society and citizens to tackle complex policy challenges across a variety of networked governance arrangements. Although evidence suggests that networks of non-state actors are equally as important as networks of state actors in terms of their contribution to governance outcomes (Bodin and Crona 2009), networked governance implies the need to develop a shared understanding of problems and solutions to problems (Huppé et al. 2012). This implies the need for a collective intelligence approach to the design of platforms that facilitate the deliberation of diverse governance networks over open data, and the co-creation of policies and projects that help to resolve societal problems, increase trust in government, and empower increasingly effective networked governance arrangements into the future.

As noted by Ojo and Mellouli (2016), the efficacy of governance networks is contingent on the inclusion of citizen in the networks, and mobile social-media platforms could constitute a key infrastructure for enabling citizen participation in this regard. However, based on their case study analyses, they also note that these networks are still largely steered by government and it remains important that governments initiate and demonstrate deep commitments to partnerships with citizens for collaborative governance networks to be effective. Ojo and Mellouli (2016) note that government is ultimately responsible for building trust with partners and are accountable for the overall outcome of the networked governance arrangement. This implies ongoing investment and iterative design, innovation and experimentation with key infrastructures that may support networked governance. Considering the specificity of the key understandability, usability, and decision-making needs identified in the current study, it is clear that governments and citizens need to work with social scientists and technology experts to design open data platforms that include a range of data analysis and decision-making affordances that support collaborative societal problem solving and policy development. This needs to be coupled with appropriate training in the use of these affordances. Based on their case study analyses, Ojo and Mellouli (2016) highlight the need to effectively motivate citizen participation in governance networks and align the divergent views of the different actors collaborating in the network. From a contextualist perspective, the collective intelligence scenario-based design thinking of stakeholders in the current study highlights that motivating citizens may be contingent on meeting their needs. This implies designing a socio-technical infrastructure that supports their social-collaborative and decision-making needs, which will be critical to sustain motivation in the use of the platform.

Consequently, based on the outcomes from our study and related literature, we conclude that: (1) the nature of barriers and needs of stakeholders can vary significantly from one context to another and this needs to be considered in the development of open data platforms that are designed explicitly for use across several local authorities or contexts; (2) the iterative use of collective intelligence scenario-based design methods employed in eliciting barriers, options and needs from different stakeholders could be an effective approach for engaging stakeholders in the design of open data platforms into the future, particularly if it can be effectively combined with other user-centered methods; (3) continued engagement of stakeholders in the design and development of open data platforms is contingent on the support provided by local authorities working with the stakeholders.

Appendix 1

Sample scenarios
Entrepreneur Annie is interested in starting a locally based café/food business and would like to connect with public administrators and potential customers to find out if there is a demand for this new business, what kind of premises or permissions she might need, what supports are available and to connect with other people who might partner/work with her in starting this business. She would like to use technology to build local social networks to connect with her business peer network and build a local customer base.
Civic Joe is part of the civic hacker community and a member of an active citizen group. He is a keen advocate for social equality and feels that citizens need a more participatory democracy to create a better society for all. He is interested in open data as a means of opening access to public information and promoting transparency. He wants to be able to interact with public data to understand how public decisions are made, to give his views in an easy and transparent way and receive feedback on them from public administrators who area leading local projects, so that he feels he has been part of the decision and policy making process. Joe also wants to be able to share ideas and data with other citizen groups, with a view to collaborating on projects and common goals.

(continued)

Sample scenarios
Jane is a public administrator in a Dublin Local Authority. Jane is helping to prepare a new plan to promote local community and economic development in Dublin and wants to explore how technology might be used to engage a wider demographic and to facilitate bottom up community building. Jane is particularly interested in consulting with young people and people with a disability or other citizens who may not engage in more formal consultations. Jane wants an easy to use platform to gather and give feedback to citizens on issues that matter to them to inform policy and to build public trust. Jane also wants to be able to negotiate and plan activities with other public administrators in her community development group in her local authority public administration offices. She wants both citizens and her colleagues in the local community development group to have some flexibility in the way they draw upon data and information when working together to develop community projects. Jane is very passionate about promoting local community and economic development in Dublin and she wants a platform and set of services that will help her do good work.
Citizen Kay is interested in putting down more roots and getting involved in her local community. She initially got involved in community issues when a group of her neighbours got together to object to a big new development that would have caused a lot of disturbance in her quiet street. As a concerned citizen she wants an easy way to put her issues on a public platform, to share and find out about local news, to discuss with other local residents and have an input into what is happening in her community. She would like a meaningful exchange with public administrators and to build local social networks to highlight the good things that are happening in her community and perhaps to start up a skillshare/ local volunteering exchange. Kay wants to be able to access information on other similar local groups, so that she can get advice on starting her own.

References

Alexopoulos C, Zuiderwijk A, Charapabidis Y, Loukis E, Janssen M (2014) Designing a second generation of open data platforms: integrating open data and social media. In: International conference on electronic government, Springer, Berlin/Heidelberg, pp 230–241

Alberts, H. (1992). Acquisition: Past, present and future. Paper presented at the meeting of the Institute of Management Sciences and Operations Research Society, Orlando, FL

Ashby WR (1958) Requisite variety and its implications for the control of complex systems. Cybernetica 1(2):1–17

Attard J, Orlandi F, Scerri S, Auer S (2015) A systematic review of open government data initiatives. Gov Inf Q (in press)

Bannister F, Connolly R (2011) The trouble with transparency: a critical view of openness in e-government. Policy & Internet 3(1):158–187. doi:10.2202/1944-2866.1076

Bertot JC, Jaeger PT, McClure CR (2008) Citizen-centered e-government services: benefits, costs, and research needs. In: Proceedings of the 2008 international conference on digital government research, Digital Government Society of North America, pp 137–142

Bodin Ö, Crona BI (2009) The role of social networks in natural resource governance: what relational patterns make a difference? Glob Environ Chang 19(3):366–374

Broome BJ, Cromer IL (1991) Strategic planning for tribal economic development: A culturally appropriate model for consensus building. International Journal of Conflict Management 2:217–234

Broome BJ, Fulbright L (1995) A multi-stage influence model of barriers to group problem solving. Small Group Res 26:25–55

Broome BJ, Chen M (1992) Guidelines for computer-assisted group problem-solving: Meeting the challenges of complex issues. Small Group Res 23:216–236

Cappelli C, Engiel P, De Araujo RM, Cesar J, Leite P (2013) Managing transparency guided by a maturity model. In: 3rd global conference on transparency research, HEC, Paris, France, 24–26 October 2013, pp 1–17
Caroll J (2000) Five reasons for scenario-based design. Interacting with Computers 13:43–60
Christakis AN (1987) Correspondence: Systems profiles. Systems Research 4(1):53–58
Coke JG, Moore CM (1981) Coping with a budgetary crisis: Helping a city council decide where expenditure cuts should be made. In: Burks SW, Wolf JF (eds) Building city council leadership skills: A casebook of models and methods. National League of Cities, Washington, DC, pp 72–85
Cohn M (2004) User stories applied for Agile software development. Addison-Wesley, Boston
Dahlander L, Fredriksen L, Rullani F (2009) Online Communities and Open Innovation. Ind Innov 15(2):115–123
Dawes S, Helbig N (2010) Information strategies for open government: challenges and prospects for deriving public value from government transparency. Electron Gov 6228:50–60
Deloitte (2013) Market assessment for public sector information. Written for UK, Department for Business, Innovation and Skills
Denis J, Goëta S (2014) Exploration, Extraction and " Rawification " The Shaping of Transparency in the Back Rooms of Open Data. In: Neil Postman Graduate Conference. New York, pp 1–8
Dwyer C, Hogan M, Harney O, O'Reily J (2014) Using interactive management to facilitate a student-centered conceptualisation of critical thinking: a case study. Educ Technol Res Dev 62(6):687–709
Fox J (2007) The uncertain relationship between transparency and accountability. Dev Pract 17(4–5):663–671. doi:10.1080/09614520701469955
Feeg R (1988) Forum of the future of pediatric nursing: Looking toward the 21st century. Pediatric Nursing 14:393–396
Ghaus-Pasha A (2007) Governance for the millenium development: core issues and good practices. Building
Greiner A, Isaac A, Iglesias C, Laufer C, Guéret C, Stephan EG, Kauz E, Atemezing GA, Bittencourt II, Almeida JP, Carrasco MT, Archer P, Albertoni R, Purohit S Córdova Y (2015) Data on the Web best practices – W3C working draft 25 June 2015. Retrieved from http://www.w3.org/TR/2015/WD-dwbp-20150625/
Grimmelikhuijsen SG, Welch EW (2012) Developing and testing a theoretical framework for computer-mediated transparency of local governments. Public Adm Rev 72(4):562–571. doi:10.1111/j.1540-6210.2011.02532.x
Groarke JM, Hogan MJ (2016) Enhancing wellbeing: An emerging model of the adaptive functions of music listening. Psychology of Music 44(4):769–791
Hayes SC, Hayes LJ, Reese HW (1988) Finding the philosophical core: a review of Stephen C. Pepper's world hypotheses: a study in evidence. J Exp Anal Behav 1(1):97–111
Habermas J (1962) The structural transformation of the public sphere (1962, trans: Cambridge Massachusetts, 1989, MIT Press)
Heald D (2006) Varieties of transparency. Proceedings-British Academy 25–43. doi:10.5871/bacad/9780197263839.003.0002
Hilgers D, Ihl C (2010) Citizensourcing: applying the concept of open innovation to the public sector. Int J Public Participation 4(1):67–88
Hogan MJ, Johnston H, Broome B, McMoreland C, Walsh J, Smale B et al (2015) Consulting with citizens in the design of wellbeing measures and policies: lessons from a systems science application. Social Indicators Research 123(3):857–877
Jaeger P, Bertot JC, Shilton K (2012) Information policy and social media: framing government-citizen Web 2.0 interactions. In: Reddick CG, Aikins S (eds) WEb 2.0 Technologies and Democratic Governance. Political, policy and management implications, Springer, New York, pp 11–25
Janssen K (2011) The influence of the PSI directive on open government data: an overview of. Gov Inf Q 28:446–456

Janssen M, Charalabidis Y, Zuiderwijk A (2012) Benefits, adoption barriers and myths of open data and open government. Inf Syst Manag 29(4):258–268

Keever, D. B. (1989, April). Cultural complexities in the participative design of a computer-based organization information system. Paper presented at the International Conference on Support, Society and Culture: Mutual Uses of Cybernetics and Science, Amsterdam, The Netherlands

Lee G, Kwak Y (2012) An open government maturity model for social media-based public engagement. Gov Inf Q 29(4):492–503

Lourenço RP (2013) Open government portals assessment: a transparency for accountability perspective. Lecture Notes in Computer Science (including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 8074 LNCS, 62–74. doi:10.1007/978-3-642-40358-3-6

Mei CS, Dewan SM (2014) Towards conceptualizing information transparency and its role in internet consumers' concerns: a literature review

Meijer A (2009) Understanding modern transparency. Int Rev Adm Sci 75(2):255–269. doi:10.1177/0020852309104175

Meijer A (2015a) E-governance innovation: barriers and strategies. Gov Inf Q 32:198/206

Meijer A (2015b) Government transparency in historical perspective: from the ancient regime to open data in The Netherlands. Int J Public Adm 38(3):189–199. doi:10.1080/01900692.2014.934837

Ojo A, Porwol L, Waqar M, Stasiewicz A, Osagie E, Hogan M, Harney O, Ahmadi-Zeleti F (2016) Realizing the innovation potentials from open data: Stakeholders' perspectives on the desired affordances of open data environment, 17th IFIP working conference on virtual enterprises, Porto, Portugal, 3–5 October 2016, Springer

Ojo A, Mellouli S (2016) Deploying governance networks for societal challenges. Gov Inf Q. doi:10.1016/j.giq.2016.04.001

Peled A (2011) When transparency and collaboration collide: the USA open data program. J Am Soc Inf Sci Technol 62(11):2085–2094

Pepper SC (1942) World hypotheses: a study in evidence. University of California Press

Piotrowski S, Conference G, Sasaki D (2011) Conceptualizing the Quality of Transparency Paper prepared for the 1, 0–27

RezaeiZadeh M, Hogan M, O'Reilly J, Cunningham J, Murphy E (2017) Core entrepreneurial competencies and their interdependencies: insights from a study of Irish and Iranian entrepreneurs, university students and academics. Int Entrep Manag J 13(1):35–73

Rosson MB, Carroll J (2002) Scenario-based design. In: Jacko J, Sears A (eds) The human-computer interaction handbook: fundamentals, evolving technologies and emerging applications. Lawrence Erlbaum Associates, Mahwah, pp 1032–1050

Sandoval-Almazan R, Gil-Garcia JR (2012) Are government internet portals evolving towards more interaction, participation, and collaboration? Revisiting the rhetoric of e-government among municipalities. Government Information Quarterly 29:72–81

Sato T (1979) Determination of hierarchical networks of instructional units using the ISM method. Educational Technology Research 3:67–75

Van Velzen L, Van der Geest T, Ter Hedde MD (2009) Requirements engineering for e-Government services: a citizens-centric apporach and case study. Gov Inf Q 26:477–486

Warfield JN (1994) Science of generic design: managing complexity through systems design. Iowa State Press, Ames

Warfield JN (2006) An introduction to systems science. World Scientific, Singapore

Zuiderwijk A, Janssen M (2014) Open data policies, their implementation and impact: a framework for comparison. Gov Inf Q 31:17–29

Michael Hogan is a senior lecturer and researcher at NUI, Galway, Ireland. His research foci include individual, social and technology factors contributing to adult learning, motivation, and collaborative performance. He is a co-director of the Structured PhD in Perception, Cognition and Action, co-director of the Structured PhD in Learning Sciences, and a co-leader of the Health and Wellbeing theme at the Whitaker Institute for Innovation and Social Change, NUI, Galway.

Dr. Adegboyega Ojo is Senior Research Fellow at the Insight Centre for Data Analytics, National University of Ireland Galway (NUIG). He leads the E-Government Group at Insight Centre, serves as Adjunct Lecturer at the College of Engineering and Informatics. His current research interests include data driven innovations in government, Open data policies and Infrastructures, data analytics and governance of smart cities. He is member of the Editorial Boards of the ***Government Information Quarterly*** and ***International Journal of Public Administration in the Digital Age***.

Owen Harney is a PhD candidate (Learning Sciences) at the School of Psychology, NUI Galway. His PhD research focuses on the integration of systems science methodologies into educational contexts. Outside of his PhD research, Owen has applied his knowledge of systems science and collective intelligence methodologies in a wide variety of research and organisational contexts, including: collaborative learning, e-governance, chronic pain, personalised nutrition, and citizen engagement.

Erna Ruijer is a postdoctoral researcher at the Utrecht School of Governance in the Netherlands. Her research focuses on open data, government transparency, open government and government communication.

Albert Meijer is a Professor of Public Innovation at the Utrecht School of Governance in the Netherlands. His research focusses on e-government, government transparency, co-production in the public sector and public innovation.

Jerry Andriessen is a senior scientist and research director of Wise & Munro learning Research, The Hague, Netherlands. Wise & Munro participates in many innovative European projects, on technology, open data, collaboration, primary education, and cybersecurity. These projects add societal relevance to their scientific implications. Jerry has more than 25 years of experience in uses of technology for support of learning and collaboration in various settings. His current interest is in the qualitative interpretation of discourse and action, including the roles of emotions.

Mirjam Pardijs is an independent educational scientist. She is co-director of Wise & Munro Learning Research, the Hague, Netherlands. She specialises in the design, coaching, and interpretation of collaborative learning in educational and professional contexts. Her main interests are narratives as a tool for learning, appropriation of technology, and the role of pedagogical support for innovation in learning settings.

Paolo Boscolo gained a Masters degree in Electronics Engineering in 1986. In 1992 he joined the Comune di Prato as head of the Telecommunications group. Is new responsible for the general coordination of the ICT service and for co-funded project in ICT field. During last 10 years has been charged for the management of advanced eGovernment projects for the Prato City Council. He is currently responsible for the definition of the Prato Smart City Plan. He's the responsible for Route-to-PA project operations at Comune di Prato.

Elena Palmisano received a degree in Civil Engineering in 1988 and a Ph. D. in Methods and Technologies for Environmental Monitoring in 1994 at the University of Florence (Italy). She works as a consultant with PIN Scrl (a public/private Consortium managing the University of Florence site in Prato) and with the Municipality of Prato. She has taken part in many regional, national and EU projects in the field of innovation technology, ICT applications in different contexts, such as infomobility, e-government, cultural heritage and education. She is currently collaborating with the Municipality of Prato in two H2020 projects: Route-to-PA (GA N. 645860), where she acts as community manager in the pilot activity, and City.Risks (GA N. 653747) where she contributes to the managemnt of dissemination activities. With PIN S.c.r.l. she is also involved in the definition of the guideline for the development of the Smart City plan in Prato.

Matteo Satta is an international Political Sciences graduate in Turin (Italy), he is a senior project manager that has always been involved, between France and Italy, in the field of R&D and

Innovation (EU and International level) with a particular focus on its valorisation and exploitation. Since 2005, he has contributed to the management and the development of various European projects, such as e-Photon/ONe, the Researchers' Night in Turin (Italy), RADICAL, OTN, ECIM, Citadel… on the Move and ROUTE-TO-PA, and IPR Licensing programs, such as MPEG Audio (MP3) and DVB-T. He is today EU Project Manager in Issy Média, a semi-public company of the City of Issy-les-Moulineaux, specializing on Smart City subjects and projects with a particular interest in citizens' participation, Living Lab, Open Data and Smart Mobility.

Jonathan Groff is a researcher in cognitive psychology. He is currently working at the National Center for Scientific Research (CNRS), Paris. He is interested in human computer interactions and multimedia information processing (in the field of education and in the transport sector). He carried out work designed to evaluate the effect of attentional cueing and interactive animation on comprehension, using an eye tracking approach. He developed a pictographic system that aims to promote the quick understanding of emergency announcements in multimodal hubs. Currently, he is studying cognitive processes in collaborative design situations.

Michael Baker is a Research Director (tenured Research Professor) in psychology and language sciences, of the Centre National de la Recherche Scientifique (CNRS). He currently works in the Social and Economics Science Departement of Telecom ParisTech, the French National Telecommunications Engineering School. His research aims to analyse and model the processes of knowledge elaboration in dialogues produced in learning and work situations, focussing on argumentation and the role of technological mediation. Michael Baker recently published the following book, with Baruch Schwarz: "Dialogue, Argumentation and Education: History, Theory and Practice" (Cambridge University Press, New York, 2017).

Françoise Détienne is research director at CNRS, Paris. Her research in cognitive ergonomics focusses on collaboration, design, creativity and online communities as well as on the role of socio-technical systems. She is associate editor of ***International Journal of Human Computer Studies***, and member of the editorial board of Interacting With Computers and CoDesign.

Dr. Lukasz Porwol is a Postdoctoral Researcher and deputy unit leader at Insight Centre for Data Analytics (formerly known as DERI), National University of Ireland, Galway. At Insight Centre for Data Analytics, his research work focuses on leveraging social media, games and mobile technologies to support effective dialogue between citizens and decision-makers. His background combines solid engineering and scientific knowledge (MSc in Computer Science and Engineering in Information Technologies) with good management and PR skills.

Vittorio Scarano is Computer Science Associated Professor at the Dipartimento di Informatica of Università di Salerno. He is coauthor of more than 150 papers in journals and international conferences (with reviews) at IEEE, ACM etc. and was advisor (or co-advisor) of 12 PhD thesis in Computer Science at the University of Salerno. His research is mainly focussed on open data, distributed, parallel and cooperative systems, and to their applications in the fields of collaborative learning and virtual interactive environments (Cultural Heritage).

Delfina Malandrino is an Assistant Professor at the Dipartimento di Informatica of the University of Salerno. Her research activities mainly focus on: privacy, distributed systems, collaborative systems, social networking, privacy, social network analysis, green computing.

The Privacy/Transparency Balance in Open Government

Teresa Scassa and Amy Conroy

Abstract This paper explores strategies for balancing privacy with transparency in the release of government data and information as part of the growing global open government movement and within an evolving technological context. Government data or information may contain many different types of personal information. In some cases, transparency will require the release of this personal information; in other cases, the release of personal information will not advance the goals of government transparency. The situation is complicated by the availability of technologies that facilitate widespread dissemination of information and that allow for the mixing and mining of information in ways that may permit the reidentification of individuals within anonymized data sets. This paper identifies a number of strategies designed to assist in identifying whether data or information contains personal information, whether it should be released notwithstanding the presence of personal information, and what techniques might be used to minimize any possible adverse privacy impacts.

Introduction

This paper explores strategies for balancing privacy with transparency in the release of government information. It does so within the context of the global movement towards more open and transparent government – a movement which encourages the release of government data and information through open data and proactive disclosure. It also does so within a rapidly evolving technological context and one in which big data analytics plays an ever-increasing role. In this paper we identify strategies for balancing privacy with transparency, although we do not set out to establish what the outcome of that balance should be. The appropriate balance may

T. Scassa (✉)
University of Ottawa, Faculty of Law, Ottawa, ON, Canada
e-mail: tscassa@uottawa.ca

A. Conroy
Carleton University, Department of Law and Legal Studies, Ottawa, ON, Canada
e-mail: Amy.Conroy@carleton.ca

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3_13

vary from one jurisdiction to another. In some countries, transparency may be favoured over privacy because of particular social, political or historical circumstances; in others, privacy may be more strongly protected for similar reasons. These differences in circumstances highlight the fact that balancing privacy with transparency is not a purely mechanical task. The strategies identified in this paper do not prejudge particular choices regarding the balance to be struck in any given case. Nevertheless, in most cases they offer ways to reduce adverse privacy impacts. The decision as to whether those impacts are sufficiently reduced to enable release of data or information rests with the data custodian.

There are a number of reasons to balance privacy with transparency values in open government. Some of these are practical ones. For example, in some cases, governments, their departments or agencies will be under legal obligations to protect personal information in their custody or control. As technology advances, the scope or extent of the protection required may change (Scassa 2014). Other reasons for balancing are more normative. Where no specific legal obligations exist to limit disclosure, there may still be important values served by protecting privacy. These can include protecting individuals against harms resulting from the disclosure of their personal information (Solove 2004) or enhancing public trust in government (Bennett and Raab 2006).

The first part of this paper explores the meaning of open government, while the second part examines the technological context in which it takes place. Parts 3 and 4 explore the key concepts of 'transparency', 'privacy' and 'personal information'. Part 5 discusses strategies for protecting privacy in the release of government information. The paper concludes with an overall assessment of approaches to achieving a balance between privacy and transparency in open government.

Open Government Data and Information

A key component of open government is the release of government-held information to the public. This can take place in a number of different ways, including in response to access to information requests, through open data, proactive-disclosure, public registries, and open courts. As the meaning of 'open government' expands, the volume, type and format of the released information can change (Davies 2014).

Government information is available in many countries through 'freedom of information' or 'access to information' requests (Janssen 2012). This information is typically released to the specific individuals who request the information, and there are not necessarily any guarantees that it will be provided in reusable formats or under an open license. Some governments are beginning to make the information or data sought under access to information requests available to a broader public by making the same (sometimes redacted) information available through an online portal. An example of this is the British Columbia Open Information website which makes publicly available the digital results of past access to information requests (British Columbia 2016).

Open data involves the release of government data in reusable digital formats and under an open license (Kitchin 2014). While transparency is one of the goals of the open data movement, other objectives include stimulating innovation and encouraging citizen engagement (Janssen 2012). Vejkovic et al. (2014, 281–282) identify the data sets most frequently released as falling within the categories of "Finance and Economy, Environment, Health, Energy, Education, Transportation, Infrastructure, Employment and Population."

Proactive disclosure can be of data or other types of government information. The goal of proactive disclosure is to anticipate and release the kinds of information most frequently sought from governments and to ensure that this information is freely and easily accessible. Rather than having to file individual freedom of information requests in order to access government information, proactive disclosure can push more information towards the public, minimizing cost and delays (Queensland 2013).

In many countries the principle that court proceedings should be open to the public underlines the point that transparency is essential to a properly functioning judicial system (McLachlin 2003). This principle of openness is generally extended to the publication of court decisions by default, with exceptions made only in very particular circumstances where the public interest requires it (Winn 2004). Many courts now make their decisions freely available to the public online either through their own websites or through 'legal information institutes' – online portals designed to facilitate public access to court decisions (Greenleaf 2011). Some courts are also extending public access to other documents (such as legal briefs, for example) through online portals. Some administrative tribunals are following suit and making their decisions publicly available online. While on the one hand, digital openness of this kind can enhance transparency, it is not without its impacts on privacy. Online and fully searchable dissemination of this information may cause harm to individuals that was not considered significant enough to warrant suppression of the information when distribution of these materials was paper-based (Scassa 2014). The disclosure of the personal information of litigants in digital format and on a global scale may have certain positive impacts (for example increasing transparency in cases of serial bankruptcy or fraud). The increased exposure of personal details about litigants may also, however, have adverse impacts on the administration of justice and on public confidence in judicial or administrative processes if details of highly sensitive cases (for instance family law disputes) become searchable online.

Finally, some government information is made available to the public through registries. Such registries frequently contain personal information. The public disclosure of this information may be mandated by law (as, for example, in the case of public land titles registries, political campaign donor lists, or other information deemed disclosable in the interests of transparency). As these registries move from paper-based to online platforms, digital dissemination may change the nature of the privacy impacts (for example making it easier and more convenient to access personal information out of curiosity, for malicious purposes, or for data mining or profiling, rather than for the purpose for which the paper registry was created). As a result, the change towards making this information more readily available online may require some mitigation of potential privacy harms.

Within the vast stores of government information is found a significant quantity of personal information. This information is collected by governments in the course of providing programs and services. Much of this information may be quite sensitive in nature, and can include criminal histories, financial information, health information, and information about citizen encounters with government administrative and assistance programs of all kinds. While access to information regimes have created policies and infrastructure for protecting privacy in the release of information in response to specific, targeted requests for information, both proactive disclosure and open data pose significant new challenges when it comes to ensuring that a proper balance is struck between privacy and transparency. The shifting of public paper-based access to digital forms of access to government information found in registries and court records also creates new privacy challenges. This is not simply because of the potential presence of personal information or personally identifiable information in the material being released. It is because this release takes place within a technological context in which vast stores of information, extensive processing power, and expanding big data analytic capacity increase opportunities for reuse of government information that may pose new threats to privacy.

Technological Context

The technological context in which governments now release data (meaning raw facts) and information (contextualized or interpreted knowledge) (Kitchin 2014) has changed dramatically and these changes are ongoing. Indeed, the demand for increased openness of governments is driven in part by this technological change. The value of government data for research, analysis and innovation has greatly increased as the technologies that enable reuse of this information have evolved and shifted into the hands of individuals, civil society organizations and large and small corporate entities. Not only are governments pressured to release more information, they are asked to do so in formats that are machine-readable and easily reusable.

While the Internet has greatly facilitated the dissemination of information of all kinds, including government data, available and evolving technologies also permit rapid and low-cost storage, reuse, dissemination, copying, mining and analysis of the data (Kitchin 2014). Big data analytics have become mainstream, with the analysis of vast stores of information being used across all sectors of decision-making from weather prediction to consumer profiling, and from professional sports to medical research. Governments are also taking advantage of big data analytics for planning and resource management purposes, among many others (Mayer-Schönberger and Cukier 2014).

It is into this evolving technological landscape that governments release information and data under open government programs and under existing laws. While much of this material may have no privacy implications and may contain no personal information of any kind, other data sets or information do contain personally identifiable information. It is within this context that the balance between privacy and transparency must be assessed. While excessive concerns for privacy should not be allowed to trump transparency (and while privacy should not be used as an excuse to avoid transparency such as, for example, with respect to political campaign financing or public contracting), it must also be taken into account that much of the data may be sought not for its transparency value but for its potential for commercial reuse (for instance to support consumer profiling or marketing). In this context a lack of attention to privacy might undermine citizen confidence in government and might lead to privacy harms, including for instance a chilling effect on people communicating with government for fear that their personal information will not be properly protected (Borgesius et al. 2015).

Transparency and Privacy

According to Yu and Robinson (2012 at 186), "open government" has been used "primarily as a synonym for public access to previously undisclosed government information." In this sense, open government is about transparency. The transparency objectives of open government are often focused on making more information available at a lower cost. The reduced cost is not due only to the fact that information is made available to the public without fees – lower costs can include reducing the time or effort needed to access – or to reuse – the data or information (Candeub 2013). Both open data and proactive disclosure reduce the time, cost and effort of access to data and information, and in this sense, they increase government transparency. Whether there are actual outcomes – such as increased accountability of government – will depend on whether the information is used by anyone to serve these goals.

The concept of transparency in government is often linked to 'openness' (Schauer 2011). However, 'transparency' itself has little normative content. There is no single standard for the degree or terms of openness required of governments. Further, as Schauer notes, the concept of transparency does not dictate any particular outcomes; a more transparent government does not necessarily mean one that is held more strictly to account. Transparency merely requires that government information, data, and processes should be publicly available or accessible – as appropriate in the circumstances.

Used in this sense, the concept of transparency focuses on providing access, not on specific results. By contrast, the open government movement is more results-oriented. For example, the Open Government Declaration (Open Government Partnership 2011) identifies a range of objectives for open government. Signatories commit to "greater civic participation in public affairs, and seeking ways to make their governments more transparent, responsive, accountable, and effective." Open data is also released in order to stimulate innovation by encouraging its reuse in the private sector. Open government, therefore, is not only about transparency; it serves a diversity of goals. Not only is it important to consider what may drive the demand for certain types of data, it is also difficult to predict how data sets may be used in order to achieve transparency.

These dynamics are important when balancing transparency with privacy. The disclosure of information that is either personally identifying or capable of being used to identify individuals may make governments more transparent (at the expense of personal privacy) but it does not necessarily make them more accountable. The disclosed information may be used for accountability purposes, but it may also be used to serve purely private or commercial interests.

The disclosure of personally identifiable information in the hands of government has an impact on individual privacy, although the nature or degree of impact may not always be evident, and may depend upon the nature of the information that is disclosed. Personally identifiable information may be used to attack or stigmatize individuals (as, for example, when personal health information is revealed in a tribunal decision posted online). If very specific identifiers are revealed, they might be used in targeted attacks such as identity theft or impersonation. In many cases, though, what will be disclosed is deidentified or anonymized information; privacy impacts might therefore depend upon the existence of both a desire to reidentify and the resources to do so. In some instances, various data sets will be combined and used to contribute to profiles of individuals that may have direct or indirect effects on them that are difficult to identify or quantify, as where data is used in big data analytics to profile or target particular consumers.

How the balance is struck between transparency and privacy may depend upon cultural norms within any given jurisdiction. These may include different views on what constitutes sensitive personal information and, as a result, what type of information should be released or withheld in an effort to ensure transparency in government (Zuiderwijk and Janssen 2014; Article 29 Working Party 2013 at 18). Social and political factors such as the level of secrecy in government or the level of citizen engagement will also influence the understanding of transparency and privacy as well as expectations about what information the government should be permitted to release (Roy 2014).

Personal Information

Two categories of personal information are relevant in considering the protection of privacy in open government. Both are found under the broad umbrella of "personally identifiable information". The first category of information is that which directly or fairly quickly leads to the identification of specific individuals. Most commonly, this consists of persons' names, but it can also include unique identifiers (such as drivers' licence numbers), or civic addresses in combination with other details. While this kind of information may be redacted or anonymized in order to protect privacy, it may also be left intact in a number of different types of documents or datasets made public by governments or their institutions. For example, public registries, court or tribunal decisions, and some information mandated for public disclosure such as campaign donation records, will all contain this type of personal information.

The second category of information is that which does not on its own identify a specific individual, but can be used to identify an individual when it is combined with other available information. Increasingly advanced anonymization techniques are needed to forestall reidentification as more and more information becomes available for cross-referencing (El Emam and Fineberg 2009). In some cases, while information may appear to have been anonymized, it may be relatively easy to identify the other pieces of information that could be used to identify an individual from an anonymized dataset. However, in the big data environment it is becoming increasingly difficult to know just what other data is available. This is not simply because governments at all levels are releasing large volumes of data, but also because huge stores of personally identifiable information are also in the hands of private sector actors (Ohm 2010). Assessing reidentification risk can therefore be challenging. It can also be a moving target as both the stores of available data (both personal information and de-identified data) and analytic capacity increase (Ohm 2010; Schneier 2015). This means that the cost in terms of time and effort required to properly anonymize information before it is released proactively or as open data can be expected to rise. A relevant question to ask is how to fund these activities as part of the overall effort to release more and more government data/information (particularly given the potential for commercial gain as it is used in new and innovative ways by private sector actors).

Strategies for Managing Privacy in Open Government

The privacy problems discussed here have been identified and addressed by data commissioners in different contexts and at different times. Many responses have evolved in the access to information/right to know context. There is therefore a growing body of information on ways to protect privacy in the release of government information. In this part of the paper, we distill some of these into a set of strategies that offer ways in which government institutions can protect privacy in the release of government information, whether it be through open data, open courts, proactive disclosure or access to information requests. The strategies are adapted to the Web 3.0 environment. They take into account the need to protect privacy while meeting transparency goals. As a result, they require consideration to be given to the balance to be struck between privacy and transparency. This balance may be different in different contexts, and may depend upon factors such as: the degree of sensitivity of the information, the circumstances under which the information was provided to government, the risk of harm from reuse/misuse of the information, the risk of reidentification (in the case of anonymized data) and the transparency value of the information.

The first two strategies outlined below (data minimization and inter- and intragovernmental consultation) address overall institutional practices. The third strategy is aimed at assessing the extent to which personally identifiable information is present within any given dataset or document. The fourth, fifth and sixth strategies offer ways of managing privacy impacts in datasets or documents where personally identifiable information may be present.

Data Minimization

One way in which citizen privacy can be protected in the context of open government is through the minimization of the amount of personal information that is collected in the first place. Data minimization principles are already present in public and private sector data protection laws. For example, the UK *Data Protection Act 1998* provides in Schedule 1, Part I, art. 3 that: "Personal data shall be adequate, relevant and not excessive in relation to the purpose or purposes for which they are processed." Canada's *Privacy Act* (s. 4) restricts the government to collecting only information that "relates directly to an operating program or activity of the institution." Other countries have started implementing an "entry once" principle to require reuse of data that has already been collected as opposed to collecting the same information directly from the individual a second time (Meyerhoff-Nielsen and Krimmer 2015 at 279). The idea behind data minimization is simple: only personal information genuinely required to meet the needs of a particular program should be collected. In endorsing data minimization, Ontario's former Information and Privacy Commissioner (Cavoukian 2009 at 10) recommended that interactions between government agencies and the public should "begin with non-identifiable interactions and transactions as the default". The minimization of personal information collection will mean that there is less personal information to protect in contexts where disclosure is sought or where the decision is made to release information through proactive disclosure or as open data. Efforts to ensure citizens are informed of the information that the government holds about them and the purpose for which it was collected and is used (see discussion of MyPage initiatives in Norway and Denmark in Meyerhoff-Nielsen and Krimmer 2015) may potentially promote increased attention to the need for data minimization in the government.

Although data minimization principles can shape what information is collected by government agencies, they can also apply to the disclosure of information for secondary purposes. Such purposes might include health or other types of research. For example, El Emam and Fineberg (2009) argue that government agencies that disclose health data to researchers should make use of anonymization techniques in order to limit the amount of personally identifiable information that is released. In the context of courts (and by extension administrative tribunals) data minimization principles could apply at the release stage to ensure that only that personal information necessary to serve the purposes of providing transparency in legal proceedings should be disclosed in decisions in order to avoid privacy consequences for individuals when decisions are published online (Sherman 2013; Berzins 2008).

Data retention policies that require the purging of personal information that is no longer required to meet the purposes for which it was collected are also a means by which government agencies can limit the amount of personal information in their hands, and therefore the privacy risks to individuals (Office of the Privacy Commissioner of Canada 2014; UK ICO 2016). Data minimization through limits on retention presents somewhat of a challenge in the Web 3.0 environment as the destruction or disposal of data goes against the ethos that more is better and that it is impossible to know what data will be relevant or useful in analytics (Office of the Privacy Commissioner of Canada 2014; Kitchin 2014). Nevertheless, as an element of privacy protection and government accountability, limiting the retention of personal information and properly disposing of personal data when it is no longer required protects privacy and limits the risk of improper disclosure of personal information.

Data minimization is not, on its own, a solution to the privacy challenges identified in this paper. It is a strategy that can help reduce the amount of personal information in the hands of government, thereby diminishing the possibility of inappropriate or harmful release of personal information. The reality is, however, that governments will always need to collect personal information in order to operate their many programs and services. Because of this, it should be used in combination with other strategies (including ensuring citizens are able to become informed of the information that the government holds about them) as part of an overall information management plan.

Inter- and Intra-Governmental Communication

Although it may seem obvious to identify inter and intra-government communication as a strategy for protecting privacy, this type of communication is frequently lacking. What is recommended is not simply intra-governmental communication, but also communication between different levels of government including federal, regional and municipal levels. The proliferation of open government agendas in a big data environment makes this type of communication all the more necessary. This is because data sets that appear either innocuous or sufficiently anonymized when considered individually may pose more significant privacy risks if other departments or levels of government are also releasing data that, in combination, might lead to the reidentification of individuals. The UK Information Commissioners Office (2012 at 40) notes that

> Organisations should seek to share information about planned disclosures with other organisations, to assess risks of jigsaw identification. For example it would be helpful for public authority A to know that public authority B is also planning an anonymised disclosure at the same time, one on health and one on welfare, both using similar geographical units. They can then assess the risks collectively and agree [on] mitigation for both datasets.

Inter- and intra-governmental communication can also facilitate knowledge sharing about decision-making processes relevant to the release of government information as well as strategies and techniques used to deidentify data or otherwise prepare material for release. Zuiderwijk and Janssen (2014) argue for “systemic collaboration” within governments to achieve the goals of open data, observing that political messaging to the public about open data may not match the realities experienced by public servants who are charged with making data available as open data. Writing in the Canadian context, Roy (2014) argues for a national strategy involving all levels of government in order to co-ordinate the different open data initiatives. While neither Roy nor Zuiderwijk & Janssen specifically address balancing privacy and transparency in open government, their arguments in favour of greater communication and collaboration both within and between governments are relevant to the management of privacy issues.

As with data minimization, communication and cooperation both within and between governments is not a panacea for addressing the challenges of balancing privacy with transparency. They are both broad strategies that can contribute to an environment that improves the management of personal information and decision-making around the coordinated release of government information and data. However, within this environment, case-by-case decisions must still be made regarding the public release of particular data sets and other types of government information (including court decisions or information released as part of proactive disclosure). The next four strategies are ones which are aimed at this case-by-case decision-making process.

Assessing Privacy Risks

Prior to the release of open government data or government information through proactive disclosure, steps must be taken to determine whether the dataset or information contains personally identifiable information, and to assess the impact that its release might have. The privacy impact assessment is a tool used by government (UK ICO 2014; Government of Canada 2002) (and increasingly by the private sector (Wright and DeHert 2012; UK ICO 2014)) to identify and minimize privacy risks. Wright and DeHert (2012 at 5) define a privacy impact assessment as

> a methodology for assessing the impacts on privacy of a project, policy, programme, service, product or other initiative which involves the processing of personal information and, in consultation with stakeholders, for taking remedial actions as necessary in order to avoid or minimize negative impacts.

Privacy impact assessments (PIAs) can be used in open government initiatives in two ways. They can be used to assess the overall privacy implications for an open data programme, identifying privacy issues that may arise and articulating strategies for dealing with them (such as, for example, the use of deidentification techniques). They can also be used in more a more targeted way in relation to decision-making around the disclosure of particular data sets, databases (e.g., digital registries such as land titles registries), or collections (e.g., making available online the decisions of a particular administrative tribunal). In all of these instances, a PIA can assist in identify potential privacy risks and in finding ways to minimize privacy impacts.

The PIA can be specifically adapted to the open government context. This context is one in which the protection of privacy may have to be balanced against transparency values. The Australian Information Commissioner's *Guide to Undertaking Privacy Impact Assessments* (2014) offers an example of an assessment process that is designed to take into account competing and counterbalancing considerations. It provides that

> a PIA is much more than a simple compliance check. It should 'tell the full story' of a project from a privacy perspective, going beyond compliance to also consider the broader privacy implications and risks, including whether the planned uses of personal information in the project will be acceptable to the community. (Office of the Australian Information Commissioner 2014 at 2)

This suggests that a PIA adapted to the open government context should take into account not just the privacy impacts but also the transparency value of the data or information that is to be released. If there is a high transparency value this may favour release in spite of privacy implications; data or information with a low transparency value might require stronger measures to protect personal information from release or reidentification.

The PIA process for open data and proactive disclosure can incorporate a series of specifically designed questions that explore both privacy risks and transparency values. The list of questions below is adapted from Scassa and Conroy (2016).

1. *What is the purpose of disclosure of the information or release of the dataset?*
   (Possible purposes might include furthering government transparency, encouraging open engagement, or supporting innovation, or research)
2. *Does the document or dataset contain any personal information?*
   (Personal information includes any specific identifiers such as the name of a person, their address, or a unique identifying number)
3. *If the answer to Question 2 is 'yes', is the personal information relevant to the purpose(s) for disclosure?*
4. *Does the data set contain any personally identifiable information?*
   (This can be information which does not, on its own, identify specific individuals, but which, when linked to other information might lead to their identification. Examples can include postal codes, gender, profession or other demographic information. For example, if the information is in the form of court decisions, the names of the parties may be relevant to the principle of open courts that motivates the publication of the decisions.)
5. *If the document or data set contains personally identifiable information, are any individuals identifiable by reference to those variables?*
   (It is possible, for example, with small sample sizes that information such as gender might lead to the identification of a specific individual)
6. *If the answer to question #5 is 'yes', is the personally identifiable information relevant to the purpose(s) for the disclosure?*
   (For example, a dataset disclosed that provides demographic information about government employees by department might need to include information about gender in order to be useful in assessing the extent of efforts to increase the representation of women in these positions).

7. *Is any information that can be linked to specific individuals sensitive in nature?*
   (Sensitive information may vary according to the context, but it may include information such as personal health information, criminal history, religious beliefs, and so on.)
8. *Are any of the variables in the data easy to identify in specific persons?*
   (If so, this could lead to reidentification. Examples might include a medical condition that is observable).
9. *Could reidentification be expected to have serious consequences for an individual?*

(Such consequences might include physical, emotional, or financial harm).

The first question engages the balance between privacy and the benefits of disclosure. There may be some circumstances in which, for example, the transparency value of the information outweighs the privacy risks. Questions 2 and 3 address the issue of personal information. In most cases, if such information is present in the document or data set, it should be removed to protect privacy. However, this information may be relevant to the purposes for disclosure. This is immediately obvious in the case of personal information (such as the name and position of an individual) in government reports being considered for proactive disclosure. While this is identifying information, it may not be "private" in the sense that it is information about an individual carrying out their public duties. Depending on the legal and cultural contexts of particular jurisdictions, other types of information may be considered personal but not private, and thus subject to disclosure. Questions 4 through 6 address the presence of information which, while it does not on its face identify an individual, can, in combination with other information, lead to identification. This is often a difficult assessment to make, as the information might be linked with other information contained in sources external to the dataset under consideration for release. As more and more information becomes available – much of it closely held in the hands of private sector corporations – it will be increasingly difficult to make such assessments. Questions 7, 8 and 9 are designed to help assess how easy reidentification might be, how sensitive the information at issue is, and what impact it might have on the individual if reidentification takes place. This can assist in balancing the privacy interests with the transparency value of the information or data at issue.

There may be circumstances where, in spite of the presence of information that might lead to the identification of specific individuals, the release of the document or data set is still considered to be desirable. In such cases, the use of an anonymization technique (considered below) may help maintain the appropriate balance between privacy and transparency. In cases where the risk of reidentification is difficult to assess – particularly in the big data environment – other strategies might be of some use. These are also discussed below.

Anonymization of Data

Data sets that contain personal information can be anonymized by removing all personal information (El Emam 2013; Fraser and Willison 2009). Further, data sets that contain personally identifiable information can also be manipulated to eliminate or reduce the risk of reidentification (UK ICO 2012). There are a number of available techniques. *Aggregation*, a technique typically used with statistical data, displays data as totals, averages or in ranges. The presentation of data in this way may be suitable for some purposes, although it may not be sufficiently fine-grained for other purposes. *Randomization* involves the scrambling of direct and indirect identifiers in the database (UK ICO 2012). The coding or *pseudonymization* of data involves the replacing of unique identifiers with codes or pseudonyms. This is a technique commonly used in the context of research involving personal health information (Emam and Fineberg 2009; UK ICO 2012). Where the information at issue is qualitative, personal and personally identifying information can be removed through *redaction* (UK ICO 2012).

In cases where the datasets contains personally identifiable information – in other words information that is not itself identifying of individuals, but could be used in combination with other information to identify specific individuals – techniques such as heuristics or analytics may be used (Emam and Fineberg 2009). *Heuristics* makes use of threshold rules to assess the risk that an individual might be uniquely identifiable through any combination of quasi-identifiers in the data set; or that outside sources of information might be combined with the data to identify specific individuals within the dataset. Some data may be suppressed if it is determined that the reidentification risk will be too high if it remains.

Although anonymization and deidentification techniques can be useful to protect privacy in the release of government information, the risk of reidentification is increased by the vast amount of other data that is already available as open government data or that is in the hands of the private sector. In the big data environment, reidentification risk is real (Ohm 2010; Daries 2014). The EU Article 29 Data Protection Working Party (2013) observes that there are a number of reasons why an individual or an organization might attempt to reidentify individuals whose deidentified information is released within the open government context. These might include reidentification for commercial or law enforcement purposes, or to reveal personal information that may be newsworthy or relevant in an adversarial political setting, or simply to satisfy individual curiosity. The UK Information Commissioner (2014) warns that organizations should periodically review their anonymization practices in order to ensure that they are keeping up with reidentification risk within the big data environment.

Techniques used to anonymize data or to protect against reidentification typically have an impact on the quality of the data and its fitness for some purposes (Cavoukian, et al. 2014; Daries 2014). The decision regarding what technique or techniques to employ and in what circumstances may depend upon an assessment of the risk of reidentification, the degree of sensitivity of the information, the purposes to which the data may be put, and the transparency value of the data. Where the transparency value is high, disclosure of anonymized information may be warranted even if there is a risk of reidentification. The argument for disclosure may be less compelling if the reidentification risk is high and the transparency value of the information is relatively low. Of course, it is not always obvious what the transparency value of data may be, as it might be used in unprecedented combination with other data to produce unanticipated results. Some data sets have a more obvious value for use in holding the government to account. For other data sets, it may be that a case for their value will need to be made.

License Restrictions

In those jurisdictions in which governments hold some form of copyright or database right over collections of data, open data is typically released under an open licence. It is therefore possible for governments to impose certain restrictions on uses of the data that may violate privacy rights in the open government licences. Some open government licences currently in use contain general terms that address personal information. For example, the UK Open Government Licence for Public Sector Information provides that the license does not extend to any personal data that is part of the licensed information. Canada's Open Government Licence stipulates that it does not confer on the licensee any rights to use personal information. Neither license therefore grants rights to use personal information, including personally identifiable information.

It is questionable how useful such terms are. Because personal information is expressly excluded from the licence terms, a person who uses the licensed data in combination with other data to identify specific individuals may not be in breach of the license – they may instead be making an unlicensed use of government information. The licences do not specifically prohibit the use of the licensed data to reidentify individuals.

It is unlikely that someone who uses anonymized geodemographic data provided as open data under such a licence would be in breach of the licence if they used that data to create profiles of individuals based upon assumptions derived from the data (rather than actual reidentification). The profile may become, by virtue of the way in which it is used, 'personal information' about the individual. However, this personal information is manufactured, rather than extracted from the government data and there may thus be no breach of the licence terms. These are interesting questions that have yet to be resolved by courts and they highlight some of the limitations of using general open government licences to address privacy issues.

More specific terms could be included in data licenses to address privacy considerations. For example, additional license provisions for data that may contain personal information or be capable of reidentification could: (i) make it clear that the data has already been anonymized; (ii) prohibit licensees from using the data to reidentify individuals; and (iii) require that licensees notify the licensor of any reidentification that occurs (UK ICO 2014).

In cases where the release of government information that raises significant privacy concerns is being contemplated, customized licences that contain additional terms and conditions could be used to provide an additional layer of privacy protection. For example, Australia has a Restrictive Licence Template (AusGoal 2011) for circumstances where it is necessary to protect personal or confidential information in a government data set. This is not really an open licence since the terms and conditions that may be imposed go beyond what would be considered acceptable in an open licence. Nevertheless, as part of a suite of possible licence templates it gives some flexibility to government and allows for the release of data that might not otherwise be released, albeit under more restrictive terms.

The EU Article 29 Data Protection Working Party (2013) notes that in order to comply with data protection laws and the EU Directive on the re-use of public sector information, public sector bodies may attach specific conditions and safeguards to personal information when making it available online for reuse. The opinion notes, however, that such terms should not place unnecessary restrictions on reuse; the key concern is viewed as the need to ensure that personal information is not used for a purpose inconsistent with that for which the information was collected (Article 29 Working Party 2013 at 3 and 26).

One area where licence terms that restrict the use of personal information contained in government data may be particularly useful is where the information released by a government institution contains directly identifying personal information. This is typically the case, for example, in court or administrative tribunal decisions that are published online. Principles regarding the transparency of judicial proceedings often require that the names of the parties to proceedings and of the witnesses be made public (unless there is a compelling reason to provide anonymity). Court and tribunal decisions may also contain a variety of other personal information. Where these decisions are published online, any licence permitting reproduction and reuse of these materials could place specific restrictions on uses of the personal information contained in the decisions.

The use of licences to protect personal information is far from a perfect solution. The investigation and enforcement of breaches of licence terms may simply not be practicable (Daries 2014; Article 29 Working Party 2013; UK ICO 2012). Since the licensor is the government, it would have to be sufficiently motivated to take legal action against a licensee who uses personal information in a manner contrary to the terms of the licence. In addition, in some cases, it may simply not be possible to establish the source of certain personal information that is being misused. In other words, it may be impossible to trace it back to the government data set, as opposed to some other source. It may even be difficult to tell whether or how government data sets were used in reidentification processes. Licence restrictions, particularly in otherwise open licences may also make productive reuse of the licenced data more complicated, since the use of this data in combination with other datasets made available under different license terms can create headaches for downstream licensing of end-products or services (Mewhort 2012).

Technological Barriers to Re-Use

Technological barriers to reuse are generally not consistent with open data, since one of the goals of open data is to encourage reuse of the data provided and not to create obstacles to reuse (Borgesius et al. 2015). However, technological barriers may be useful in some circumstances where the goal is to provide access to government information for transparency purposes but there is a need to limit reuse in the interests of privacy. An example of such circumstances is in the online publication of court and tribunal decisions. While transparency values may require publication of these materials without redaction, and might be best served by broad and open dissemination, such decisions may contain a considerable amount of often sensitive personal information (Austin and Pelletier 2005). In addition, the availability of this sensitive personal information online may increase reidentification risks elsewhere as it may be used to identify individuals within other anonymized government data sets.

Technological barriers can be as simple as using restricted proprietary formats such as PDF for the release of information. Such formats can make information more difficult and time-intensive to reuse. Nevertheless, those determined to reuse the data will find ways to circumvent technological barriers (Thompson 2014). Online applications already exist that make it possible for the average user to defeat many such technological barriers and to manipulate data into machine-readable formats. Thus, where there is a high degree of interest in reuse of the data, technological barriers will provide only a very limited protection for the privacy interests at issue. At the same time, they may impose an undesirable transparency cost.

Another form of technological barrier is the use of software to prevent the indexing of web pages in search engines (Austin and Pelletier 2005). For example, the Canadian Legal Information Institute (CanLII), a website which provides free online access to Canadian court and tribunal decisions, states in its privacy policy:

> CanLII adheres to the principle of openness and transparency of legislative and judicial processes, and recognizes their fundamental importance in democratic societies. In order to minimize the negative impact of such transparency on the privacy of those involved in cases leading to judicial decisions, CanLII does not permit its case law collections to be indexed by external search engines. (CanLII 2016)

The policy also states that external search engines are prohibited from indexing the text and style of cause of court decisions published by CanLII. A similar approach is adopted by the Australian Legal Information Institute (AUSTLII) and by the British and Irish Legal Information Institute (BAILII), which provides in its privacy policy:

> BAILII does not consent to the contents of these databases being indexed by other web sites. BAILII attempts to prevent such indexing occurring by placing these database outside the permitted scope of web ‘crawlers’, ‘robots’ or ‘spiders’ that adhere to the voluntary Robot Exclusion Standard (BAILII Privacy Policy 2016)

The usefulness of this type of technological barrier is limited by the fact that the Robot Exclusion Standard is voluntary and depends upon the willingness of search engines to comply with it. Major search engines such as Google, Bing and Yahoo currently do so, but others may not.

CanLII also places limits on bulk downloads of court decisions. This limitation is both technological and contained in the site's licence terms. Although there may also be other reasons to prevent bulk downloads, doing so reinforces the other technological privacy protections since it prevents others from downloading court decisions in bulk and publishing them elsewhere online in fully indexable and searchable formats. The importance of this issue was highlighted when a complaint was made to the Office of the Privacy Commissioner of Canada (OPCC) after an individual found that detailed personal information from her past appeared that had been reported in a Canadian court decision appeared in a Google search for her name. The court decision had been one of a very large number of decisions that a Romanian-based company named Globe24 had downloaded in bulk from different sources including official court websites in Canada (Dobby 2015; PIPEDA 2015).

While the Globe24 case reveals the importance of the technological measures adopted by CanLII and others to protect privacy of personal information originating from government sources, it also reveals their shortcomings. These restrictions did not prevent the information in question from becoming repurposed by another site in a way that adversely impacted personal privacy. This strongly indicates that government institutions would be unwise to rely solely upon either license restrictions or technological measures to protect the privacy of personal information.

In addition, the use of technological barriers to access government information has been criticized. Some argue that anyone should be able to build a fully searchable database of court decisions (Cameron-Huff 2014). Such a perspective denies the obligation of governments to protect citizen privacy and favours free enterprise over a balancing of interests.

Conclusion

In this paper, we have outlined strategies that can be used by those responsible for the release of information through proactive disclosure or as open data. These strategies are intended to assist in balancing transparency goals with personal privacy in the release of government information. Achieving this balance is made more challenging by the fact that the presence of personally identifiable information may be difficult to gauge, particularly where individuals may be reidentified in anonymized data sets by combining that data with other available data from indeterminate sources. The rapidly evolving big data environment is one in which massive quantities of data are already available and more is constantly being generated or released. This makes it difficult to anticipate what data might be used in order to achieve reidentification (Conroy and Scassa 2015).

We identify several strategies that can be adopted in order to balance privacy with transparency in open government. The first two strategies are addressed to general practices. Data minimization can reduce the amount of personal information both by limiting collection only to that which is specifically necessary, and by limiting retention only for as long as is necessary. Data minimization principles can also be applied in terms of the disclosure of any personally identifiable information. Inter- and intra-governmental communication around data release is also recommended as a means to develop a greater understanding of the types of information being released by different institutions at all levels of government.

In addition to these broad strategies we have identified specific practices which can be helpful in minimizing or obscuring personally identifiable information or in limiting its reuse. These strategies are not mutually exclusive. A first strategy is that of assessing privacy risks in order to determine the nature and extent of the personal information at issue. Once this determination is made, the information can be removed or minimized by various anonymization techniques. Because such techniques are susceptible to reidentification strategies, there must still be some assessment of the transparency value and the privacy risks. Anonymization techniques may affect the quality of the data released. The more significant the manipulation to anonymized data sets, the less fit for some purposes the data becomes. This is a factor to weigh in the transparency/privacy balance.

Other options to protect personal information or personally identifiable information include license restrictions and technological barriers to reuse of the information. Technological barriers and licence restrictions can limit the ease with which government data or information can be reused, processed or digitally analyzed. These limitations should also be considered in balancing transparency and privacy, although they are not entirely effective and may have some disadvantages.

These different strategies for balancing privacy and transparency have their basis in the view that individuals should be protected to an appropriate extent from the privacy harms that might flow from the release by governments of their personal information or of personally identifiable information through proactive disclosure or open data. At the same time, transparency values are important, and may in some circumstances outweigh the privacy risks. Given that some of the strategies identified may adversely impact data quality or the usefulness of the data for some purposes, and given the fact that other strategies may create barriers to reuse, these impacts must also be taken into account in striking the necessary balance. Ultimately, those charged with the release of government datasets or other information should evaluate the proportionality of any restrictions on access to or the quality of released government data in order to ensure that the focus remains on balancing the goals of open government and open data with any risks to personal privacy.

Acknowledgments The authors gratefully acknowledge the support of the Social Sciences and Humanities Research Council of Canada for the Geothink project of which this research forms a part.

References

Article 29 Data Protection Working Party (2013) Opinion 06/2013 on Open Data and Public Sector Information ('PSI') Reuse. Retrieved from: http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2013/wp207_en.pdf

AusGoal (2011) Restrictive Licence Template. Retrieved from: http://www.ausgoal.gov.au/restrictive-licence-template

Austin LM, Pelletier F (2005) Synthesis of the comments on JTAC's discussion paper on open courts, electronic access to court records, and privacy (Prepared on Behalf of the Judges Technology Advisory Committee for the Canadian Judicial Council, 2005). Retrieved from: https://www.cjc-ccm.gc.ca/cmslib/general/news_pub_techissues_Synthesis_2005_en.pdf
BAILII Privacy Policy (2016) Retrieved from: http://www.bailii.org/bailii/privacy.html
Bennett CJ, Raab C (2006) The governance of privacy: policy instruments in global perspective. MIT Press, Cambridge, MA
Berzins C (2008) Personal information in the adjudicative decisions of administrative tribunals: an argument for limits. Advocates' Q 34(3):261–284
Borgesius FZ, Gray J, van Eeechoud M (2015) Open data, privacy, and fair information principles: towards a balancing framework. Berkeley Technol Law J 30(3):2073–2130
British Columbia (2016) Open information. Retrieved from: http://www2.gov.bc.ca/gov/content/governments/about-the-bc-government/open-government/open-information
Cameron-Huff A (2014) Why Google can't build a case law search engine in Ontario. Retrieved from: http://www.cameronhuff.com/blog/ontario-case-law-private/index.html
Candeub A (2013) Transparency in the administrative state. Houston Law Rev 51(2):385–416
CanLII Privacy Policy (2016) Retrieved from: https://www.canlii.org/en/info/privacy.html
Cavoukian A (2009) Privacy and government 2.0: the implications of an open world. Ontario, Information and Privacy Commissioner. Retrieved from: https://www.ipc.on.ca/images/Resources/priv-gov-2.0.pdf
Cavoukian A, Dix A, El Emam K (2014) The unintended consequences of privacy paternalism. Information and Privacy Commissioner, Toronto. Retrieved from: https://www.ipc.on.ca/images/Resources/pbd-privacy_paternalism.pdf
Conroy A, Scassa T (2015) Promoting transparency while protecting privacy in open government in Canada. Alberta Law Rev 53(1):175–206
Daries JP (2014) Privacy, anonymity, and big data in the social sciences. ACM Queue 12(7):1–12. Retrieved from: http://queue.acm.org/detail.cfm?id=2661641
Davies TG (2014) Open data policies and practice: an international comparison (September 5, 2014). Available at SSRN: https://ssrn.com/abstract=2492520 or http://dx.doi.org/10.2139/ssrn.2492520
Dobby C (2015) Canadians upset with Romanian Website that exposes court case details. The Globe and Mail (4 January, 2015). Retrieved from: http://www.theglobeandmail.com/report-on-business/industry-news/the-law-page/canadians-upset-over-romanian-website-that-exposes-court-case-details/article22284367/
El Emam K (2013) Guide to the de-identification of personal health information. CRC Press, Boca Raton
El Emam K, Fineberg A (2009) An overview of techniques for de-identifying personal health information. CHEO Research Institute, Ottawa
Fraser R, Willison D (2009) Tools for de-identification of personal health information. Report Prepared for the Pan-Canadian Health Information Privacy (HIP) Group. Retrieved from: https://www.infoway-inforoute.ca/en/component/edocman/supporting-documents/500-tools-for-de-identification-of-personal-health-information
Government of Canada (2002) Privacy impact assessment policy. Canada, Treasury Board Secretariat, Ottawa. Retrieved from: http://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=12450
Greenleaf G (2011) Free access to legal information, LIIs, and the free access to law movement. In: Danner R, Winterton J (eds) IALL international handbook of legal information management. Ashgate, Aldershot/Burlington VT, pp 201–228
Janssen K (2012) Open government data and the right to information: opportunities and obstacles. J Community Informatics 8:2. online: http://ci-journal.net/index.php/ciej/article/view/952/954
Kitchin R (2014) The data revolution: big data, open data, data infrastructures & their consequences. SAGE Publications Ltd., London
Mayer-Schönberger V, Cukier K (2014) Big data. Mariner Books, New York
McLachlin B (2003) Courts, transparency and public confidence – to the better administration of justice. Deakin Law Rev 8:1–12

Mewhort K (2012) Creative commons licenses: options for Canadian open data providers. (2012) Report for the Canadian Internet Policy and Public Interest Clinic. Retrieved from: https://cippic.ca/sites/default/files/Creative%20Commons%20Licenses%20-%20Options%20for%20Canadian%20Open%20Data%20Providers.pdf

Meyerhoff-Nielsen M, Krimmer R (2015) Reuse of data for personal and proactive service: an opportunity not yet utilised. Retrieved from: https://www.researchgate.net/publication/278023437_Reuse_of_Data_for_Personal_and_Proactive_Service_An_Opportunity_Not_Yet_Utilised

Office of the Australian Information Commissioner (2014) Guide to undertaking privacy impact assessments. Retrieved from: https://www.oaic.gov.au/resources/agencies-and-organisations/guides/guide-to-undertaking-privacy-impact-assessments.pdf

Office of the Privacy Commissioner of Canada (2014) Personal information retention and disposal: principles and best practices. Retrieved from: https://www.priv.gc.ca/information/pub/gd_rd_201406_e.asp

Ohm P (2010) Broken promises of privacy: responding to the surprising failure of anonymization. UCLA Law Rev 57:1701–1777

Open Government Partnership (2011) Open Government Declaration. Retrieved from: https://www.opengovpartnership.org/open-governmentdeclaration

PIPEDA Report of Findings No. 2015–002, [2015] C.P.C.S.F No. 2, [2015] S.C.C.P.V.P.C. No 2

Queensland, Office of the Information Commissioner (2013) Proactive disclosure and publication schemes. Retrieved from: https://www.oic.qld.gov.au/guidelines/for-government/access-and-amendment/proactive-disclosure/proactive-disclosure-and-publication-schemes

Roy J (2014) Open data and open governance in Canada: a critical examination of new opportunities and old tensions. Future Internet 6(3):414–432. doi:10.3390/fi6030414

Scassa T (2014) Privacy and open government. Future Internet 6:397–413. doi:10.3390/fi6020397. Available at: http://www.mdpi.com/1999-5903/6/2/397

Scassa T, Conroy A (2016) Strategies for protecting privacy in open data and proactive disclosure. Canadian J Law Technol 14:215–262

Schauer F (2011) Transparency in three dimensions. Univ Ill Law Rev 4:1339–1358

Schneier B (2015) Data and goliath: the hidden battles to collect your data and control your world. W.W. Norton & Co., New York

Sherman J (2013) Court information management: policy framework to accommodate the digital environment. Canadian Judicial Council, Ottawa. Retrieved from: http://www.cjc-ccm.gc.ca/cmslib/general/AJC/Policy%20Framework%20to%20Accommodate%20the%20Digital%20Environment%202013-03.pdf

Solove DJ (2004) The digital person: technology and privacy in the information age. New York University Press, New York

Thompson SA (2014) Unlocking Ontario public sector salary data. Media Canadian Assoc Journalists 16(2):27

United Kingdom, Information Commissioner's Office (UK ICO) (2012) Anonymisation: managing data risk code of practice. ICO, Cheshire. Retrieved from: https://ico.org.uk/media/for-organisations/documents/1061/anonymisation-code.pdf

United Kingdom, Information Commissioner's Office (UK ICO) (2014) Privacy Impact Assessment Code of Practice. Retrieved from: https://ico.org.uk/media/for-organisations/documents/1595/pia-code-of-practice.pdf

United Kingdom, Information Commissioner's Office (UK ICO) (2016) Retaining Personal Data (Principle 5). Retrieved from: https://ico.org.uk/for-organisations/guide-to-data-protection/principle-5-retention/

Veljkovic N, Bogdanovic-Dinic S, Stoimenov L (2014) Benchmarking open government: an open data perspective. Gov Inf Q 31(2):278–290

Winn PA (2004) Online court records: balancing judicial accountability and privacy in an age of electronic information. Symposium – Technology, Values, and the Justice System. Washington Law Rev 79:307–330

Wright D, deHert P (eds) (2012) Privacy impact assessment. Springer, Dordrecht
Yu H, Robinson DG (2012) The new ambiguity of open government. UCLA L Rev Disc:178–208
Zuiderwijk A, Janssen M (2014) Open data policies, their implementation and impact: a framework for comparison. Gov Inf Q 31(1):17–29. doi:10.1016/j.giq.2013.04.003

Dr. Teresa Scassa is the Canada Research Chair in Information Law at the University of Ottawa, where she is also a professor at the Faculty of Law. She is the author or co-author of several books on intellectual property and technology law subjects. She is a past member of the External Advisory Committee of the Office of the Privacy Commissioner of Canada, and of the Canadian Government Advisory Committee on Open Government. She is a member of the GEOTHINK research partnership, and has written widely in the areas of intellectual property law, law and technology, privacy, and open government.

Dr. Amy Conroy recently completed her doctorate in the Faculty of Law at the University of Ottawa. She is a part-time professor at Carleton University. She has co-authored several papers in the area of privacy law with Teresa Scassa. Her doctoral dissertation, entitled "E-racing the Genetic Family Tree: A Critical Race Analysis of the Impact of Familial DNA Searching on Canada's Aboriginal Peoples," argues against using familial searching in Canada's national DNA data bank based on the discriminatory impact this would have on Aboriginal peoples in Canada.

Index

A. Ojo, J. Millard (eds.), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Public Administration and Information Technology 32, DOI 10.1007/978-3-319-63743-3