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Scientific Foundations of Digital Governance and Transformation

Concepts, Approaches and Challenges

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To Nadiya, Lefki and Melina,

To Synne, Christiane and Marianne,

To Michael and Noah,

with love and gratitude

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Foreword

The core contribution of governments is the realization of public values, through the appropriate people, processes, and systems. Public values relate to what the public sector organizations contribute to society, including transparency, responsiveness, inclusion, safety, and social security. The digitalization of our society results in the need for governments to create public values using digital means, this requiring the building of the right capabilities and competencies, but also significant transformations.

Thus, digital transformation is high on the agenda of governments, all over the world. Transformation is about doing things differently than in the past and affects all aspects of the organization, ranging from the technical to the managerial and even legal levels. Such changes lead to a complete redesign of organizational arrangements and impact a broad range of aspects including organizational processes, people, culture, and structures.

In this book, the focus is on the transformation of digital governance, in which governments utilize information and communication technologies (ICT) to create public values.

Digital governance and transformation is a very broad area. This book is dedicated to analysing the various aspects and challenges of digital governance and transformation. The chapters present the foundations, latest research advancements, and findings to increase our knowledge of the domain. The authors drive us through theoretical foundations, principles, methodologies, architectures and technical frameworks, contributing to the creation of a science base for digital governance and transformation.

Digital governance requires participation by the public, but how this can be arranged is yet not fully understood. The future of digital governance is not easy to predict, as many directions can be taken. Trust between the public and the government will be a key aspect of shaping the future of digital governance. Also, how the government transformation is shaped, the resulting institutional structures, the stakeholder's interactions and their capabilities will influence the future. Therefore, a whole section of this book is dedicated to perspectives on the future of digital government.

We are only at the start of this transformation.
I congratulate the editors and authors on the excellent work done and its results.
Enjoy reading!

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Acknowledgements

This book is the result of the collective work of several scientists, industry experts, and practitioners in the fields of digital governance, information systems, political science, law, management, and socio-economics. We are highly grateful to all the authors for their continued efforts and dedication towards a high-quality publication.

We are also very pleased to acknowledge the support of the Editorial Advisory Board and all the colleagues involved in overall guidance, stimulation of the community, the review process, and the book finalization.

Many thanks go to colleagues from the Government 3.0 project, at United Nations University in Portugal, Koblenz University and the National e-Government Centre in Germany, Agder University in Norway, Danube University Krems in Austria, University of the Aegean in Samos, Greece, the Lisbon Council in Belgium, PWC Greece, and SingularLogic Cyprus, since this book was conceived within this pioneering project. We also thank all the external experts involved in the various Government 3.0 workshops and activities, for their ideas and encouragement towards this difficult task of scientific foundations of digital governance.

We are especially grateful to Zoi Lachana, Ph.D. Candidate at University of the Aegean at this time, for her continued support during the publication process and to the publisher's team, for their professional guidance and feedback, decisive in keeping this project on schedule.

We would also like to thank Marijn Janssen, Professor at TU Delft and a prominent member of our community for his warm foreword in this book.

May this work be an inspiration for our students, colleagues, and friends, in their own path for development and fulfilment.

June 2021

Yannis Charalabidis
Leif Skiftenes Flak
Gabriela Viale Pereira

Introduction

Towards a Science Base for Digital Governance

Digital governance refers to the phenomenon where administrations, enterprises, and citizens utilize information and communication technologies (ICT) to a great extent, aiming at advanced levels of service provision quality, openness and transparency, collaboration and evidence-based decision making for enhancing the quality of living and promoting sustainable development.

During the last decades, digital governance has been recognized as a well-established application domain studying the problems related to the needs of public sector organizations and proposing novel methods and frameworks for enhancing service quality through the use of ICT. Substantial progress has been made through international and national research in a number of areas, yet the lack of scientific foundations in the digital governance domain seems to hinder unlocking the real transformative value and full potential to all its stakeholders, from researchers, to industry and administrations. Such a scientific background would document the existing knowledge and open the pathway for systematic and reproducible solutions to identified problems, without the danger of repeating research or missing opportunities for application.

In this quest for scientific recognition, the key challenges that digital governance and transformation will have to face include substantiation of value, strong engagement and support by industry, sustainable research in the domain through appropriate curricula and roadmaps, coordination of efforts undertaken by stakeholders and neighbouring disciplines, development and application of assessment methods, and finally systematization of methods and tools to achieve specific results in each case.

A recent and relevant European Union initiative in the field is the project titled "Government 3.0—Scientific foundations, training and entrepreneurship activities in the domain of ICT-enabled Governance" (https://www.gov30.eu/). In this research project, numerous universities, enterprises, and public sector organizations worked together to extend the state of the art in training, roadmapping, and documenting the progress of digital governance. This project was a key enabler for the conception and realization of the present title.

Objective of this Book

The present book aims at providing the latest research advancements and findings for the scientific systematization of the digital governance and transformation knowledge, such as core concepts, foundational principles, theories, methodologies, architectures, tools, assessment frameworks, and future directions. It brings forward the ingredients of this new domain, proposing its needed formal and systematic tools, exploring its relation with neighbouring scientific domains and finally prescribing the next steps for eventually achieving the thrilling goal of laying the foundations of a new science.

Organization of the Book

The book is composed of 16 chapters, structured in three parts as following: the first part is titled "Scientific Foundations of Digital Governance" and includes six chapters laying the foundational framework for digital governance, describing its proposed structure, giving a full-breadth view of and analysing relations to other scientific domains. Section 2 is titled "Digital Governance Problem and Solution Space", including in its six chapters approaches for researchers and practitioners, thus giving some initial directions for deploying new methods and tools for tackling governance problems in a systematic way. The third part on "Perspectives and Future Research Directions for Digital Governance Research" includes four chapters presenting more holistic, groundbreaking approaches for digital governance research and education, leading to further development of the science base.

Part A—Scientific Foundations of Digital Governance

This part includes six chapters offering distinct and varied philosophical, theoretical and methodological perspectives on the field of digital governance. Contributions include the epistemological aspects for digital transformation and governance, as well as applications and systematic approaches contributing to the foundation of the science base.

Chapter "A Science Base for Digital Governance—Why, What and How", by Charalabidis, Lachana, and Alexopoulos, tries to answer the main questions around the development of this scientific base. This chapter provides the rationale for this approach, the main contents of the science base, and the present and next steps for its evolution.

In chapter "Digital Governance as a Scientific Concept", Engvall and Flak outline core constructs of digital governance and discuss how these have evolved into our current understanding of the phenomenon. The authors did not identify a distinct difference between *e-Governance* and the newer *digital governance* and found that digital governance is typically either studied with emphasis on the use of ICT in governance or on structural or normative transformational outcomes of digital governance.

Scholl digs further into the diversity of the domain and its development trajectories and offers predictions of where the domain might be headed in the coming decades in chapter "Digital Government Research: A Diverse Domain". According to this chapter, we are still in the early phases of transition and transformation and are likely to see more wide reaching and profound changes in the decades to come.

Chapter "On the Structure of the Digital Governance Domain" by Lachana, Charalabids, and Keramidis dives deeper into the structure of the digital governance and transformation domain, a key ingredient of the science base, by analysing the generations, the main areas, and the key terms. Following an automated analysis of thousands of publications, the chapter presents an ontological representation of the domain, its structure, and the interrelations among its elements.

Sarantis, Ben Dhaou, Alexopoulos, Ronzhyn, and Mureddu show in chapter "Digital Governance Education: Survey of the Programs and Curricula" how the emergence of digital government practice and research has provided a basis for digital government education and illustrate typical contents of such programmes based on an elaborate analysis of 57 existing programmes. The topics highlighted in this chapter offer guidance that can inform continuous improvement of existing programmes and serve as a basis for developing new and novel university courses and study programmes.

Chapter "Discussing the Foundations for Interpretivist Digital Government Research", by McBride, Misnikov and Draheim, suggests that the digital governance domain is largely lacking a common theoretical, philosophical, and epistemological basis. In response to this shortcoming, this chapter lays out the foundations for the role of interpretivism and research philosophy more generally for the digital government domain.

Part B—Digital Governance Problem and Solution Space

Part B also contains six chapters exploring different aspects of the problems digital governance aims to address as well various solutions to current challenges.

In chapter "Understanding Digital Transformation in Government", Danielsen, Flak, and Sæbø explore the current phenomenon of digital transformation from the information systems and management fields and discuss how this may inform and influence the digital governance discourse. An important contribution from this chapter is a model nesting the related concepts *digitization*, *digitalization,* and *digital transformation.*

Van Veenstra and Timan offer a novel impact assessment framework for digital governance based on public values to support policy formation and evaluation in chapter "A Public Value Impact Assessment Framework for Digital Governance". The chapter highlights six elements that should be taken into account when performing public value impact assessments within digital governance.

Chapter "Fostering a Data-Centric Public Administration: Strategies, Policy Models and Technologies" by Mureddu, Osimo, Kenny, Upson, and Peristeras investigates how public administrations can address the current issue of data-driven development to understand the usefulness of strategies, methods, and technologies. The chapter contains a number of important takeaways on how to foster data-centric public administration.

In chapter "A Methodology for Evaluating and Improving Digital Governance Systems Based on Information Systems Success Models and Public Value Theory", Loukis outlines a methodology for evaluating and improving digital governance systems. The chapter is theoretically founded on the Delone & MacLean model for information systems success and public values theory and illustrates the usefulness of this combination through two empirical cases.

Abril and Crompvoets argue that implementation orientation is of critical importance and illustrate its relation to the public policy context in chapter "Understanding the Impact of Public Policy Context on the Implementation Orientation for the Digital Transformation of Interoperable Public Services". Moreover, the authors develop a model for Interoperable Digital Public Services Implementation Orientation and test the model on ten interoperable services across the EU.

Chapter "Agent-based Modeling in Digital Governance Research: A Review and Future Research Directions" by Sukhwal and Kankanhalli offers a review of the literature on agent-based modelling in digital governance. As in several other areas of digital governance research, the authors found ample opportunity for theoretical development as well as suggestions for new application areas for agent-based modelling.

Part C—Perspectives and Future Research Directions for Digital Governance Research

The last part of the present book contains four chapters highlighting some of the key areas in which digital governance research needs to evolve in the years to come.

Chapter "Government 3.0: Scenarios and Roadmap of Research", by Ronzhyn and Wimmer, summarizes findings from a recently completed EU project aiming to outline a roadmap for future research related to the current development stage of digital governance, *Government 3.0*. The authors suggest a research agenda for disruptive technology application in government that needs to be sensitive to positive *and* negative effects.

Chapter "Building Digital Governance Competencies: Baseline for a Curriculum and Master Programme", by Viale Pereira, Ronzhyn, and Wimmer, reports findings from the same project as chapter "Government 3.0: Scenarios and Roadmap of Research" but focuses on core competences and the building of curricula to support education in the digital governance area. An extensive review of existing courses and curricula forms the baseline for digital governance curriculum from a European perspective.

In chapter "E-Justice: A Review and Agenda for Future Research", Yavuz, Karkın, and Yıldız explore an arena that is expected to increase in significance during the years to come, namely eJustice. The authors identify key issues and map theoretical foundations for the issues. Based on this new insight, the chapter offers directions for further explorations in the area of eJustice.

Finally, chapter "Digitalisation and Developing a Participatory Culture: Participation, Co-production, Co-destruction", by Edelmann, moves in the direction of co-creation between government organizations and citizens and suggests that digitalization has affected culture in public organizations to become more oriented towards participation. The chapter highlights important issues related to participation and co-production. While the shift towards increased collaboration is considered valuable, the author also points out the potential for negative consequences that may lead to co-destruction.

Conclusions

The 16 chapters in this book show that digital governance is a promising domain of research and practice, providing administrations and businesses with methods, systems, and services to allow them enjoy the merits of new processes, new and advanced technologies, and novel organizational principles. Digital governance integrates several "parent disciplines" such as information systems, management and political sciences, while also interacting with several neighbouring disciplines—such as computer science, service science, law, or sociology.

Although delivering ideas and solutions for more than two decades, we cannot yet consider digital governance a rigid scientific domain, able to offer deterministic diagnosis and problem solving in the public administration domain by following standardized practices. Mostly relying on standards that need to be adopted, often forcing public sector organizations to accept the minimum "common denominator", digital transformation practitioners are in need of a deeper understanding and more systematic approaches to common problems.

This book is a collection of chapters outlining foundational issues as well as current and emerging topics related to digital governance, mostly stemming from core scholars of the field and in the Government 3.0 project. Our purpose has been to give out a holistic account of the field that can serve as a reference point for developing a science base for digital governance and transformation. This way, the book offers a starting point for defining and arranging the various elements needed for a new scientific domain: definition of the digital governance concepts and areas, formal problem and solution description methods, assessment tools and metrics, systematization of empirical evidence, as well as relations with neighbouring domains.

Seen together, the 16 chapters outline substantial potential for development of new services, novel ways of offering existing services and ways to improve formulation, implementation, and evaluation of policy. While we are confident that future development will yield considerable value for society, this book also contains important warnings of possible undesirable consequences of uncritical applications of disruptive technologies. We hope the latter will sensitize us as a community and motivate responsible development of practice and knowledge in times of digital transformation.

The first steps have been made towards establishing a scientific base for digital governance and transformation, able to revolutionize the way public administrations and enterprises organize themselves, develop and utilize information systems, structure information and knowledge, finally prosper or reorganize.

It is now the research and practice communities, from industry, academia, and policy making that may take these initial developments further, towards realization and externalization. And then, digital governance science base might have been the first attempt of conceiving this “science of digital public service provision and transformation” that covers data, systems, processes, organizations and, above all, human beings.

For the digital governance and transformation science base, “iacta alea est”.

Yannis Charalabidis
Leif Skiftenes Flak
Gabriela Viale Pereira

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About the Editors

Yannis Charalabidis is Full Professor of Digital Governance at the Department of Information and Communication Systems Engineering at the University of the Aegean in Samos, Greece. He is the founding director of the Digital Governance Research Centre, coordinating policy making, research and application projects for governments and enterprises worldwide. He is heading the MSc on Digital Innovation and Entrepreneurship and the Aegean Startups entrepreneurship accelerator. He has more than 25 years of experience in research and development of complex information systems, 10 of which as general manager in SingularLogic Group software products unit. He has published more than 10 books and 300 papers in international journals and conferences, and actively participates in international scientific and policy-making bodies. He has been teaching as an invited professor at UC Berkeley, TU Delft, Stevens Institute NY, State University NY, University of Washington, City University Hong Kong, Swinburne University Melbourne, and Wollongong University in Australia. In 2016, he was ranked as the eighth most prolific author in Digital Government, among 10,000 authors of the domain, by the Washington University survey. In 2018, he was included in the "100 most influential people in Digital Government," by Apolitical Group.

Leif Skiftenes Flak is Full Professor of Information systems and Director of CeDiT—Centre for Digital Transformation, both at the University of Agder in Kristiansand, Norway. He is also co-founder and board member of GoForIT, Norway's arena for knowledge development and dissemination in the intersection between digitalization and sustainability. Flak holds a PhD in Computer science from Aalborg University and has close to 20 years of experience with research on digitalization in the public sector. His work has been widely published in Information systems and Digital Government journals. Professor Flak is active within the international research community through memberships in networks such as the AIS SIG eGov & Digital transformation. Flak is a popular speaker and is regularly invited to give talks to both practice and academic audiences. He is recognized as an expert in his field and has served on reference groups and expert panels for organizations such as The

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Gabriela Viale Pereira is an Assistant Professor for Information Systems at the Department for E-Governance and Administration at Danube University Krems and a Research Fellow of the Center for Technology in Government, University at Albany. She holds a Post-Doctoral Degree from the Center for Research on Public Administration and Government at Getulio Vargas Foundation and a Doctoral Degree in Administration from the School of Business at Pontifical Catholic University of Rio Grande do Sul. She is Coordinator of the Erasmus+ Strengthening Governance Capacity for Smart Sustainable Cities (CAP4CITY) project. Her research is focused on digital government and ICT-related Governance, especially in the context of smart cities. She has authored and co-authored more than 40 peer-reviewed publications on Information Systems and digital governance. In addition, she has been working with a variety of organizations such as United Nations, ITU, and Council of Europe and she is a Board Member of the Digital Government Society and of IFIP WG 8.5 in ICT & Public Administration.

Scientific Foundations of Digital Governance

A Science Base for Digital Governance—Why, What, and How

Yannis Charalabidis, Zoi Lachana, and Charalampos Alexopoulos

Abstract During the last decades, the evolution of information and communication technologies (ICTs) has offered new capabilities to citizens, businesses and administrations worldwide. Governmental units depend more and more on such new technologies, due to their tremendous potential to assist governments in implementing their mission, aiming at enhancing quality of life and promoting sustainable growth. In this course, Digital Governance has been recognized as a well-established application domain, studying the problems related to the needs of public sector organizations and proposing novel methods, frameworks and tools for enhancing service quality and enhancing the collaboration between administration and citizens. Although substantial progress has been made during the last two decades, the lack of scientific method in analysing situations, proposing solutions and applying them in a systematic way is evident, as still the majority of relevant projects and attempts usually fail to deliver on promise. The current chapter aims to contribute towards the establishment of a Science Base for Digital Governance and Transformation that can make such efforts more repeatable and predictable.

Keywords Scientific foundations · Digital governance · Science base · Digital transformation

1 Introduction

There are many definitions of government in literature. Wright (1977) defines Government as "a bureaucracy instituted to rule a populace by right of authority right of authority". Another definition describes government as an "organized, popularly elected entity committed to work with citizens and groups within the community to find sustainable ways to meet their social, economic, and material needs and improve the quality of their lives" (Hogue, 2013). On the other hand, governance is defined as a method (Bakry & Alfantookh, 2006) or the means (Durham & Becker, 2016)

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by which an activity, a goal or ensemble of activities and goals is/are controlled or directed, such that it/they deliver(s) an acceptable range of outcomes according to some established social standard.

Digital Governance is a term that has emerged, initially as e-Government, at the end of the twentieth century as a relatively innovative method to carry out a substantial part of the work of governments with the use information and communication technologies. There is no substantial difference between the terms "Electronic" and "Digital" (Van Dorsten, 2012). Based on Oxford's Dictionary (Digital, 2020; Electronic, 2020), they have a common meaning: "*computers' involvement or the technology that lies behind the computers on something*". As a matter of course, there are many more definitions either that focus on the technology, or on the technical perspectives of using a computer, a machine (Durán, 2017), or they focus on the result, for instance, of being digital (Dörner & Edelman, 2015).

The exact place and the time that a human government (or even better, the first human government) formed are lost in time. However, there are traces that human governments exist, in their unique and different forms, more than 4500 years ago (Farmer et al., 2004; Klein, 1981). Around 2500 years ago, in ancient Greece, the democratic form of government emerged. Democracy is a Greek term (δημοκρατία), a compound word formed by the words demos (=the whole of peoples with political rights) and kratos (=state but in the sense of power, of authority) (Fleck & Hanssen, 2006). Putting aside Ancient Greece for the moment, we move on much later in time, during the eighteenth century, the Industrial Revolution. The First Industrial Revolution (IR) took place in Europe (it started in Great Britain and spread to Western Europe and the USA during the eighteenth–nineteenth centuries). Industry 1.0 introduced the concept of mechanical mass production by using steam-powered machines while the first mechanical loom (around 1784) appeared (Campbell, 2010; Lachana et al., 2018). During that period, significant political developments took place such as the French Revolution and the US Constitution. Democracy (post-kingdom democracies) also made its appearance in the working classes and their working conditions with significant changes in the legislation of countries. That was when we first met the first generation of Government, Government 1.0, with the division of labour and the first economy rules. With the introduction of the division of labour and mass production with the help of electrical energy (1870–1914), the second IR was carried out. The second IR led to major technological advances, the light bulb, the telephone, the internal combustion engine, the phonograph, and the first assembly line used on a large scale by the meat-packing industries of Chicago and Cincinnati during the 1870s (Kanji, 1990; Mokyr, 1998). During the same period, the first post-empire democracies around the world appeared, and the second evolution of the government (Government 2.0) was "part of the history". This new generation included processes, bureaucracy, management science, workflow, project management, logistics, and typewriters. Another century passed, and it was then when the third IR arose (known, also, as the Digital Revolution). The third IR is the shift from mechanical and analogue electronic technology to digital electronics through the use of electronic and information technology systems that further automate production. The first programmable logic controller (PLC), Modicon 084, made its appearance during 1969, and further advancements include the Internet, personal computers, and ICTs (Australian Government 2.0 Taskforce, 2009). In other words, the third IR took advantage of distributed communication systems such as the Internet (Web evolution, social networks, collaboration, and distributed renewable energy transforming the world, the economy, and the energy (Rifkin, 2011)). During the same period, the new generation of government, Government 3.0, was developed with the integration of computers, information systems, software, the Internet, interoperability standards, and mobile devices. This new era involves the appearance of the terms we mentioned before: Digital Government, Digital Governance, divided into the three Government Generations (Digital Governance 1.0, Digital Governance 2.0, Digital Governance 3.0) and Digital Transformation.

While Digital Government refers to the use of ICTs by governmental bodies/agencies to deliver better services to businesses and citizens (or even internally), the broad definition of Digital Governance is the advanced use of ICTs as enabling tools for enhancing organizational efficiency (Bakry & Alfantookh, 2006). These two terms may cause confusion, and they are commonly thought to be exactly the same with the same meaning, but in fact, they are totally different. Based on Bryat (2018), we can easily differentiate these two terms by using two (2) words. Digital Government refers to the structure while Digital Governance to the functionality, thus Digital Governance is a term that is a superset of Digital Government.

Plato (428–347 BC) the Greek philosopher and innovator, who is still considered to be an important figure in the history of Western Philosophy, was probably the first who found scientific elements in governance. Plato's work covers a broad spectrum of subjects such as justice, courage, love, duty, nature, religion, and science. His work, which has been saved in the form of philosophical dialogues, has exerted a huge influence on ancient Greek and Western philosophy. In one of his dialogues, Politicos (in Greek «Πολιτικός»), Plato claimed that governance is a science and particularly "… the science of governance, this most difficult but also the most important of all …". This statement reveals the belief that Governance may be a scientific domain, and the study of it is then a necessity for those who will lead.

Nowadays, 2400 years after Plato's death, we attempt a similar postulation: that Digital Governance may have scientific characteristics. By now, it is apparent that at least some problems concerning the needs of public sector organizations were either susceptible to similar resolution or even predictable. Substantial progress has been made through research in many areas, yet the lack of scientific foundations in the Digital Governance domain seems to hinder unlocking the real transformative value and full potential to all its stakeholders, from administrations to researchers and industry. By organizing and documenting the existing knowledge of the domain, there will be a lot to be gained for societies and administrations. Such a movement will eventually lead to more repeatable and effective solutions to identified problems of administrations, reducing the problem-solving time, and enhancing the possibilities of successful outcomes.

The present chapter contributes towards the establishment of Digital Governance and Transformation Science Base, which is expected to evolve over time. The current research was conducted using a systematic literature review methodology and frequent deliberation with the scientific community, trying to answer why we need, what is the structure of and how we can develop such a scientific foundation.

The rest of this chapter is structured as follows: the necessity of establishing the DGSB and the landscape of the Digital Governance era is presented in the second section. The third section presents the followed methodology, while the fourth section presents the three stages of developing a science base. An analysis of the key ingredients of the DGSB is presented in Sect. 5, while Sect. 6 presents the steps followed for the evaluation of the initial design, leading to Sect. 7—the conclusion of this chapter.

2 State of the Art

"What is science" is a question answered by many researchers (even though it is difficult for someone to define science precisely), without them using the same definition, but they do agree to the same point. Science (from the Latin word "Scientia", meaning "knowledge" (Sarkar & Pfeifer, 2006)) is a process to gather knowledge based on evidence, to answer questions and find solutions to trivial or non-trivial problems by the use of method (Bohm, 1977; Popper, 1960; Sund & Trowbridge, 1967; The Science Council, 2009). In short, science aims at creating scientific knowledge by approaching the truth rather than claiming the absolute truth. The term "scientific knowledge" is defined as "original scientific research results, raw data, metadata, source materials, digital representations of pictorial and graphical materials, and scholarly multimedia material" (Redalyc et al., 2003; Sitek & Bertelmann, 2014) or based on Webster's Dictionary (1989) as "a branch of knowledge or study dealing with a body of facts or truths systematically arranged and showing the operation of general laws" (Poole, 2017). Based on the book "Philosophy of Science" (Sarkar & Pfeifer, 2006), five criteria need to be met for someone to obtain this kind of knowledge (trimmed object; rigorous language; democratic knowledge; knowledge which is controlled by logical forms—inductions and deductions and capability to foresee new phenomena). The word curiosity and a series of thoughtful practices to satisfy this curiosity by studying, listening, watching, documenting, and experimenting are what lie behind science (Campbell & Campbell, 1952; Doumeingts et al., 2009; Popper, 1960).

Furthermore, science has its one five fundamental principles:

1. Impartiality: Evidence, results, and the science itself should be unbiased. A clear distinction between an opinion and a fact should exist (Jevons, 1874; Watkins, 1948).
2. Open mindedness: A science is expected to evolve over time. New or even unexpected discoveries are the outcomes of this evolution. Open mindedness refers to the willingness to accept all these unexpected discoveries (Parratt, 2014).

3. Reproducibility/transparency: Each experiment, as well as the followed method(s) to conduct each experiment, should be described in detail. Reproducibility or else transparency refers to an experiment's capability to be repeated for the same results to be scrutinized by others, and thus dishonesty will not be tolerated (Pearson, 1957).
4. Collaboration: Every aspect of any science should be published and disseminating. The scientific community should be there since science be built only in small incremental steps, with each successive primary research study building on the previous one (Charalabidis & Lachana, 2020a, 2020b; Staver, 2008).
5. Clarity and precision: Clarity and precision are results of definitions, standards, and patterns that are delimited after drawing conclusions from research and observation. Standards, patterns, and definitions are main components of any science (National Academies of Sciences, 2019; Silverman, 1989).

Feynman (1969) described the relationship between science and scientists in one sentence "*Science is the belief in the ignorance of experts*". In other words, scientists are the "neck" of science, the bridge which unites the science to the body of knowledge. Hence, these fundamental principles can be considered the characteristics and attitudes that scientists should also have. Scientists continually observe, test, and modify the body of knowledge (Zapf & Dror, 2017) by following scientific methods to design patterns, to define standards to satisfy their curiosity, and solve problems. There are several scientific methods for approaching the truth, each one of them, or even a combination of them, can be used or applied by scientists in a different wide range and circumstances (e.g. methods for analysing results or for carrying out investigations).

If reality is complex, it is up to science to complexify its models, highlight the relevance of relationships, and propose a knowledge capable of addressing the most emblematic issues that society needs to continue constructing its history.

A Science Base (or scientific base) builds and organizes the knowledge that consists of the theories, principles, axioms, and concepts of an area (Charalabidis, 2014). Except for its own knowledge, a Science Base should underlie axioms and principles combined with the arose knowledge from other related domains. Moreover, it should be a structured, ordered, and semantically searchable body of knowledge so that other researchers (or non) can use it to provide solutions to any problematic situation.

Which are the requirements for the establishment of the Science Base of a scientific domain? Apparently, this is the second question of major importance that needs to be clarified. For this to happen, several decades of evolvements are needed as well as two characteristics (Curd & Cover, 1998): (1) The domain should be more progressive than any other theory over a long period of time to face unsolved problems, even the ones that it foresees that it will face, and (2) the community of this domain should make great efforts for developing theories and practices by examining, observing, testing, and evaluating (confirmations and disconfirmations should be considered) the results with a view to long-term problem-solving, as opposed to short-term solution provisioning.

To clarify whether the Digital Governance and Transformation field is mature enough, to lay the groundwork for the domain's scientific foundations, we need to focus on analysing the State of Play.

There are thousands of initiatives funded in Europe by the European Commission. Between 2014 and 2020 it is estimated that more than 80 bn euros were funded for research in the field, while it is estimated that in the days to come, the fund of more than 1.5 trillion for the same purpose between 2021 and 2027 will be announced.[1] Through the initiatives, the European Commission aims to derive a better status for all EU governmental bodies in Digital Governance and Transformation by promoting sustainable development and enhancing the quality of living. With the same point of view, until now, trillions of dollars have been funded by the US Federal Government to similar initiatives on the field. One of the most typical examples is the e-Government Act of 2002 that aims to improve the Federal Government services and promote them to the citizens and business.

An interesting EU initiative in the field is the "Scientific foundations training and entrepreneurship activities in the domain of ICT-enabled Governance-Government 3.0", which sets up the third generation of e-Government, the Government 3.0 (Pereira et al., 2018). This initiative aims to set up the Government 3.0 field and attract new researchers through an entrepreneurship competition, bridging the Digital Governance and the Entrepreneurship fields and lays the groundwork for researchers' next generation by developing free online courses. The main objectives of the Government 3.0 project are to develop the research roadmap (Wimmer et al., 2018), new curricula (Sarantis et al., 2019) for pre-and postgraduate as well as for company executive levels, and new approaches for fostering entrepreneurship attempts through competition in the domain (Pereira et al., 2018).

Many international scientific conferences on the domain have played an important and crucial role in the domain's evolution. Scholl and Dwivedi, in their research (Scholl & Dwivedi, 2014), revealed that, since 2000, both the conferences' number and thus the number of the studies on the field have increased. Each conference is divided into different thematic tracks, with hundreds of them being on the Digital Governance and Transformation domain per year. Each scientific research presented and discussed in a conference "lays the stone" towards the domain's scientific foundations.

The Digital Government Reference Library (DGRL, previously named EGRL—Electronic Government Reference Library) was developed in 2005 by the University of Washington and was publicly released in 2006 (Scholl, 2019). It is a unique database that today (version 16.0) contains more than 13,000 scientific publications in Digital Governance and Digital Government. The purpose of the DGRL is the unhindered and free access to the domain's knowledge improving the quality of research (Scholl & Dwivedi, 2014). Imagine how much knowledge of the domain is hidden among this enormous number (but can be found) and how much exists.

A widely general overview of the Digital Governance and Transformation State of Play is presented in this section. Still, if we thoroughly examine the "numbers" (the

[1] https://ec.europa.eu/commission/presscorner/detail/en/QANDA_20_2088.

thousands of scientific papers, the hundreds of tracks, etc.), what might be included in each one of these thousand scientific papers, we will fully understand the domain's maturity. There have been many defined theories that have been used in the field (e.g. structuration theory, diffusion theory, critical success factors, theory of planned behaviour), many research methods in use by the researchers of the domain (e.g. no discernible method, questionnaire, interview, document analysis), best practices (e.g. smart cities—Estonia) or even applications of new technologies in addressing problems and new ways of service provision and many more.

3 Methodological Framework

For this study to be conducted, a variation of the systematic literature review methodology was adopted to review and analyse scientific papers. A systematic literature review identifies, evaluates, and interprets available research relevant to a particular research question or an interesting area (Bigdeli et al., 2013; Kitchenham et al., 2009; Safaron et al., 2017). The entire process of identifying literature and then selecting the relevant ones for the final analysis is objective in nature and repeatable (Singh et al., 2020).

The research questions that are explored are as follows:

Research Question 1 (RQ1): Why do we need a Digital Governance Science Base?
Research Question 2 (RQ2): What are the contents of DGSB?
Research Question 3 (RQ3): How can the Science Base be developed?

Part of the systematic review to identify the relevant literature is the development of a search strategy. For this purpose, derived key terminologies are extracted from the research questions, including also any synonym and substitute of these terminologies. The research was conducted in the Scopus database, and both "AND" and "OR" operators were used. To be more precise, the used searching terms/criteria were as follows:

(ALL ("science base" foundations) OR ALL (foundations "scientific domain") OR ALL ("Scientific foundations") AND TITLE-ABS-KEY ("Name of a Scientific Domain")) AND DOCTYPE (all).

Each word included in the "Name of a Scientific Domain" search field was based on a list retrieved from the Web of Science.[2] The research was conducted from March to May 2020. The title, source title, author(s), abstract, type of publication, and the year of publication were the extracted information of each publication. A number of additional criteria were determined to select appropriate studies for inclusion in the review. To be included in the review, articles should:

[2] https://images.webofknowledge.com/images/help/WOK/hs_research_domains.html#dsy5469-TRS_technology.

(a) be published in a peer-reviewed journal or conference proceedings,
(b) have more than 80 citations,
(c) present research about the above-mentioned research questions,
(d) be accessible in full text,
(e) be presented in English,
(f) not duplicate with articles from other databases.

After filtering, the article set was narrowed down to 62 articles. All these eligible publications were manually read to check their relevance. An evaluation based on the full-text reading reduced the number of articles to 58.

Based on the outcomes of the previous steps, a thorough examination of each one of the scientific domains was conducted to understand their philosophy and to identify their key ingredients and components. The initial proposals stemming from literature on the contents, structure and methods of the Science Base were then put under the scrutiny of the scientific community.

During a number of dedicated workshops, held in conjunction with Digital Governance conferences, such as DG.O, ICEGOV, ICIS, EMCIS, EGOV-CeDEM-ePart and the Samos Summit, more than 200 experts and, researchers and practitioners contributed with their critique, corrections and new ideas. The elements presented in the next sections are the result of the above analysis, hypothesis and deliberation process.

4 The Three Stages of Developing and Establishing the Digital Governance and Transformation Science Base

Previous attempts to develop a scientific base in an existing domain, like Software Engineering (Redwine, 1985) and Enterprise Interoperability (Charalabidis, 2014; Jardim-Goncalves et al., 2013) revealed three main stages of activities for developing and establishing the scientific foundations of a domain. These stages for the Digital Governance domain are presented below.

Stage 1: Development of the DGSB Basic Structure

The first stage aims to accomplish two goals: (1) the identification and description of the domain's problems along with their linked solutions and (2) the establishment of the domain's research community. In other words, Stage 1 lays and builds the foundations of the DGSB structure. On these foundations, and after establishing the initial structure, the community will work on, and consultations and public discussions among the stakeholders will let the DGSB evolve continuously. Thus, this stage's division into two steps seems inevitable, for its proper implementation as a meticulous and concise structure to minimize the risk of following a wrong path and ending up with a non-applicable and unrealistic result.

The first step focuses on collecting and analysing the domain's knowledge (the foundational principles), while the second step on the formulation of the concept and the initial steps that should be taken by the community in the sense of establishing solid and inclusive definitions of the domain's key problems identified during the previous step. The word knowledge includes all the principles, the rules, the methodologies, the basic ideas, the concepts, and the formal approaches developed in the domain, including all the borrowed—knowledge from the neighbouring domains that the domain uses. The first step will reveal the initial taxonomy of the DGSB domain. The initial taxonomy, in turn, will formalize the problems and the solutions per research area in the sense of alternative (sub)-taxonomies of the domain's structure. The first step will reveal the initial DGSB taxonomy. The initial taxonomy, in turn, will formalize the problems per research area. The problems' taxonomy, combined with the set of accumulated knowledge, will empower researchers' ability to identify, describe in a common language (using common terms) the problems, and identify specific solutions (solve other similar problems, e.g. by using specific methodologies followed, good practices). Thus, this will result in alternative (sub)-taxonomies of the field's structure (problems and solutions taxonomies).

On this basis, the second step that aims at establishing the research community will be developed in parallel through the necessary actions taken by the domain's researchers to publish the above results. Various stakeholders will be involved during this step, even from neighbouring research areas, and the community will grow.

Stage 2: Hypothesis and Experimentation

Stage 2 builds upon the first stage but in a reusable and scalable way to stabilize the results. It focuses on the two resulted taxonomies, while its focal points are experiments and simulations to foster discussions among the stakeholders. Hence, consensus will be reached, and more challenges will be identified. Simultaneously, any recommendations will be reported and analysed by the researchers, which will lead to the improvement of the first stage's results. Thus, the existing structure will be enriched with scenarios, developed approaches, experimental applications, etc., creating two new classifications of problem-solving tools and methods used both for a problem detection and solving. On this basis, the application of technologies to real problems that have already been identified in the field of Digital Governance will also be examined. In order to stabilize the results, the creation and integration of an educational programme are considered equally necessary. In conclusion, the results of the second step that will prepare the third stage for the popularization of the DGSB are the bridging of problems and solutions with tools and methods and the development of educational programs that analyse the domain's knowledge, laying the foundations for a new generation of researchers who will continue, and promote field research.

Stage 3: Empowerment

The last stage aims to strengthen the DGSB through proper liaisons with the scientific, research, and stakeholders' communities, emphasizing and highlighting value's substantiation. It seeks to inspire the new generation of scientists that will promote and advance research on the domain, design a comprehensible manuscript documenting the identified problem/solution paths, and identify research priorities. For the above to be achieved, it includes steps for publicizing and communicating the scientific basis to the wider society, presenting the results of the previous actions. In addition, it provides for the integration of exported educational programs in university and vocational training programs. An essential element will also be related to the completeness of the approach, implementing end-to-end Digital Governance solutions, and covering issues in a sustainable way.

5 Digital Governance Science Base Key Ingredients

The identification of the DGSB key ingredients was a result of the third thorough analysis of the selected studies along with the three stages. The analysis resulted in 11 key ingredients, nine of which answer the three "crucial questions of Metamodeling", mentioned by Kokol (1993): Why? What? and How? The answers to these questions seem to be simple and clear, but in fact, they are more complicated (Brooks, 1994).

The key ingredients of DGSB are presented below in Fig. 1 and explained in the following paragraphs.

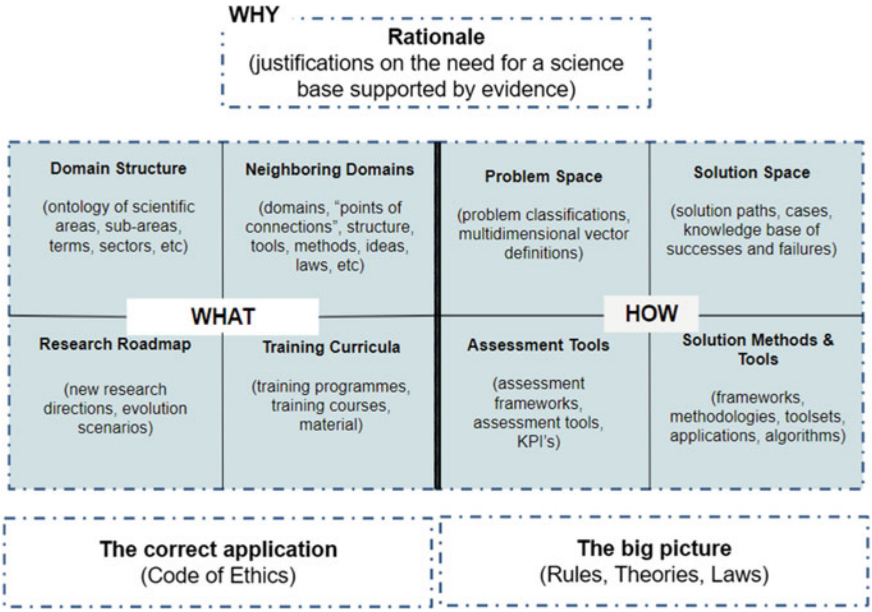

Fig. 1 Digital governance science base—key ingredients

Rationale (Relating to RQ1: Why Do We Need a Digital Governance Science Base?)

The rationale behind Digital Governance and Transformation Science Base constitutes the first component as well as the answer to this question. Generally, rationale, "the tool" for diagramming reasoning on any topic (Van Gelder, 2007), clarifies the importance of the existence of a domain as it offers a thorough overview, analysis, and interpretation of the Science Base's objectives covering, also, the aspects of its development and maintenance. Regarding the Digital Governance domain, establishing its Science Base will lead the public sector to effective and systematic solutions to identified issues. At the same time, it will reduce the problem-solving cost and time.

Domain Structure (Relating to RQ2: What Are the Contents of the DGSB?)

The domain structure element constitutes the second component of the DGSB. It provides in-depth and comprehensive knowledge and understanding of the field, a decomposition of the domain. It is simple but flexible enough to be convincingly deep if needed, allowing different analysis levels or even abstractions. There are different views, myriads of different viewpoints, and thus experts of the domain could always have different views on some issues.

There are many lexicons, several taxonomies, and few ontologies of how the Digital Governance domain is structured. One of the main aspects of the domain structure is the "Areas." The view of Areas as a tree corresponds to the Digital Governance Area Taxonomy since they have a title, definition(s), links, etc. Each Area corresponds to a specific topic of the domain, and it can be analysed into subareas at an infinite level (e.g. interoperability → legal interoperability, organizational interoperability, semantic interoperability, and technical interoperability. Each one of them can be analysed into sub-levels). Each Area belongs to one or more Streams. **Streams** are elements where Areas are classified without them sharing common terms. Apart from the "Areas", Streams correspond but also enlarge to information systems elements as described below:

1. Process and regulation: consist of series of activities, rules or regulations controlling efforts to achieve a desired outcome or goal.
2. Data: semantic elements, raw or organized information of any type and form.
3. People: the human element, users, citizens, employees, etc.
4. Infrastructure: technologies, systems, devices, and applications, a combination of software, hardware, networks, etc. (including all IT-related equipment).
5. Intelligence: specific combinations of processes, data, people, and infrastructure that simulates properties of the human mind.

Four additional domain structure elements were identified. Among them, the **Digital Government's Generations** known as Government 1.0, Government 2.0, and Government 3.0 could not be missing. The element **Generations** is an identifier of the Digital Governance field's significant movements, corresponding to the field's evolution over the years. A Generation may include several Areas and vice versa. Each Area corresponds to one or more Generations. An additional element is

"**Collectives**". Collectives are arbitrary, well-coined, and recognized identifiers that act as sets of Digital Governance Areas. Smart cities constitute a typical example of Collectives since it contains several Areas. **Verticals**, the third additional element, are sets of Areas in the same sector of the economy or society (e.g. eHealth, eJustice, etc./each containing several Areas). Last but not least, **Sectors** are well-known economy or society sectors, where verticals are classified. These five elements are linked to each other and describe the aspects of the Digital Governance and Transformation field.

Research Roadmap (Relating to RQ2: What Are the Contents of the DGSB?)

A research roadmap illustrates the link between the past and future. A research roadmap acknowledges the state-of-the-art and future research challenges/issues of Digital Governance. These challenges can be presented in the form of a research roadmap without favouring any specific solutions. The purpose of the roadmap is to address newly emerged developments in the field. At the same time, it outlines and sorts out the activities (research or technological training) that the research community should take.

Furthermore, based on the roadmap, new research can be conducted on the emerged identified topics. It supports the formulating of the research community since it demands close collaboration among the stakeholders to ensure that research generates practical impact and contributes to the DGSB evolution. In other words, a roadmap is an extended look at the future of a chosen field of inquiry that sets the action plan (the "what next?") by identifying the research objectives it aims to meet. There are many research roadmaps in the literature (e.g. Mureddu et al., 2012, 2020; Ronzhyn & Wimmer, 2018; Wimmer et al., 2018; Zaoui & Souissi, 2020). In addition, Gartner, on its "hype cycle for digital government technology 2019" (Fig. 2), reveals all the technologies that are expected to have the most impact on the public sector in the next 5–10 years (Moore, 2019).

These roadmaps involve the disruptive technologies in the Digital Governance and Transformation domain while they reveal the future research and training needs of their adoption by the public services.

Neighbouring Domains (Relating to RQ2: What Are the Contents of the DGSB?)

There is not any scientific domain that stands alone. Thus, Digital Governance needs to be analysed together with a selection of established and emerging neighbouring scientific domains that can provide useful knowledge and inspire the development of its scientific base. In a few words, "Neighbouring Domains" refers to the recognized interdependencies among Digital Governance and other scientific disciplines. Neighbouring domains constitute the already established knowledge, while the principles that arise from them are the lessons learned from the history of sciences and can be applied to the DGSB.

Until now, based on many deliberations conducted during the last 2 years in various international conferences (more are presented in Sect. 6), 11 neighbouring domains were identified. Particularly, these are (1) Social Science and Humanities, (2) Law Science, (3) Management Science, (4) Economics, (5) Computer Science,

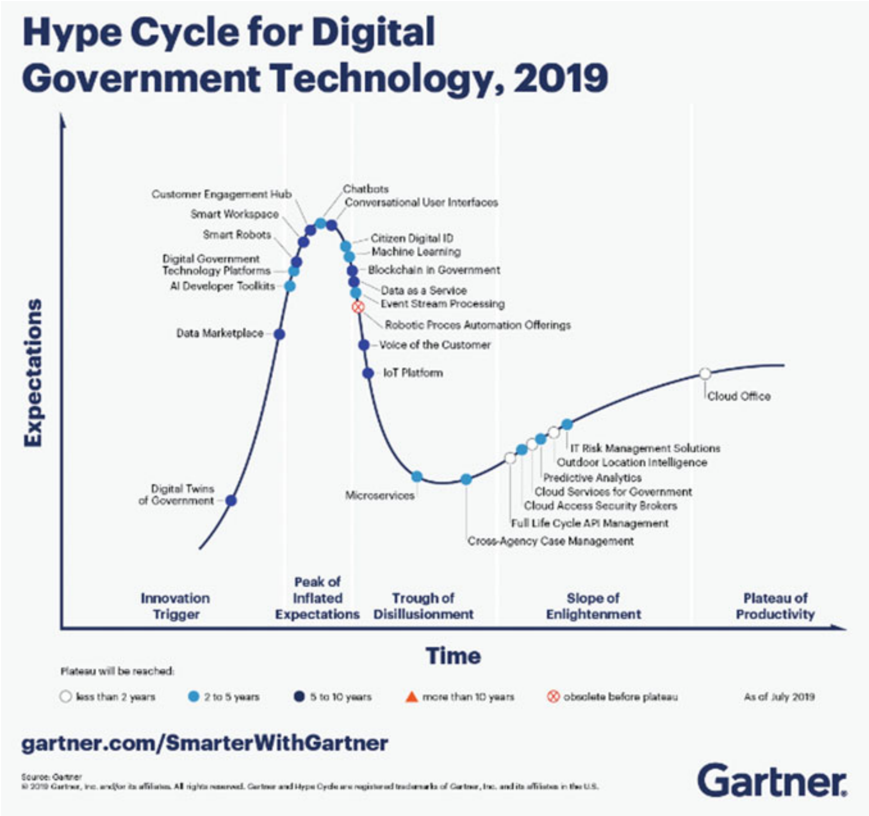

Fig. 2 Gartner Hype Cycle for Digital Government Technology, 2019. Retrieved from https://www.gartner.com/smarterwithgartner/top-trends-from-gartner-hype-cycle-for-digital-government-technology-2019/

(6) Digital Economy, (7) Political Science, (8) Sociology, (9) Psychology, (10) Philosophy/ethics as well as (11) Development Theory, which are part of the DGSB neighbouring domains.

The neighbouring domains are adjacent to specific parts of the DG Domain Structure. Thus, a Cartesian product (at least 11 × 100) is needed to analyse neighbouring domains' proximity to DG areas. To understand the previous statement, think of the Open Data as a selected Area. While Computer Science is a directly involved neighbouring domain from which you can absorb lessons, Psychology is not.

In addition to the above, a further analysis by the field's researchers on the neighbouring domains ingredient is deemed necessary to:

(1) Confirm that the above-mentioned scientific fields are indeed elements of this component;
(2) Include all the established and emerging neighbouring scientific domains.

Thus, the following concrete methodological steps are suggested:

Step 1: Identification of the Already Established Methods Used in the Digital Governance and Transformation Domain

The first step concerns the identification of the following five elements: (1) research approaches, (2) research methodologies, (3) theories, (4) analysis methods, and (5) techniques that are used in the Digital Governance domain (e.g. qualitative research (Jackson et al., 2007); observational research (Crabtree et al., 1999); quantitative research (Muijs, 2010); sampling (Sharma, 2017); action research; web content evaluation/analysis; conceptual modelling methods/conceptual model (Wahid, 2012); bootstrap method (Efron & Tibshirani, 1994; Huang & Xia, 2017); data collection methods (Crabtree et al., 1999)).

Step 2: Identification of the Already Established Scientific Domains

The second step refers to the analysis of the science's branches following the same approach as Step 1. After identifying all the scientific domains, a concrete analysis of the five above elements used for each one of them is needed.

Step 1, as well as Step 2, will result in two different lists or tables.

Step 3: Identification of the Common Methods Used in the Digital Governance Domain and the Other Scientific Domains

The final step examines which of these five elements are commonly used in the Digital Governance domain along with the identified scientific domains. This step is of paramount importance as it will directly assist in designing the neighbouring domains component. This step contributes to revealing the domains (neighbouring domains) that Digital Governance and Transformation interact with. These domains disclose the "lessons learned", what we can adopt, and where we should pay attention.

Training Curricula (Relating to RQ2: What Are the Contents of the DGSB?)

Training Curriculum is just as of significant importance in all Science Bases as it is in the DGSB. It is the groundwork for the next generation of researchers and practitioners, which will advance the knowledge and the practical contribution in the domain. Training Curricula contribute to creating a new training culture that will breed a new generation capable of leading both the development of new research paradigms in Digital Governance and Transformation, as well as fostering the creation of new services and industries. It is connected both to the structure domain and the roadmap, while neighbouring domains, as well, are of the same necessity to be part of it. The Training Curricula element aims to advance research on the domain by making known all field's aspects. At the same time, it empowers researchers' ability to identify, describe the problems, and identify specific solutions. It is a means to inspire the new generation of scientists who will promote and advance research on the domain.

Problem Space (Relating to RQ2: What Are the Contents of DGSB?)

A sequence of activities is needed for a problem to be solved, starting with identifying and understanding the "as-is" situation. The "problem space" component is the mirror of the "as-is" situation, a taxonomy of the spectrum of the main application and theoretical problems and challenges that have to be addressed by the domain, organized to be used to characterize the "real-life" application. It constitutes an *n*-dimensional space assessment/situation pattern that denotes problematic situations that (usually) need improvement for a specific subject. It is formulated by a brief description of the problem and a typology, pinpointing the problem's nature, which uses assessment methods and tools.

Assessment Tools (Relating to RQ2: What Are the Contents of DGSB?)

The assessment tools identify existing problems in government agencies, e.g. concerning the exploitation of ICTs to support, transform, and enhance their essential functions.

The main aspects of the assessment tools are as follows:

(1) **The Subject**: The subject of an assessment may be a service, or a system (composed of services but also including other stuff), or an organization, people (their skills, their behaviour, their opinions, and more), a city of a country, a region of a country, a country or even a continent, a set of countries).

(2) **The Method**: A method can be (1) a manual process to produce the assessment results for the subject, utilizing the structure of the assessment method, carried out by non-experts. It may include digital inspection of services or systems, sampling of opinions through questionnaires or interviews, and gathering data elsewhere, (2) an automated process, where the assessment results are produced by systems (sensors, information systems, web services, etc.) or even (3) a hybrid process, combining the above.
Regarding the manual assessment, the following postulation can be made: the manual "raw" assessment, by means of putting values to indicators (and not explaining what they mean), is not a process for experts (e.g. doctors). Trained personnel (e.g. laboratory staff) can do the job.

(3) **The Results**: The "assessment result" contains categories of indicators (including subcategories, sub-subcategories, and so on), indicators, and values of indicators. In other words, the results are a set of categories and indicators including their values (e.g. Fig. 3). An indicator can be measured as follows:
Indicator = (Code, Label, Measurement Unit, Measurement Range, Value)*, code can contain the category if it is properly designed.

(4) **The Time Element**: Or the timeline element. A timeline is a list of important events arranged in the order in which they happened. Timelines explain what happened during a certain period of time, starting with the earliest event and moving forward through time.

(5) **A Set of Rules Which Indicates the Quality of a Result**. It contains ranges for any kind of situation (e.g. good, normal, bad) or reveals any dependencies to other assessment tools.

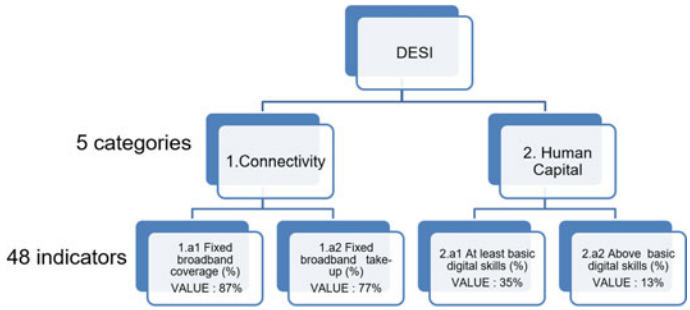

Fig. 3 DESI example

They are hundreds, and a few examples of these can be any established indicator (e.g. DESI,[3] eGov Factsheet,[4] EGDI[5]), research theories (e.g. structuration theory,[6] the theory of trust[7]), a service, a system or even a city.

Solution Paths (Relating to RQ2: What Are the Contents of DGSB?)

Understanding the “as-is” situation is of major importance, as it assists in identifying solution paths and specific solution methods and tools that allow the transition from the “as-is” to the “to-be” situation. The identification of the problem and the “as-is” situation are the two critical points of the «solution path» and the “solution methods and tools” components to follow.

As mentioned above, assessment results are seen as vectors, with n-dimensions, and thus a specific vector denotes the current situation of what is being measured. For example:

- $\text{DESI}_{\text{Greece 2020}} = (17\%, 31\%, 46, 67\%, 75\%, 99, 0, 32\%, \ldots, 93\%)$
- $\text{DESI}_{\text{Italy 2019}} = (14\%, 81\%, 46, 93\%, 70\%, 91, 4, 22\%, \ldots, 88\%)$
- $\text{IMAPS}_{\text{Passport Issuing, Greece 2019}} = (2, 4, 3, 0, 1, 1, 0, 0, 2, 2, 3, 4, 4, 3, 2, \ldots, 1)$

That leads to the need for corresponding standard patterns of “problems”, like.

$\text{IMAPS}_{\text{good service}} = (>2, > 3 >1, >0, >3, >3, >3, = 4, <3, 2–3, >3, 4, 4, 3, 2, \ldots, 1)$ or.
$\text{DESIEU}_{\text{average}} = (25\%, 35\%, 50, 67\%, 78\%, 99, 0, 32\%, \ldots, 90\%)$.
$\text{DESI}_{\text{Typical}}$ EU South $= (15–17\%, 20–30\%, < 45\%, 0, > 87\%, \ldots, 80–90\%)$.
$\text{IMAPS}_{\text{lack of technical interoperability}} = (–, –, –, –, –, –, –, < 1 < 3, < 2, –, –, –, –, 0, 0, 1, 1)$.

[3] https://ec.europa.eu/digital-single-market/en/digital-economy-and-society-index-desi.
[4] https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framework-observatory/digital-government-factsheets-2019.
[5] https://www.statista.com/statistics/421580/egdi-e-government-development-index-ranking/.
[6] https://www.britannica.com/topic/structuration-theory.
[7] https://plato.stanford.edu/entries/trust/.

The “solution path” component is the converse of the problem space. It provides a taxonomy of knowledge available that allows the identification of paths–directions for solving domain application problems. In turn, this assists in identifying links to specific solution methods and tools.

Solution Methods and Tools (Relating to RQ2: What Are the Contents of DGSB?)

The “solution methods and tools” component is a typology of methods and tools capable of solving any issue and aims at providing solutions to an identified problem.

For the analysis of the problem space and the solution paths, a systematic collection and analysis of all assessment methods and tools are deemed necessary. This also includes their categorization of what they measure, how they do it, what they produce, etc. This taxonomy of methods will be the DGSB set of “examination tools”. For each assessment tool, typical patterns (ranges of values for each dimension) should be defined. These patterns will constitute the “problem space”.

In addition, for a subject that needs transition from the as-is to the to-be situation, some part ways (or else a set of actions) need to be defined based on the literature, the knowledge, and the domain’s experts’ experience. This will constitute the “solution path”.

The road from the problem space to the solution path is a repetitive method, an iterative process. A public sector body needs to take various steps and go through various paths to move to the “to-be” situation.

Rules, Theories, and Laws

In any scientific field, laws, rules, and theories (laws from now on) are defined as detailed, analytic statements about a phenomenon, an observation, an experiment, etc., usually based on an empirically defined constant. Such scientific laws should always be applied under the same conditions and imply the causal relationship between the elements they contain. In general, laws are applicable rules or guidelines (dos and don’ts) based on observation and rationalization, on specific assumptions. Since a law is the distillation of continuous observation results around specific issues and cases, its applicability is generally to circumstances either resembling or cases that have already been observed. Scientific laws must be widely accepted and confirmed through the process of inductive reasoning.

Code of Ethics

The code of ethics is a guide of principles designed to help anyone conduct anything honestly and with integrity. A code of ethics document may outline the mission and values, the way of approaching problems, the ethical principles based on the core values, and the professional standards. Government ethics constitutes the application of ethical rules to those who govern. It refers to ethical behaviour and the approach of organizing the processes and rules of governance that show concern for citizens and is transparent and accountable. It is that part of practical jurisprudence, or the philosophy of law, that governs the operation of government or a business and its relationship with the people that it governs. But it is more than that. Like the rules, laws, and theories, the code of ethics exists everywhere, in any Science Base and any technology.

6 Digital Governance Science Base Evaluation

Throughout the research, in its various stages, the results were presented to stakeholders. Until now, nine workshops have been held validating the insights coming out of the presented research in various international conferences with over 200 stakeholders' participation. Among them were professors, governors, undergraduate students mainly in the computer science field, postgraduate students in Digital Governance, and Ph.D. candidates and students doing their dissertations in Digital Governance and Transformation field or any other neighbouring domain. The countries where their given work is being performed were 90% within the European Union, and a percentage of ten were from the USA, Brazil, Colombia, India, and Mauritius.

To date, there has been a unanimous agreement from all participants concerning both the DGSB structure and the neighbouring domains that the research revealed, with some additions that of geography in terms of neighbouring domain and many different problem-solving methods. These additions were significant since the field's researchers' participation is needed as the first stage is revealed. During each workshop, an extensive analysis of the research results was conducted. After the end of the analysis, a questionnaire was distributed to the participants. Among all, each questionnaire was asking stakeholders about the severity and the rigour of the study. An open discussion of the results was followed in all workshops. During the discussion, the main focus was mainly on the importance of each element and its analysis. Critical remarks and discussions were also made on the methodologies to be followed for the next steps of this research which is the analysis of each field. Finally, it is essential to note that everyone agrees that the development of the DGSB is an important step that the field's research community should take.

7 Conclusions

Although Digital Governance has been recognized as a well-established research and practice domain studying the problems related to the needs of public sector organizations and proposing novel methods and frameworks for enhancing service quality and policy-making effectiveness through the advanced use of ICT, there are not any steps taken towards the establishment of scientific foundations of the domain. For the establishment of the Science Base, a coherent and vibrant community is needed which will make the knowledge that has been empirically observed by the experts, explicit as well as sustainable and extensible activities for ensuring advanced results. In this research, a first attempt towards the establishment of the DGSB has been made. Through comprehensive research, the first structure of the domain's Science Base is presented. In addition, the active participation of such a large number of stakeholders in the first steps of the research and the acceptance of the DGSB as a thought and, more importantly, as a fact is a positive accomplishment. The acceptance of the DGSB key ingredients (some of which were expected to be part of the DGSB) and the research that so far is considered rigorous revealed that we are on the right path. It was acknowledged that it could not be possible to fully cover the extension of such a research, concerning that a Science Base can be built only in small incremental steps with each successive primary research study building on the previous one. Kuhn (1962) in his book titled "The Structure of Scientific Revolutions" revealed and explained the five phases, a repeated cycle, of the process of scientific change. Based on his approach, DGSB is in its first phase, the "Pre-Paradigm" phase where the domain has already several theories and practices, but most of them are characterized as incomplete or incompatible since most scientific inquiry takes the form of lengthy books, as in many cases there is no common body of facts that may be taken for granted. Scientists' existence in the domain is a part of Kuhn's first phase, and they are the only "weapon" that can move DGSB to the next phase, contributing to the domain by establishing a widespread consensus on the appropriate choice of methods, terminology, and on the kinds of experiments.

For DGSB to obtain recognition and be scientifically rigorous, stakeholders within the domain's community should collectively undertake a concrete set of actions. Indubitably, stakeholders' backgrounds should be different, and any perspective or challenge should be highly examined. Within this framework, a step back should be taken to gather and analyse the developed content of the domain and then move to the next step, which is the publication of the results that leads to the public consultation among all interested stakeholders.

In this research, we mainly focused at covering the first stage of activities for the Digital Governance Science Base that is defining its key elements and initiating the second stage (hypothesis and experimentation). The completion of stage 2 and the exploration of stage 3 (further empowerment and exploitation of the Scientific Base) are subjects of further research. Technology in combination with new scientific knowledge may lead to new discoveries and applications.

The next steps along the proposed approach include analysing each key element separately and the continuation of work along the stages to further expand the results in a sustainable way. As a matter of course, knowledge exchange among various stakeholders, including neighbouring scientific disciplines, should be present throughout the research. The main beneficiaries of this effort will be the public sector, industry, citizens and the researchers. Like many other scientific domains, it is expected that the Digital Governance Science Base will evolve over time, based on the empirical findings, and probably it needs several decades, in order to be fully established as a science, as Plato postulated, more than 2000 years ago.

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Digital Governance as a Scientific Concept

Tove Engvall and Leif Skiftenes Flak

Abstract The term eGovernance has been used for almost 2 decades and suggests a relationship between some electronic—or digital—aspects and governance in a traditional form. Several scholars have pointed out that eGovernance has been defined and used in a number of ways in the academic discourse. This is problematic as it may hinder the development of cumulative knowledge and robust theoretical constructs. To investigate how eGovernance has been used and understood, we reviewed the eGovernance and digital governance literature to identify the theoretical foundations and to understand variations in the use of the term. Our overall objective was to contribute to a consolidation of the understanding and use of the term. This chapter suggests that there is considerable variation in how eGovernance is understood and applied in the literature. Recently, some argued that eGovernance has evolved into the term "digital governance". Although there seem to be more theoretical contributions related to the concept of eGovernance and the digital aspect of digital governance has been slightly more elaborated, we found no clear conceptual distinctions between the two concepts and used digital governance for our conceptualization. To provide clarity, we posit that *governance* and *digital* are basic elements of digital governance. Further, we found that digital governance is typically either studied with emphasis on the use of ICT in governance or on structural or normative transformational outcomes of digital governance. As a novel contribution, we suggest a definition of digital governance.

Keywords eGovernance · Digital governance · Concept analysis

1 Introduction

Development of concepts is a central part of the development of a scientific discipline. Concepts enable generalization and transfer of understanding. It can clarify phenomena and create order. Development of concepts and theory are intertwined.

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The better the concepts are, the better theories can be developed (Khazanchi, 1996). "In essence, conceptual development provides a means of crisply defining and elaborating ideas regarding certain phenomena" (Khazanchi, 1996, p. 1).

It is fundamental that concepts are clear and understandable, and there should be a strong underlying logic and rationale behind a concept and theory. A common problem though is that concepts are often interpreted in inconsistent and ambiguous ways (Conboy, 2009). There is rarely a clear agreement on their meaning, and the IS field has even more challenges due to its continuously changing environment and technologies (Khazanchi, 1996). The management information systems (MIS) field has for instance been criticized for its lack of a formal and consistent development, and a methodology for construct development in MIS is suggested by Lewis et al. (2005). They argue that in construct development, level of analysis and philosophical aspects with different levels of abstraction ought to be addressed (Lewis et al., 2005).

Characteristics of qualities of a concept are, for instance, clarity, parsimony, possible applications of the concept, theoretical glue and whether it is cumulative (building on research in the field) (Conboy, 2009).

Concepts and theories can be native or imported. A native theory for the IS field is a theory that is developed specifically for IS phenomena, while an imported theory is borrowed from another discipline (Straub, 2012). Concepts have an important role in different ways. Wand and Weber (1988) have for instance modelled information systems based on definitions on central concepts. It is used to formalize aspects of information systems, to develop requirements for information systems, formalize the representation (of the real world) and perceived system and develop a theoretical foundation for decomposition (Wand & Weber, 1988). Information systems (IS) theories have also been categorized according to five types that provide analysis and description, explanation, prediction, explanation and prediction or prescription (design and action) (Gregor, 2006).

A scientific foundation for the digital governance field has recently been requested (Charalabidis & Lachana, 2020a, 2020b), and conceptual development is an important element of such a foundation. The digital governance concept can be seen as an evolvement of the eGovernance (electronic governance) concept (Misuraca & Viscusi, 2014). Bannister and Connolly (2012) noted a decade ago that eGovernance had so far been used with considerable elasticity in the literature and that this is unfortunate as the consequence is that there is no agreed upon definition of the term. They especially emphasized the blurred lines between eGovernance and eGovernment and suggested that the two terms were often used haphazardly in the literature.

Over the years, a number of competing or overlapping terms have been suggested and used. In addition to the already mentioned digital governance, eGovernance and eGovernment, terms such as open government (Misuraca, 2006), joined-up government (Mundkur & Venkatesh, 2009), smart governance (Alotaibi, 2019) and digital era governance (Dunleavy, 2006) have emerged in the literature. While some of these may offer nuances or distinctions adding to the existing understanding of eGovernance, our fascination for developing new terms may also inhibit us from a deep necessary understanding of the basic terms and concepts in our field of study. Nevertheless, to be certain to include both early and recent developments, we decided to study both eGovernance and digital governance.

In light of the above, we wanted to investigate if Bannister and Connolly's concerns from 2012 are valid today or if there has been a clear conceptual consolidation of the field of eGovernance and digital governance. We were specifically interested in how the literature uses the eGovernance concept, but also how governance and technology are understood, and how this has evolved into the term of digital governance.

1.1 Method

This chapter is based on a literature review. A literature review enables us to build on and extend existing knowledge, discover what is already known and stimulate further research (Levy & Ellis, 2006). The digital governance field is a relatively young field and also an interdisciplinary field that draws on multiple theories, why literature reviews may seem to be a challenging task. Nevertheless, it is important for theory development to accumulate knowledge and for the distinctness of a field. Literature reviews can also be used to describe and analyse concepts (Webster & Watson, 2002).

This chapter is based on an inductive and interpretative study of the concepts eGovernance and digital governance. The aim of an interpretative study of concepts is to describe and interpret meanings of concepts and their definition, as it is formulated in written texts, and to formulate new definitions where it is needed (Nuopponen, 2010). The quality of an interpretative study of concepts, such as rigour and plausibility, relates to the interpretative ability of the researcher (Takala & Lämsä, 2004). The interpretation of concepts will be affected by research approach. Four types of interpretative studies of concepts have been identified: heuristic, theory-oriented, descriptive and critical. This study is descriptive, as it intends to develop understanding of the meaning of the concept of eGovernance, and partly critical, in a way that it has analysed assumptions and values embedded in the definition or description of the concept (Takala & Lämsä, 2004).

Two sources have been used for this literature review; the Digital Government Reference Library—DGRL (Scholl, 2020) and Google Scholar.[1] The DGRL is a database containing more than 14 000 publications in the field of digital governance and digital government. It is maintained by the University of Washington and is publicly accessible (Scholl, 2020). Google Scholar was chosen because it is a database that has a good coverage of scientific publications. Search terms that were used in the DGRL bibliography were "eGovernance" and "e-Governance", with the selection in title journals, and in title journals and books, and 145 articles were downloaded. Search in Google Scholar was made with the search terms "eGovernance theory" (with 21 articles selected) and "eGovernance definition" (with 13

[1] https://scholar.google.com/.

articles selected) to focus the search on theory and conceptual definitions (a search on eGovernance in Google Scholar gave 23 800 hits which was too broad). Articles that were journal or conference publications and that were related to definitions of eGovernance were included. The articles were read briefly, and certain parameters were put into a concept matrix in an excel sheet. Next, a selection was made where articles that had a definition of eGovernance were included. A new matrix was developed. The definitions of eGovernance were then analysed, and themes were identified. The main categories drawn from this as an understanding of eGovernance were "ICT in governance/government services" and "outcomes of eGovernance". The analysis is presented in text and tables. Finally, this was concluded with a discussion on contributions and limitations of existing concepts and understanding of eGovernance. After this, a search was made in both databases on digital governance, where 20 articles were selected from the DGRL database, and 14 articles were selected from Google Scholar. In our sample, we observed that there has been more theoretical development around the concept of eGovernance than the more recent digital governance.

2 Results

We reviewed a subset of the literature to understand its meanings. Our analysis suggests that for eGovernance, "governance" and the notion of "e" are fundamental concepts that in combination can lead to transformation of government structures, governance processes, relationships and effects. The result section is organized as follows. First, we outline different views on eGovernance. Then we explore how the literature has used governance and e as foundational constructs. Third, we outline the transformational aspects of eGovernance and discuss outcomes of eGovernance efforts. Finally, we discuss our results in light of the more recent term digital governance.

2.1 eGovernance

We identified a number of definitions of eGovernance in the literature we studied. There seems to be considerable agreement that eGovernance can affect, or for the most part, improve, governance by utilizing some form of digital technologies. However, when investigating how eGovernance has been described more closely, we identified distinct variations in what different scholars emphasize. Examples of definitions of eGovernance are presented in Table 1.

Our analysis of the different definitions of eGovernance suggests that eGovernance can be viewed in two distinct but interrelated ways:

- Use of ICT in governance/government services;

- Outcomes of eGovernance as transformations (e.g. service improvement, stakeholder involvement and participation).

These aspects are illustrated in the literature in different ways, and a synthesized understanding is depicted in Table 2.

Table 1 Example definitions of eGovernance

Example definition	Emphasis	Reference
"eGovernance means the utilization of internet and World Wide Web (www) for transfer of information and delivery of services from government to citizens"	Use of ICT in governance/government services	Din et al. (2017, p. 3)
"eGovernance may be defined as the delivery of government services and information to the public by using electronic means"		Barthwal (2003, p. 288)
"eGovernance or electronic governance may be defined as the delivery of government services and information to the public using electronic means, including the dissemination of information to the public and other agencies. There are three aspects to e-governance: – automating the routine government functions – web-enabling the government functions so that the citizens will have a direct access – improving the government processes so that openness, accountability, effectiveness and efficiency may be achieved. In general, it may be defined as 'giving citizens the choice of when and where to access government information and services"		Akotam et al. (2013, p. 136)
"eGovernance refers to new processes of coordination which apply the advancements of information and communications technology (ICT) to governance"	Functions of governance	Pathak et al. (2010, p. 2)

(continued)

Table 1 (continued)

Example definition	Emphasis	Reference
"E-governance is the application of electronic means to improve the interaction between government and citizens; and to increase the administrative effectiveness and efficiency in the internal government operations. Further, it is the application of information technology to the government processes to bring simple, moral, accountable, responsive, and transparent (SMART) governance"	Improvements and achievement of objectives	Ramadoss and Palanisamy (2004, p. 1)
"The UNESCO definition (…) is: 'E-governance is the public sector's use of information and communication technologies with the aim of improving information and service delivery, encouraging citizen participation in the decision-making process and making government more accountable, transparent and effective. E-governance involves new styles of leadership, new ways of debating and deciding policy and investment, new ways of accessing education, new ways of listening to citizens and new ways of organizing and delivering information and services. E-governance is generally considered as a wider concept than e-government, since it can bring about a change in the way citizens relate to governments and to each other. E-governance can bring forth new concepts of citizenship, both in terms of citizen needs and responsibilities. Its objective is to engage, enable and empower the citizen'"		Palvia and Sharma (2007, p. 3)

(continued)

Table 1 (continued)

Example definition	Emphasis	Reference
"eGovernance is a broader term (than eGovernment) that includes transformation on at least four levels. First, it involves the transformation of the business of government (e-government). Second, it involves a transformation in the operational definitions of the principles upon which governance is founded, shifting towards increased participation, openness, transparency, and communication (…). Third, it involves a transformation in the interactions between government and its (internal and external) clients (…). Finally, it involves a transformation of society itself, through the emergence of so-called "e-societies", made up of networks of relationships like citizen-to-citizen connections, as well as relations among non-government organizations (NGOs), built and sustained using electronic means"	Transformation at different levels	Pablo and Pan (2002, pp. 289–290)

The core characteristics of eGovernance are the use of ICT or electronic means in governance processes, including government services and interaction with stakeholders (Bah & Mansour, 2018; Barthwal, 2003). Services and interactions can be performed online via the Internet (Al Athmay, 2015; Din et al., 2017) and be automated (Ray & Mukherjee, 2007) to different extent.

It is common to include aims and outcomes in definitions and descriptions of eGovernance. ICT is viewed as a means to achieve certain objectives (van der Meer & van Winden, 2003), such as improved service delivery and interaction with stakeholders (Palvia & Sharma, 2007; Ramadoss & Palanisamy, 2004; Saxena, 2005), improved transparency, accountability, efficiency and effectiveness (Akotam et al., 2013; Ray & Mukherjee, 2007), as well as increased participation of stakeholders (Misuraca, 2006; Nyirenda & Cropf, 2009), enhanced democracy (Bubou et al., 2018; Saxena, 2005) and good governance (Lal & Haleem, 2002; Misuraca, 2006; Saxena, 2005). Technologies support interactions in a networked, online context (Meijer & Bekkers, 2015) and facilitate transformation and innovation at multiple levels throughout societies. New forms of leadership, coordination, communication and collaboration may emerge.

Table 2 Understandings of eGovernance

eGovernance understanding	Description	Example References
Use of ICT in governance/government services	ICT (or electronic means) is used in governance processes and in provision of government information and services, utilizing the Internet and WWW ICT enables automation and supports internal operation and external interactions	Din et al. (2017), Barthwal (2003), Bah and Mansour (2018), Pathak et al. (2010), Khanra and Joseph (2019)
Outcomes of eGovernance as transformations	eGovernance may transform both structural and normative aspects of governance, including governance processes and structures, relationships between stakeholders, values and means and methods to achieve governance objectives Common objectives are to improve efficiency, effectiveness, participation, transparency, accountability, responsiveness, good governance, democracy and economic development	Ramadoss and Palanisamy (2004), Pablo and Pan (2002), Palvia and Sharma (2007), Chen and Hsieh (2009), Akotam et al. (2013), Kalsi and Kiran (2015)

The concepts of eGovernance and eGovernment tend to be conflated and used interchangeably. For instance, eG*overnment* has been defined as “the use of ICT and its application by government for the provision of information and public services to the people” (Meyerhoff Nielsen, 2016, p. 109), while others describe eGovernance with the same meaning (e.g. Barthwal, 2003; Din et al., 2017). eGovernance is sometimes interpreted as an incorporation of technology in the traditional governance concept (Larsson & Grönlund, 2016), while others emphasize that in order to be considered to be eGovernance, it has to involve a transformation (Bannister & Connolly, 2012). When eGovernance is distinguished from eGovernment, eGovernance is seen as a broader concept that involve multiple actors, not just the operation of governments. eGovernance is also different from traditional public governance (Bannister & Connolly, 2012). It includes new forms of organization and leadership, communication and decision-making (Palvia & Sharma, 2007; Rubasundram & Rasiah, 2019). Sometimes eGovernment has a structural perspective, while eGovernance is more focused on processes (Bubou et al., 2018). eGovernance has a broader scope than eGovernment and includes different actors and relationships throughout society. eGovernance involves an active use of ICT to achieve certain outcomes that can facilitate transformation at multiple levels throughout societies and also how multiple actors relate to each other and take a more active role (Misuraca, 2006).

2.2 *Basic Elements of eGovernance*

eGovernance consists of two basic elements: "governance" and "e". This part of the chapter addresses how these elements are understood in the literature.

2.2.1 Governance

In the literature, governance is typically seen as a process, including steering, decision-making and policy-making. It tends to have an emphasis on relationships and *how* things are conducted (see Table 3 for an overview).

Governance is seen as a steering process (Misuraca, 2006), the authority to steer, control, influence or lead (Lal & Haleem, 2002).

> The word governance has its origin in the Greek language and it refers to steering (…). As an act of steering a people's development, Governance is about processes not about ends. While the study of "Government" is primarily concerned with understanding the institutional means through which public management is realized, "Governance" is concerned with the broader relationships between citizens and those institutions. (Misuraca, 2006, p. 210)

Governance includes processes of making and implementing decisions (Finger & Pécoud, 2003; Lal & Haleem, 2002; Singla & Aggarwal, 2014), who is involved and how account is rendered (Kalsi & Kiran, 2015). Governance includes processes in which groups articulate their interests, exercise their rights and obligations and mediate their differences. It includes.

> authority to steer, control, influence or lead in the management of a country's politics, economy and administration; the making and implementation of decisions (…); encompassing the state, but transcending the state by including private sector and civil society groups. Thus governance also implies a certain set of mechanisms, processes, and structures that guide political and socio-economic relationships and the articulation of interests; an enabling environment for social and economic development. (Lal & Haleem, 2002, p. 99)

In the Handbook on Theories of Governance, governance is defined as

> the process of steering society and the economy through collective action and in accordance with common goals. (Ansell & Torfing, 2016, p. 4)

Processes and institutions (both formal and informal) guide and restrain activities of a group and can be conducted in multiple sectors and include multiple stakeholders. Government is a subset of governance and has the authority to create formal obligations (Palvia & Sharma, 2007). Government can be seen as "an actor in the process of governance" (Bannister & Connolly, 2012, p. 8). Central activities of a government are regulation, service delivery and policy-making (Zwahr & Finger, 2004). Governance concerns the state's ability to serve citizens and other actors, as well as the manner in which public functions are carried out, public resources are managed and public regulatory powers are exercised, including interactions between government and social organizations and how they relate to citizens (Kalsi & Kiran, 2015).

Table 3 Understandings of governance

Governance understanding	Description	References
Steering	• Steering	Misuraca (2006)
	• Authority to steer, control, influence or lead	Lal and Haleem (2002)
Governance as a process	• Governance is about processes	Misuraca (2006)
	• Processes and institutions that guide and restrain activities of a group	Palvia and Sharma (2007)
	• “The process through which institutions, businesses and citizens groups articulate their interests, exercise their rights and obligations and mediate their differences”	Lal and Haleem (2002, pp. 99)
Managing policies and procedures	• Governance can be conducted in different sectors and can manage policies and procedures	Palvia and Sharma (2007)
Decision-making and implementation	• The process by which decisions are made and implemented	Akotam et al. (2013); Lal and Haleem (2002)
	• “The process whereby a society makes important decisions, determines whom they involve and how they render account”	Kalsi and Kiran (2015, p. 171)
	• Governance refers to decision-making processes in networks of public and private actors	Larsson and Grönlund (2016)
Governance relates to “how”	• Governance refers to how governments and stakeholders interact, how public functions are carried out, public resources are managed and regulation are conducted	Kalsi and Kiran (2015)
Relationships	• Governance is concerned with the broader relationships between citizens and public institutions	Misuraca (2006)
	• Governance includes multiple stakeholders	Lal and Haleem (2002)

Descriptions of eGovernance also include new processes of coordination (Pathak et al., 2010), planning, formulating and implementing decisions and operations related to governance challenges (Bubou et al., 2018), which point towards that governance implies processes of coordination, planning, formulating and implementing decisions and operations.

To sum up, governance can be seen as processes for steering in order to respond to common challenges. This includes decision-making, implementation and coordination that includes multiple actors. From an IS perspective, it would be beneficial with a structured outline of governance functions, in order to identify how information systems and digitalization can contribute to achieve governance objectives, as well as to further theorize the role of the "e" element.

2.2.2 Notion of "e"

Our analysis of the eGovernance literature illustrates that the notion of *e*, referring to something digital, is generally superficially dealt with. Apparently, the most common reference to *e* is *information and communication technologies*, *ICTS* or *ICT solutions*. However, some also refer to the *utilization of Internet and the World Wide Web*, *advanced forms of ICT*, *new technologies*, *electronic means*, *Internet-based technologies* and *computer networks*. An outline of how the literature deals with *e* is shown in Table 4.

The literature seems to rely on an assumption that *e* represents ICT and ICT networks as necessary enablers for positive changes to governance. In definitions of eGovernance, many authors in some way imply the use of ICT or electronic means in governance and government services. Some authors also refer to eGovernance as a process where ICT is used to automate procedures and interactions (Akotam et al., 2013; Gberevbie et al., 2016; Ray & Mukherjee, 2007), while others refer

Table 4 Notion of e

Notion of "e"	Description	References
Information and communication technologies Information and communication technologies (ICTs), especially the Internet ICT solutions	Electronic governance is the application of information and communication technologies (ICTs) for delivering government services through integration of various stand-alone systems between government-to-citizens (G2C), government-to-business (G2B) and government-to-government (G2G) services	Chen and Hsieh (2009) Singla and Aggarwal (2014) Bah and Mansour (2018) Finger and Pécoud (2003) Larsson and Grönlund (2016) Molinari (2011)
Utilization of Internet and World Wide Web	Similar to the above, but with emphasis on the Internet	Din et al. (2017) Garcia-Sanchez et al. (2013)
Advanced forms of ICT	No further description on what is understood with advanced forms of ICT	Haque (2002)

(continued)

Table 4 (continued)

Notion of "e"	Description	References
New technologies	No further description on what is understood with new technologies	Meijer (2015)
Electronic means	…to improve the interaction between government and citizens; and to increase the administrative effectiveness and efficiency in the internal government operations	Ramadoss and Palanisamy (2004) Marche and McNiven (2003)
Internet-based technologies	Direct online connection with the common people, entrepreneurs and other stakeholders	Khanra and Joseph (2019)
Computer networks	To permit expanded public involvement in policy deliberations, an area sometimes described as "E-governance" to distinguish it from service initiatives	Carlitz and Gunn (2002)

to the utilization of Internet for providing services (Akotam et al., 2013; Din et al., 2017; Garcia-Sanchez et al., 2013; Khanra & Joseph, 2019; Potnis, 2010; Singla & Aggarwal, 2014), or the use of technologies to support government relations and interactions (Bannister & Connolly, 2012; Carlitz & Gunn, 2002; Meijer, 2015; Meijer & Bekkers, 2015).

Some argue that *e* refers to the use of new or advanced technologies (Haque, 2002). While this may be true in several cases, one can easily point to eGovernance efforts utilizing mature technologies such as ERP systems or simple technologies such as apps, social media or discussion forums.

The representations of e in Table 3 can all be seen as coarse categories that offer basic understanding beyond indicating that ICT and ICT networks are integrated components of eGovernance. While the literature provides a variety of examples of ICTs used for eGovernance, we found few attempts to classify, categorize or theorize *e*. A notable exception is Bannister and Connolly's reflection that technology is not value free but rather ingrained with specific values that are likely to affect the outcomes of its use. We also found examples of categorizations. For example, Ramadoss and Palanisamy (2004) suggest a layered architecture perspective on technology.

In summary, our analysis left us with the clear impression that *e* is superficially understood in the eGovernance literature. This offers ample opportunity for future research to further define the digital aspect that can be used in further theory development.

2.3 Outcomes of eGovernance

This section addresses how eGovernance can be understood in terms of intended outcomes and as transformation—structurally and normatively. A central underlying assumption in the eGovernance literature seems to be that the combination of digital technologies and governance enables innovation or transformations in various areas, e.g. relationships, processes and structures, in order to achieve some desired outcomes or effects. eGovernance should also be understood in a context of technological development in a co-evolution with institutional development as well as societal changes and how collective problems are managed (Rossel & Finger, 2007).

2.3.1 Outcomes as Structural and Normative Transformations

Outcomes related to eGovernance can be categorized in terms of being structural or normative.

> Structural governance is defined to be the 'how' of government. It encompasses things such as processes, structures, lines of authority, laws, regulations, stakeholders, forms of communication and responsibilities – the mechanisms by which power is exercised, decisions made, policy is created or changed and its implementation achieved. Normative governance is the set of value-related features of structural governance including transparency, accountability, integrity, honesty, impartiality, efficiency and so on that governance is desired to enable, to possess or to deliver. Structural governance may be designed to support or achieve normative aims, but in itself it is about how something is done, not about whether or not the way it is done is efficient (or honest or fair). In summary, normative governance qualifies structural governance and structural governance may be, but does not have to be, designed to deliver or support norms. (Bannister & Connolly, 2012, p. 7)

We consider this a valuable, high-level distinction and discuss eGovernance outcomes in our sample in light of these two categories. Much of the literature is concerned with the transformational effects of eGovernance, and we therefore refer to outcomes as structural and normative transformations.

Structural Transformations

The literature offers a number of examples of outcomes as structural transformations. These are summarized in Table 5.

ICT is used to enable transformation of governance processes and relationships to citizens, businesses and different governmental bodies (Khanra & Joseph, 2019; Wong et al., 2007). It provides means to facilitate stakeholder interaction (Haque, 2002; Molinari, 2011) and is assumed to involve an increased participation, openness and transformation in communication and interactions (Al Athmay, 2015; Calista & Melitski, 2007; Carlitz & Gunn, 2002; Pablo & Pan, 2002; Ramadoss & Palanisamy, 2004). It includes transformation in multiple relations, classified as.

Table 5 Structural transformations of eGovernance

Structural transformations	Description	Example References
Service delivery	ICT changes processes for service delivery	Zwahr and Finger (2004), Al Athmay (2015), Banerjee et al. (2015), Chen and Hsieh (2009), Finger and Pécoud (2003), Palvia and Sharma (2007)
Regulation	ICT changes processes for regulation Electronic rulemaking	Zwahr et al. (2005), Zwahr and Finger (2004), Barthwal (2003), Finger and Pécoud (2003), Misuraca (2006)
Policy-making	ICT changes processes for policy-making	Zwahr et al. (2005), Zwahr and Finger (2004), Haque (2002), Dawes et al. (2016), Finger and Pécoud (2003), Misuraca (2006), Rubasundram and Rasiah (2019)
Governance mechanisms	New governance mechanisms may be developed New governance structures	Zwahr et al. (2005), Dawes (2016), Lal and Haleem (2002)
Relationships, interaction and participation	ICT changes governments relationships and interactions with stakeholders Increased participation of stakeholders in governance processes Electronically facilitated network interactions, e-societies	Haque (2002), Wong et al. (2007), Pablo and Pan (2002), Nyirenda and Cropf (2009), Finger and Pécoud (2003), Gberevbie et al. (2016), Ray and Mukherjee (2007), Bannister and Connolly (2012), Saxena (2005)
Coordination	ICT enables new forms of coordination	Misuraca (2006), Pathak et al. (2010), Myeong et al. (2014)
Decision-making	ICT enables new processes for planning, formulating and implementing decisions	Larsson and Grönlund (2016), Akotam et al. (2013), Kalsi and Kiran (2015), Marche and McNiven (2003)

> government-to-citizen (G2C), government-to-business (G2B), government to its internal employee clients (G2E), government to other government institutional clients (G2G), and citizen-to-citizen (C2C). (…) Finally, it involves a transformation of society itself, through the emergence of so-called “e-societies”, made up of networks of relationships like citizen-to-citizen connections, as well as relations among non-government organizations (NGOs), built and sustained using electronic means. (Pablo & Pan, 2002, pp. 289–290)

eGovernance changes processes for managing and sharing information and knowledge (Al Athmay, 2015; Meijer & Bekkers, 2015; Ray & Mukherjee, 2007) and ways to deliver services (Haque, 2002; Zwahr & Finger, 2004). New governance mechanisms to manage social interactions may also develop, instead of being primarily governmental (Zwahr et al., 2005). Technologies are used to support networked interactions between government organizations and stakeholders (Bannister & Connolly, 2012; Meijer, 2015). Central is the exchange of information between government and citizens and is a form of interface between them (Singla & Aggarwal, 2014). Technologies have an impact on the role of the state and its core functions service delivery, policy-making and regulation. It is according to Zwahr and Finger (2004) even one of the key drivers of state transformation, while others (Bannister & Connolly, 2012) mean that technology enables transformation but there is little evidence that it is the driving factor.

ICT is used to facilitate processes for decision-making and implementation, as a medium for communication and collaboration and enables active participation and citizen involvement (Misuraca, 2006). It may include electronic consultation, controllership and engagement (Bubou et al., 2018).

eGovernance is also related to innovation and improvement and is often intended to bring something new. eGovernance is argued to enable new styles of leadership and decision-making, new ways of conducting and transacting business, new ways of communicating and debating and new ways of organizing and disseminating information (Gberevbie et al., 2016; Lal & Haleem, 2002; Palvia & Sharma, 2007). eGovernance has even been referred to as "an innovation management process in the public sector" (Potnis, 2010, p. 41), and a main rationale for eGovernance is to trigger innovation (Haque, 2002). It brings a new understanding of governance, which requires of all actors to participate actively (Misuraca, 2006). eGovernance will raise new practical and theoretical problems, which also motivates it to be a distinct field of study (Bannister & Connolly, 2012).

To sum up, structural outcomes of eGovernance may involve transformations in structures and processes for service delivery, policy-making, regulation, decision-making and interaction between stakeholders. Technologies may also enable development of new mechanisms, means and methods for governance, which will raise new issues for problematization.

Normative Transformations

Our analysis suggests that the eGovernance literature has a strong emphasis on outcomes in the form of normative transformations, i.e. improvements in different areas. Table 6 summarizes these.

Some definitions and descriptions of eGovernance include expected outcomes, effects or aims in terms of normative aspects, such as efficiency, transparency and accountability (Akotam et al., 2013; Din et al., 2017; Haque, 2002). Aim is to improve the quality of services and governance and to encourage and empower citizen participation in decision-making. This may change the notion of citizenship and understandings of needs and responsibilities (Palvia & Sharma, 2007). Central objectives with eGovernance are to achieve good governance (Barthwal, 2003; Misuraca, 2006; Saxena, 2005), advance democracy (Bubou et al., 2018; Gberevbie et al., 2016; Haque, 2002; Pathak et al., 2010), strengthen civil society (Haque, 2002), and support

Table 6 Normative transformations of eGovernance

Normative transformations	Description	Example References
Efficiency	eGovernance is argued to be more efficient including cost efficiency and time efficiency	Akotam et al. (2013), Haque (2002), Calista and Melitski (2007), Din et al. (2017), Gberevbie et al. (2016), Kalsi and Kiran (2015), Khanra and Joseph (2019), Ray and Mukherjee (2007)
Transparency	Information and communication technologies (ICTs) are seen by many as effective and convenient means to promote openness and transparency and to reduce corruption	Akotam et al. (2013), Barthwal (2003), Din et al. (2017), Haque (2002), Kalsi and Kiran (2015), Khanra and Joseph (2019), Nyirenda and Cropf (2009), Ray and Mukherjee (2007)
Accountability	eGovernance is expected to enable increased accountability	Akotam et al. (2013), Al Athmay (2015), Barthwal (2003), Choudhari et al. (2011), Gberevbie et al. (2016), Haque (2002), Misuraca (2006), Nyirenda and Cropf (2009)
Participation	eGovernance enables increased participation of stakeholders in governance processes and increased civic engagement	Saxena (2005), Calista and Melitski (2007), Carlitz and Gunn (2002), Saxena (2005), Al Athmay (2015), Choudari et al. (2011), Kalsi and Kiran (2015), Lal and Haleem (2002)
Effectiveness	eGovernance is assumed to improve effectiveness in, for instance, information and service delivery	Al Athmay (2015), Bubou et al. (2018), Dawes et al. (2016), Gberevbie et al. (2016), Khanra and Joseph (2019), Pablo and Pan (2002)
Responsiveness	eGovernance is expected to improve responsiveness	Barthwal (2003), Gberevbie et al. (2016), Khanra and Joseph (2019), Lal and Haleem (2002)
Democracy	eGovernance intends to enhance democracy	Al Athmay (2015), Calista and Melitski (2007), Chen and Hsieh (2009), Gberevbie et al. (2016), Misuraca (2006), Saxena (2005)
Good governance	eGovernance intends to enhance good governance	Barthwal (2003), Lal and Haleem (2002), Misuraca (2006), Kalsi and Kiran (2015)
SMART governance	eGovernance aims to achieve simple, moral, accountable, responsive and transparent (SMART) governance	Alotaibi (2019), Singla and Aggarwal (2014), Ramadoss and Palanisamy (2004)

(continued)

Table 6 (continued)

Normative transformations	Description	Example References
Economic development	eGovernance is expected to improve economic development	Banerjee et al. (2015), Din et al. (2017), Marche and McNiven (2003), Misuraca (2006), Nyirenda and Cropf (2009)

economic development (Banerjee et al., 2015; Misuraca, 2006; Saxena, 2005). Some authors mean that eGovernance is an attempt to achieve SMART governance (simple, moral, accountable, responsive and transparent) (Ramadoss & Palanisamy, 2004; Singla & Aggarwal, 2014).

A question is whether ICT affects normative values, and Bannister and Connolly (2012) argue that it does—technology enables certain norms. Norms may also change in themselves, and transparency is suggested to be an example of that. The argument is that transparency and provision of information are a way to transfer governance to a community by information rather than regulation. In a network society, accountability is also something that is challenged, since there are no clear nodes to make accountable as there is in hierarchical systems. New technologies, such as AI and further automation, will pose new challenges to governance, and an aspect of eGovernance will also be to address these challenges (Bannister & Connolly, 2012). eGovernance also has potential to improve access to information (Al Athmay, 2015; Barthwal, 2003; Calista & Melitski, 2007; Haque, 2002; Saxena, 2005), reduce corruption (Al Athmay, 2015; Din et al., 2017; Gberevbie et al., 2016; Haque, 2002), facilitate collaboration (Chen & Hsieh, 2009; Lal & Haleem, 2002; Pablo & Pan, 2002; Potnis, 2010), have seamless integration of information and services (Chen & Hsieh, 2009; Saxena, 2005) and decentralize power (Al Athmay, 2015; Calista & Melitski, 2007; Misuraca, 2006).

To summarize, eGovernance is often associated with normative values such as efficiency, transparency, accountability, participation, effectiveness, responsiveness, as well as enhanced democracy and good governance. Even though technologies may facilitate this, it is important to problematize this notion and to be aware of risks related to digitalization.

2.4 *From eGovernance to Digital Governance*

"Digital governance" is by some scholars (Misuraca & Viscusi, 2014) considered to be an evolvement of the concept of eGovernance. It has also been considered to have developed through four stages: organization-oriented eGovernment, citizen-oriented eGovernment, organization-oriented eGovernance and citizen-oriented eGovernance (Kang & Wang, 2018). If eGovernment has a focus on using technologies to improve public services, eGovernance embraces transformations of the relationship between governments and citizens and other stakeholders, and digital governance is a further development of this, accentuating the impact of technologies and how it transforms governance (Barbosa, 2017). A distinction is made between digital government and digital governance, where digital government refers to structural elements while digital governance is about functionality (Charalabidis & Lachana, 2020b). While for instance Charalabidis and Lachana emphasize that digital governance brings increased efficiency, others argue that it also goes beyond efficiency and includes enhanced democracy and equity (Kitsing, 2019). Nevertheless, digital governance involves an advanced use of ICT (Kang & Wang, 2018) and the use of new technologies for advanced data analysis (Chandler, 2019).

> 'Digital governance' is based on information and communication technology and big data. As a governance model, it optimizes managerial decisions and policies through integration of complex data analysis, data modeling, data optimization and data visualization in government operations and public management processes (…) Digital governance emphasizes strengthening governmental managerial capacity and enhancing the legitimacy, transparency and responsiveness of good governance. All of this is done so as to better solve social problems and serve all citizens. (Kang & Wang, 2018, pp. 92–93)

Similar to eGovernance, for digital governance it is also argued that ICT has a "potential to enhance service quality, openness, transparency and ultimately quality of life and sustainable growth" (Charalabidis & Lachana, 2020b, p. 383). It is assumed that digital governance will bring increased efficiency as well as engagement between citizens and governments. It is not clear though to what extent ICTs empower actors in actuality (Vij & Gil-García, 2017). Digital technologies are applied to develop innovative solutions to social, political and economic challenges (Bertot et al., 2016). Some authors also argue that digital governance is a means to achieve sustainable development goals (Barbosa, 2017; Janowski, 2016), but that there is a gap between aspiration and capacity (Janowski, 2016).

Digital governance relates to the use of Internet, which enables new ways for stakeholders to organize themselves and participate in various contexts (Luna-Reyes, 2017). With the application of network technologies, governance is developing into a more network-oriented form (Barbosa, 2017; Kitsing, 2019). It is also argued that digital governance may trigger a shift from new public management to digital era Governance. It is based on digital processes, citizen-oriented holism and reintegration of government organization (Dunleavy, 2006; Kitsing, 2019; Misuraca & Viscusi, 2014). Digital governance brings the possibilities to bridge fragmentation and silos and enable collaboration. However, digital technologies are not enough, development of public sector governance is to a high degree dependent on formal and informal institutions, including laws and regulations, and norms, values and habits. Network-oriented governance is distinguished as a mode of coordination, compared to hierarchical or market-based principles. Network-oriented governance builds on reciprocal relationships, mutual trust and common values and interests (Kitsing, 2019). With digital governance, values may be generated in new ways, such as through public–private partnerships. There is however a need to do more research that evaluates value outcomes from digitalization initiatives (Luna et al., 2015).

Digital governance addresses problems in terms of effects rather than causation. The complexity of today's interactions and processes makes it difficult to investigate causes of phenomena, and interventions and digitalization usually have unintended side effects. Therefore, the focus in digital governance is rather to minimize negative unintended consequences and focus on responsiveness, rather than figuring out root causes of things. The attention is on correlation and interlinkages and development of new means for sensing and responding continuously to emergent effects (Chandler, 2019).

As Almeida et al. (2020) point out, digitalization generates various dilemmas, which challenge how collective actions are conducted. Institutions have to develop resilience and adaptability in order to manage contemporary and future challenges. Governance in the digital world is not just about regulation, but is more complex. It involves multiple actors and vast cultural, political, economic and social differences. Governance mechanisms and models have to be developed that lead to public goods and promote good behaviour. There are various risks associated with the digital environment, such as misinformation, biased algorithmic decision-making, social media manipulation, monopoly situations for large tech companies, cyber attacks, how surveillance is applied and violations of privacy. Critical issues are protection of human rights, accountability, fairness, compliance and allocation of social benefits. The digital context is not territorial, and decisions made in a company may have effects in multiple countries elsewhere. Digitalization also tends to bring turbulence and fast transformations, which may bring social crises. In this context, institutions have an important role for societal resilience. Some argue that the solution to these challenges, is not more control by the state nor privatization, but polycentric governance mechanisms that promotes civic engagement and involvement of actors. Key to governance in the digital context is decentralized processes and collaborative decision-making that involves multiple stakeholders and transparency and accountability of both stakeholders and algorithms (Almeida et al., 2020). One of the changes that digitalization and informatization brings to governance, is some shift from legality towards transparency. Formal legislation tends to lag behind technological development, and there is an increasing horizontalization of relations, which partially changes power dynamics. In this context, transparency and accountability are key, with information rights as an important aspect (Bovens & Loos, 2002).

2.4.1 Definition of Digital Governance

In light of the above, there is a need for a definition of digital governance. Based on the literature on eGovernance and digital governance this definition should reflect both the use of digital technologies in processes and structures of governance, its relation to governance objectives and values, the capabilities digital technologies bring, as well as its transformative potential. Based on that, we suggest the following definition of digital governance:

Digital governance is defined as digital technology ingrained in structures or processes of governance and their reciprocal relationships with governance objectives and normative values. Digital governance includes the utilization of digital capabilities and involves a transformation of structures, processes or normative values.

3 Discussion

Considering digital governance as an evolvement of eGovernance, it was important to first develop a deeper understanding of the concept of eGovernance. There has been a development from a focus on digitalization of government services, to embracing a wider perspective that includes interaction among multiple stakeholders in eGovernance. In the literature reviewed, digital governance has many aspects in common with the notion of eGovernance, but was found slightly more elaborate regarding the digital aspect. It has an emphasis on new technologies and network organization (Barbosa, 2017) that is less visible in the eGovernance literature. This relates to the concept of digital era governance, which is a different mode of governance compared to hierarchical and new public management approaches (Kitsing, 2019) which also resonates with the new possibilities that digital technologies enable for participation and engagement of stakeholders. Digital technologies changes the conditions for governance and how power and influence are distributed, and also has an emphasis on values such as transparency, trust, mutual interest and participation. However, digitalization also brings new challenges and requires new mechanisms of governance to protect human rights and establish a societal infrastructure of fairness and accountability. Nevertheless, governance is going through a transformation, where information and digital technologies to manage, utilize and leverage on information are central mechanisms (Kang & Wang, 2018). Therefore, it is crucial to further expand the theoretical foundation for the role of both information and information systems in governance in the digital age.

According to Dawes (2009), research in digital governance has focused primarily on advancing the practice concerning online services and improved management. Due to complex and dynamic challenges that reality presents, there is a need for a holistic approach that accounts for questions of what an appriopriate digital governance infrastructure would look like, as well as basic questions regarding governance and democracy in the digital era. This has to consider institutional reforms, social trends, human elements, new technologies, information management, multiple actors, interactions and various complexities. Legitimacy, trust, power relationships and balancing of different objectives are questions that are highlighted as important to address (Dawes, 2009).

A scientific foundation for research in digital governance has been requested (Charalabidis & Lachana, 2020a, 2020b), including the following major parts; identification and description of problems and solutions in digital governance; a coherent conceptual development; methods and tools to develop scenarios, impact assessment and simulation along with training curriculum and strenghtening of the scientific foundation of digital governance (Charalabidis & Lachana, 2020a, 2020b). Related to this, this article is a contribution to the conceptual foundation of the field of digital governance.

As Kazanchi (1996) pointed out, conceptual development provides a means to define and create understanding of a phenomena. This chapter contributes to an understanding of the meaning of the concept of digital governance. Related to some of the qualities of concepts that was highlighted in the introduction, such as clarity, possible application of the concept, theoretical glue and cumulativeness (Conboy, 2009), improvements can be made. There are sometimes conflicting explanations of the concept of eGovernance, and different concepts are used quite interchangeably, so clarity of concepts can be enhanced. This tends to create some confusion and influences the theoretical robustness. Certain patterns of meanings of eGovernance and digital governance have been recognized, and our sample indicates that digital governance builds on the notion of eGovernance, which makes the cumulative aspect stronger.

A final dimension of quality of concepts is the level of abstraction that is addressed (Lewis et al., 2005). We found that eGovernance and digital governance primarily tend to be addressed at a practical level, and a more theoretical and also philosophical contribution would be beneficial and provide a deeper theoretical foundation.

4 Conclusion

This study has explored the use and understanding of the concepts eGovernance and digital governance and suggested a definition of digital governance. The literature contained a number of different views and perspectives and neither of the concepts were found to have agreed upon definitions or well-defined constructs. The concept digital governance has inherited meanings from the concept of eGovernance. While we found more theoretical contributions related to eGovernance, the digital aspect of digital governance was found to have been slightly more elaborated. In light of this, we found no clear conceptual distinction between the two concepts and therefore suggest that the scientific community from now on joins forces in developing the concept digital governance further, thus ensuring to encompass existing understandings of both terms. As a starting point, our analysis offers elaborate perspectives on existing use and understanding of the two basic elements of digital governance—namely "governance" and "digital" (where the digital aspect corresponds to the notion of "e" in the concept of eGovernance). Further theorization and conceptualization of the digital aspect in digital governance would be a valuable contribution to theory development.

The literature revealed different views on eGovernance which can be structured in two distinct but interrelated perspectives: (1) how ICT is used in governance and (2) outcomes of eGovernance as structural or normative transformations. It seems to be common to include normative values in descriptions of eGovernance, and a structured outline of (existing and possible) structural elements of governance in which information systems can play an important role would be beneficial for further development of the digital governance field.

4.1 Future Research

We suggest that the digital governance domain would benefit from increased theorization related to its basic concepts. Our analysis can hopefully be seen as an initial contribution to this work by offering clarity on what the basic building blocks are and how they have been understood and used by the community so far. Future steps may include developing more definitions on concepts, constructs and relationships that can later be further theorized and tested.

The literature tends to describe digital governance in positive terms. However, there are risks and concerns that invite critical reflection and problematization. Many times, such initiatives fall short on expectations or fail (Choudari et al., 2011; Haque, 2002; Kalsi & Kiran, 2015; Nyirenda & Cropf, 2009). Digital divide (Din et al., 2017; Haque, 2002; Khanra & Joseph, 2019; Marche & McNiven, 2003), issues of security, identity and privacy (Akotam et al., 2013; Alotaibi, 2019; Dawes et al., 2016), trust (Dawes et al., 2016), fake information (Alotaibi, 2019; Calista & Melitski, 2007), technological dependencies (Dawes et al., 2016) and information overload (Calista & Melitski, 2007) have been highlighted in the literature as concerns. Another risk that has been raised is that digital governance tends to be driven from a technocratic viewpoint, and a stronger governance angle ought to be taken (Saxena, 2005).

Even if the literature on digital governance seems to address challenges of governance in the digital environment a bit more than the eGovernance literature, there is more work to be done to develop a theoretical foundation for governance in the digital era. A further understanding of what changes digital governance brings and what this means is also suggested, whether it is improvement of current practices or whether governance per se transforms. A thorough understanding of the conceptual foundation of digital governance provides a basis for studying relationships between digital governance and societal challenges—both how digital governance can be applied to address societal challenges, as well as considering the risks that it may bring.

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Digital Government Research: A Diverse Domain

Hans J. Scholl

Abstract As formulated in the Digital Government Society's mission statement of 2006, *Digital Government* refers to "the use of information technology to support government operations, engage citizens, and provide government services." Although the term "digital" as opposed to "analog" implicitly establishes a relationship between (digital) modern "information and communication technology (ICT)" and "government," the scope and the various dimensions of Digital Government extend to more than just uses of ICTs in the public sector but rather induce and help transport transformational changes in how the business of government is conducted. This, it appears, holds for all types (democratic or not), all aspects, all levels, and all branches of government. In this chapter, the evolutionary path of Digital Government is accounted for, and the unfolding of the research tradition that accompanied, and sometimes guided, the emerging practice is described. Digital Government Research (DGR) started from humble beginnings to what is now the intermediary present. The chapter provides a projection and a preview of where this rapidly growing multi-disciplinary domain of research and practice might be headed in the next two decades. As it appears, the transformation of the business of government is only in its early phase, and major trends of transitions and transformation are observable.

Keywords Digitization · Digitalization · Digital government research directions · Multi-disciplinary research · Government surveillance

1 From Digitization of Government Documents to Digital Government

While "Digital Government" encompasses the use of modern information and communication technologies (ICTs) in the business of government along with its evolutionary and change-driving consequences, the term *digital* historically also

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connects with to the term *digitization.* In the 1990s, digitization referred to a “process from preparation and conversion to presentation and archiving” of analog hardcopy documents of all kinds into digital, that is, machine readable and transferable formats (Hazen et al., 1998, p. 1). The conversion process from analog to digital has taken the better part of two decades, and media like hardcopies played major and sometimes legally exclusive roles during that period. However, at the beginning of the third decade of the twenty-first century, vast amounts of formerly analog documents have successfully been digitized and have become accessible and searchable despite sometimes complicated conversion procedures and high costs. In parallel, and for an even longer period of time, new documents of all kinds have been created first and foremost in digital form. An ever-rising number of digitally created documents have never been converted or will never be converted into any analog formats such as printed hardcopies. With the advent of automatically executed smart contracts or exclusively cashless transactions, for example, when paying your purchase in a cashless store or a restaurant by moving your smart watch close to a credit card reader, the era of analog transaction processing and documentation is observably coming to a final close. Society’s increasing reliance and functioning on the basis of digital data, documents, structures, and processes have been referred to as *digitalization* (Castells, 2010). Digitization, then, can be viewed as an overture and important stepping stone to the first phase of societal digitalization, to which governments, non-governmental organizations, and organizations in the private sector spearheaded by the high-tech industries were instrumental catalysts and contributors.

In developed countries and many developing nations alike, instantly finding, accessing, storing, and disseminating informational digital assets and performing transactional or other processing activities on and with these digital assets by means of networked information and communications systems have become daily routine and the regular way of “doing business” for private sector and non-governmental organizations, governments, as well as for individuals. Members of generation Z (born between 1995 and 2015, also known as Gen Z) are what some have called “digital natives.” Individuals in this age group reportedly have greatest difficulties finding their ways through analog documents, for example, print maps, or using other hardcopy-based procedures and methodologies (Prensky, 2001), for example, navigating a car around based on a print map rather than a digital navigation tool.

Unsurprisingly (and significantly), the first phase of massive societal digitalization and the early two-decade era of Gen Z span the same period of time. The former began around 1995 shortly after the commercialization of the Internet and the popularization of the World Wide Web, and which came to a close around 2015 when a critical mass of developments signaled the next phase of digitalization cryptocurrencies such as Bitcoin and Ethereum based on Distributed Ledger Technologies such as blockchain as well as applications of machine learning, data science, the Internet of Things (e.g., smart grids), artificial intelligence, and decision and data visualization began to become beacons and facilitators for shaping its next phase (Sharda et al., 2020). A (related) marker and defining moment for the end of the first phase of digitalization can also be seen in the massive and unprecedented impact of social media on the business of government, for example, by enabling cleanly targeted and unchecked interferences of foreign powers on general elections and referendums of a nation, which signal the beginning of a radically new phase in the digitalization story of government including elements of cyber warfare widely visible since at least about 2015 (Hollis et al., 2017).

The first phase of societal digitalization (1995–2015) can also be viewed as isochronal to the first phase of Digital Government, which has been characterized as the period of harvesting "low-hanging fruits" and gaining "quick wins," some of which materialized in the digital replication and mimicking of frequently ineffective and even broken paper-based processes, to which some critics sarcastically referred as gigantic "manumation" efforts (Mohan & Holstein, 1990), but also, and maybe more effectively, through massive digitization campaigns of historical documents and information resources along with initial online transactional services, which would, however, at the time mostly not provide the same ease of use and performance elegance that people were accustomed to from using the private-sector informational and transactional counterparts.

Nonetheless, at the end of the first phase of Digital Government, as a standard method of business, citizens in many countries were able to directly access or request a vast array of detailed public data at the convenience of their own personal devices. It provided for electronically filing tax return forms, paying taxes and utility bills, receiving tax refunds directly at personal or business bank accounts, registering vehicles, boats, and other devices, renewing driver's, car, boat, and other licenses or permits, and voting online (Estevez et al., 2021). Businesses were requested to exclusively and electronically access request for proposals, file their bids, make and collect payments, receive permits, access government-held data, and schedule government inspections and other services in real time (Aminah et al., 2018). Government-internal (intra-agency, inter-agency, and inter-jurisdictional) business processes have been adjusted, digitalized, and accelerated. Compared to how the business of government was conducted in the mid-1990s, the observable and measurable changes were tremendous (Niehaves et al., 2013; Scholl, 2005a, 2005b). However, despite this remarkable success in digitalization, business processes still followed a quasi-paper-based blueprint, and major methods of interaction and procedures have not yet exploited the full potential of the facilitating new technologies, or radically new processes and procedures had not been invented. While societal digitalization seemingly translates into a major transformation of how society and their members act and interact, digital transformation might need some more time and effort to be fully reflected and incorporated into democratic government (Scholl, 2010a). Constitutional and other legal considerations play a main role when it comes to transforming government digitally in a way that its democratic principles such as the system of checks and balances and the respective need for the division of powers are to be preserved. It is an interesting synchronism that the second phase of societal digitalization (and with it, the second phase of Digital Government) begins.

In the following, this chapter describes and comments on the evolution of Digital Government Research (DGR) during the first phase of public-sector digitalization, the domain's academic characteristics, its outlets, research directions, its major players and affiliations, and its future role as enabler, critical company, recommender, whistle blower, and chronicler of the second phase of Digital Government, which promises (or, threatens) more deeply rooted and more radical transformations also to the underlying democratic model of government and governance, which were developed over centuries in Western democracies, however, which might be more challenged in the process than has been anticipated so far.

2 Forming Years of an Emerging Study Domain

Every new wave of technology innovation appears to follow a similar pattern: Initially, it is fueled by an almost unlimited enthusiasm about its potential benefits and by exuberantly optimistic and lofty projections regarding the overall betterment of the human cause. However, after the initial euphoria is over, a clearer understanding of more realistic and verifiable benefits, costs, and limitations evolve, which significantly moderate the initially over-optimistic projections. Digital Government has no exception from this pattern. Technologists have always been happy to propagate euphoric views and expectations, and they may have even strongly believed in themselves. However, while the invention of controlled and self-propelled aircraft-based flying of the skies was an unprecedented and a steep leap in human capability and reach, it did not even take two decades to use this liberating capability to shoot down other planes from the sky and bomb enemy positions in World War I. Without exception and for any technological advance that humans were able to fashion toward desirable ends, they swiftly also found other designations, and mostly nasty ones, to where the innovation could also be applied. In all fairness, however, innovations developed with an initial destructive intent were later also used for more peaceful, productive, and benevolent purposes. For example, drones, on whose enormous destructive capabilities the military heavily relies, are increasingly also used for emergency search and rescue operations and other non-destructive purposes such as delivery of medical supplies. In other words, the uses of technology breakthroughs apply across the whole spectrum of potential uses and/or abuses. As pointed out before, Digital Government, that is, innovations through modern networked computing, the Internet and the Web, or, in general, information and communication technologies (ICTs) and their uses for the purposes of public administration are no exception from the general rule of technological advances, which appear to be double edged by default.

Interestingly, in academia, relatively little attention was paid to the uses and roles of ICTs in public administration (Bannister & Grönlund, 2017; Kraemer & King, 1986), although their proliferation occurred in government as early as in other sectors of society. Academic research on the use and adoption of ICTs in the private sector primarily thrived in business schools that formed so-called management information systems (MIS) departments as early as the 1970s. Public administration departments and schools, in contrast, never established equivalent units or departments. The MIS research at B schools was rather taken as the role model, and the term of "public management information systems" or PMIS was introduced (Bozeman, 1986; Bretschneider, 1990) into the academic debate, although without getting much traction or receiving much attention. Before 1995, some mere twenty academic publications could be identified, which had a focus on ICTs in public administration; see (Scholl, 2021). Bannister and Grönlund counted sixty-five publications prior to 1995, which were found via the search term "e-government" in a Google Scholar search (Bannister & Grönlund, 2017). The difference between the two numbers can be explained through the wider net, which the Google Scholar search casts as opposed to the narrower filter provided by the strict inclusion criteria of the Digital Government Reference Library (DGRL). In any case, the topic of ICTs in the public sector was certainly not of great interest at the time. This lack of scholarly attention was likely also influenced by an expressed skepticism about the impact and an outright underestimation of the potentially beneficial influence of "technology" on administrative "reform" (Kraemer & King, 1986, 2003). It was rather argued that ICTs would likely maintain and perpetuate the status quo. As late as 1996 and in all seriousness, some scholars still claimed that "mainframe" computing was superior and preferential to networked PC-based computing in American local government (Norris & Kraemer, 1996).

With at best lackluster interest in the subject on part of public administration scholars, the tradition of Digital Government Research (DGR) was sparked and ignited outside the traditional public administration research and its incumbent researchers. Two government funding initiatives, one in the USA and another one in Europe, can be traced to have independently launched the DGR tradition, which initially lacked any connections to each other:

(1) In the USA, the National Science Foundation (NSF) issued the first call for research grant proposals in Digital Government in 1998 and began holding annual workshops (as of 1999) for grant holders, which culminated in what later became the Annual International Conference on Digital Government, or, short, dg.o, which was first held in 2000 (Ciment, 2003). Also, under the auspices of NSF, the Digital Government Society of North America was formed a few years later (2006).
(2) Slightly later than the USA, the European Union (EU) under its fifth and sixth framework programs along with some European nation states also began funding DGR-related research programs. The IFIP Working Group 8.5 (Information Systems in Public Administration), which was founded as early as 1987, became a major organizer of digital government-related workshops and, most notably, the EGOV conference under the leadership of Lenk and Traunmüller (2002), which was first held in 2002. This conference also served as platform for presenting results from funded DGR.

The opportunity of funding for DGR drew the attention of scholars from a range of disciplines such as computer science and engineering, human–computer interaction research (HCI), data visualization research, information systems research, communications, geography, and others, whereas traditional public administration scholars were still little interested in these particular research and funding opportunities. The topical areas of, for example, NSF-funded DGR were diverse and included meta-data generation for geographic imagery (Zhang & Zhu, 2001), individualized

Web-based government services (O'Looney, 2001), visualization of geospatial data (MacEachren et al., 2001), digital campaigning and voting (Iyengar, 2001), information sharing of law enforcement agencies (Hauck et al., 2001), and human-centric design for government services (Adam et al., 2001) to mention a few.

An important side effect of these funding programs, intentional, or not, was that researchers from multiple disciplines who had never met at any conference or other academic venue before began to learn about each other's research and disciplinary backgrounds. This created a climate of curiosity and appreciation of the multi-disciplinary perspectives on public administration and its unique challenges, which had never before been in explicit focus of any of these disciplines. Moreover, scholars from different backgrounds and epistemological affiliations began sharing ideas and research findings. Funding for DGR-related programs was maintained for about a decade in the USA and somewhat longer in the EU. Undoubtedly, it was absolutely instrumental for launching the study domain in its early phase. Without this initial funding, it is questionable whether or not the now established and vibrant DGR domain would have ever developed (see Chart 1).

3 The First Phase of DGR: Outlets and Directions

A sharp increase in peer-reviewed publications resulted from the funding boost of mostly applied research focused on ICT-based innovation projects in the public sector: From a total of less than one hundred peer-reviewed publications in DGR overall before the year 2000, the number rose to 1138 for the five-year period (2000–2004). The rapidly growing number of research reports also required an increased number of high-quality and widely respected publication outlets. Since at the time DGR represented only a small niche, or even a very special topic within the above-mentioned traditional disciplines, the study domain, while in the process of forming a community with fairly diverse disciplinary backgrounds, was in need of finding its own dedicated publication outlets. Some already existing outlets of premier standing appreciated shared and advanced the growing interest in DGR. Elsevier's *Government Information Quarterly (GIQ)* (founded in 1984), then under the leadership of Charles McClure and John C. Bertot, and IOS Press' *Information Polity (IP)*, founded in 1988, then under Editor-in-Chief John Taylor, were two important outlets on the journal side. With regard to top conferences, it was the annual *Hawaii International Conference on System Sciences (HICSS)*, founded in 1968, under the leadership of the late Ralph Sprague that was open and welcoming as a platform for the novel topics of DGR.

As mentioned before, the multi-disciplinary composition of the DGR community has strongly influenced the reputational hierarchy between journals and conferences. While in some traditional disciplines, journals outshine the conferences (e.g., in public administration, political science, or information systems research), in other (newer and more technologically oriented) disciplines, top conferences prevail in reputation over journals (like in HCI or computer science and engineering). In DGR,

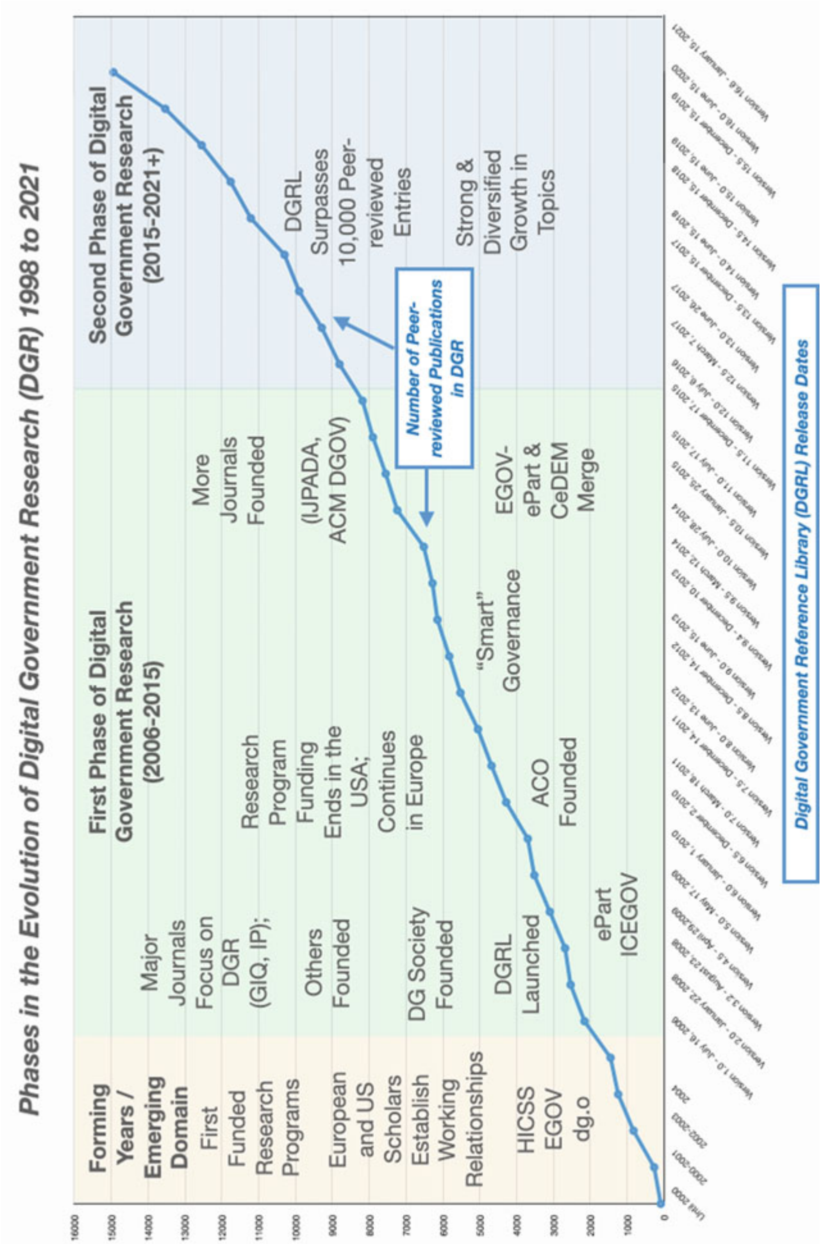

Chart 1 Evolution of the digital government study domain

no such rank order has been established, which is not surprising when considering the diverse disciplinary contributors. This led to the effect that the two journals (GIQ and IP) and the Digital Government Track at HICSS have maintained their on-a-par lead position in the study domain (Scholl, 2010a, 2010b; Scholl & Dwivedi, 2014).

As it became quickly clear, the three highly ranked outlets alone would not be able to cope with the growing surge of DGR publications. At first, quite a number of disciplinary journals dedicated one-time special issues to then new phenomenon of electronic or digital government (e.g., *Communication of the ACM* in 2003). Yet, additional outlets were needed for providing the burgeoning DGR domain with publication space. Between 2001 and 2007, a number of new DGR journals and conference outlets were established among which were the already cited dg.o and EGOV conferences and later the ICEGOV conference as well as smaller DGR tracks at the AMCIS, ECIS, and PACIS conferences. Also, new journals were established, for example, The *Journal of E-Government* (later renamed into *Journal of Information Technology and Politics (JITP)*, now published by Taylor & Francis/Routledge), the *International Journal of Electronic Government Research (IJEGR)*, published by IGI Global, *Transforming Government: Policy, People, Process (TGPPP)*, published by Emerald, the *Electronic Journal of e-Government (ECEG)* published by Academic Conferences and Publishing International, and Inderscience's *Electronic Government: an International Journal (EGaIJ).* Within the first decade of the twenty-first century, academic DGR had soared from 144 to a total 3697 peer-reviewed publications (Scholl, 2021). After 2010, only two other DGR-dedicated journal have been introduced, which were IGI Global's *International Journal of Public Administration in the Digital Age (IJPADA)* and ACM's *Digital Government Research and Practice (DGOV)*—see Chart 1.

Several studies have analyzed the topical directions in DGR in its first phase (1995–2015). A 2007 paper investigated what topics were central to DGR and identified six high-level variables and their relationships and interactions as most central to DGR as follows: (1) government operations, (2) government services, (3) citizen engagement, (4) public policy in context, (5) information use, and (6) technology use. It argued that research was the more central to DGR the more these high-level variables (and their sub-variables) were studied including their relationships and interactions (Scholl, 2007). Empirical studies confirmed this perspective and demonstrated strong research interest in improving government services, technology use, and citizen engagement (Andersen & Henriksen, 2005) in the earliest phase. In the middle and later sections of the first phase, the research interests expanded to the whole set of high-level variables, in which the topics most frequently studied were management and transformation (operations), participation and democracy (citizen engagement), government services, and technology uses followed by information uses (Scholl, 2010b, 2013). Lately, other scholars have also elaborated on the scientific foundations of Digital Government Research (Charalabidis & Lachana, 2020a, 2020b).

4 The DGR Domain: Organizational Entities and Leading Scholars

As mentioned, the two major professional organizations, the Working Group (WG) 8.5 inside the International Federation for Information Processing (IFIP) and the Digital Government Society, have remained the major affiliations, through and around which the academic DGR community organizes. The major focus of both organizations has remained the same that is organizing and conducting its respective conferences. Over the years, the two organizations have gone through a number of adjustments and modifications. In 2010 and with the departure from its former conference organizing partner, the community of the WG 8.5 created an IFIP-independent organizational format, which basically mirror-imaged the working group but also gave the community an independent arm for legally and fiscally organizing its business under the roof of Academic Conference Organization (ACO) based in Lausanne, Switzerland. The dual working group has a membership of over one hundred active scholars from all over the world. Membership is linked to in-person participation at the WG's conferences, and no formal membership fee is collected. In 2017, the dual WG joined forces with the Austria-based CeDEM organization and merged its two conferences, EGOV and ePart, the latter of which was launched in 2009, with the CeDEM conference to form the combined EGOV-CeDEM-ePart conference. So far, and despite its global reach, the EGOV-CeDEM-ePart conferences and their predecessors have always been held in Europe.

In 2013, the Digital Government Society of North America decided to expand its reach beyond the North American continent and consequently shortened its name to Digital Government Society (DGS). Shortly after and for the first time, the dg.o conference was held outside North America in 2016 (Shanghai, China). In 2018, a first national DGS chapter was constituted (China). The society collects a moderate annual membership fee, which is folded into the conference registration fee. DGS has not published member numbers. However, based on the number of conference participants, the society's number of active members can be estimated as shortly under one hundred, very few of whom are also members of the dual WG.

When analyzing the membership numbers of the two DGR affiliations, they appear to be on the low side. As one benchmark, in January of 2021 the major listserv of the DGR community, that is, the EGOV-List, http://mailman11.u.washington.edu/pipermail/egov-list/) had over 1300 subscribers. The Digital Government Reference Library (Scholl, 2021), which contains the references to the vast majority of peer-reviewed DGR publications in the English language, is another benchmark. It lists over 4000 authors, over 10% of whom are "prolific" scholars with more than 20 publications each. The latter group has been referred to as the core community of DGR. Before this background, the two major affiliations, the dual WG (ACO/IFIP) and DGS together, are estimated to have organized less than fifty percent of the core community of the study domain.

The DGRL also allows for the identification of leading scholars in DGR in terms of number of entries in the reference library. Google Scholar, then, helps assess the relative impact of these most prolific researchers. As of January 2021, this study finds the following ten scholars the most prolific in DGR (number of DGRL entries in parentheses): Marijn Janssen (236), J. Ramón Gil-García (178), Vishanth Weerakkody (124), Theresa A. Pardo (111), Yogesh K. Dwivedi (108), Yannis Charalabidis (102), Hans J. Scholl (100), Maria A. Wimmer (98), Christopher G. Reddick (95), and Luis Luna-Reyes (81), see Table 1, which updates the numbers of 2016 predecessor study on the same matter (Scholl, 2016). When looking at the impact of prolific DGR scholars in terms of number of Google Scholar citations, a slightly different list emerges for the top ten DGR scholars (citation numbers in parentheses): Marijn Janssen (16,578), Theresa A. Pardo (14,080), J. Ramón Gil-García (13,115), John C. Bertot (9377), Albert Meijer (7450), Hans J. Scholl (7176), Vishanth Weerakkody (6658), Sharon S. Dawes (6305), Christopher G. Reddick (5867), and Yogesh

Table 1 Top digital government scholars based on DGRL v16.6 entries (January 2021)

Scholar name	Number of DGRL reference entries	Percentage of research dedicated to DGR (based on 20 most cited articles in Google Scholar)	Adjusted Google Scholar citations	Adjusted Google Scholar h-index	Adjusted Google Scholar i10-index	Adjusted top-ten Google Scholar cited "signature" entries
Marijn Janssen	236	95	16,578	63	244	3.8
J. Ramón Gil-García	178	100	13,115	50	132	5.0
Vishanth Weerakkody	124	70	6658	36	90	2.8
Theresa A. Pardo	111	100	14,080	45	112	0.0
Yogesh K. Dwivedi	108	20	4544	16	60	0.4
Yannis Charalabidis	102	80	4301	26	75	2.4
Hans Jochen Scholl	100	95	7176	35	73	4.8
Maria A. Wimmer	98	95	3547	29	86	6.7
Christopher G. Reddick	95	100	5867	38	84	5.0
Luis Luna-Reyes	81	70	3432	24	56	4.9
Konstantinos Tarabanis	75	40	2616	16	54	2.0
Adegboyega Ojo	74	95	2213	24	53	5.7
Efthimios Tambouris	70	90	3082	26	67	3.6
Albert Meijer	65	95	7450	45	86	6.7

(continued)

Table 1 (continued)

Scholar name	Number of DGRL reference entries	Percentage of research dedicated to DGR (based on 20 most cited articles in Google Scholar)	Adjusted Google Scholar citations	Adjusted Google Scholar h-index	Adjusted Google Scholar i10-index	Adjusted top-ten Google Scholar cited "signature" entries
Zahir Irani	62	20	4523	16	51	0.8
Rodrigo Sandoval-Almazán	61	100	3689	25	56	4.0
Åke Grönlund	60	55	3689	25	57	2.2
Euripides Loukis	60	70	2687	23	62	0.7
Manuel Pedro Rodríguez Bolívar	59	85	3744	28	59	5.1
Paul T. Jaeger	57	30	n/a	n/a	n/a	n/a
Tomasz Janowski	56	90	2135	22	48	1.8
John C. Bertot	54	80	9377	40	111	6.4
Vassilios Peristeras	52	50	1335	14	32	2.5
Jörg Becker	52	10	1968	6	33	0.8
Sharon S. Dawes	51	100	6305	33	66	9.0
Elsa Estevez	50	100	2056	22	45	2.0

K. Dwivedi (4544); see Table 1. It is noteworthy that for adequacy of comparison, all Google Scholar citations and index numbers were adjusted according to the percentage of DGR-related research in the respective scholar's 20 most highly cited research articles. Furthermore, the Hirsch index, or h-index, which is used for determining academic impact in terms of number of highly cited contributions (h-index numbers in parentheses) has been adjusted as outlined above—see also Table 1: Marijn Janssen (63), J. Ramón Gil-García (50), Theresa A. Pardo (45), Albert Meijer (45), John C. Bertot (40), Christopher G. Reddick (38), Vishanth Weerakkody (36), Hans J. Scholl (35), Sharon S. Dawes (33), and Maria A. Wimmer (29). The so-called i10-index (i.e., counting papers with at least ten citations) is used for identifying what is in a scholar's research "pipeline." In this regard, the top ten DGR scholars are the following (i10 number in parentheses, again adjusted as outlined above): Marijn Janssen (244), J. Ramón Gil-García (132), Theresa A. Pardo (112), John C. Bertot (111), Vishanth Weerakkody (90), Maria A. Wimmer (86), Albert Meijer (86), Christopher G. Reddick (84), Yannis Charalabidis (75), and Hans J. Scholl (73).

Finally, the so-called academic signature list provides an interesting perspective on individual contributions and personal impacts by showing the number of single or lead co-authored (signature) publications among a scholar's top ten most cited publications, which is as follows ("signature" number in parentheses): Sharon S. Dawes

(9.0), Maria A. Wimmer (6.7), Albert Meijer (6.7), John C. Bertot (6.4), Adegboyega Ojo (5.7), Manuel Pedro Rodríguez Bolívar (5.1), J. Ramón Gil-García (5.0), Christopher G. Reddick (5.0), Luis Luna-Reyes (4.9), and Hans J. Scholl (4.8)—see Table 1; "signature" numbers have also been adjusted in the above-mentioned fashion.

Table 2 Top digital government scholars based on indicator list appearances (Jan. 2021)

Scholar name	In top-ten DGRL entries list (1 = yes; 0 = no)	Adjusted top-ten Google Scholar citation list (1 = yes; 0 = no)	Adjusted top-ten h-index list (1 = yes; 0 = no)	Adjusted top-ten i10-index list (1 = yes; 0 = no)	Adjusted top-ten "signature" list (1 = yes; 0 = no)	Total of top-ten indicator list appearances
J. Ramón Gil-García	1	1	1	1	1	5
Christopher G. Reddick	1	1	1	1	1	5
Hans J. Scholl	1	1	1	1	1	5
Marijn Janssen	1	1	1	1	0	4
Theresa A. Pardo	1	1	1	1	0	4
John C. Bertot	0	1	1	1	1	4
Vishanth Weerakkody	1	1	1	1	0	4
Albert Meijer	0	1	1	1	1	4
Maria A. Wimmer	1	0	1	1	1	4
Sharon S. Dawes	0	1	1	0	1	3
Yogesh K. Dwivedi	1	1	0	0	0	2
Yannis Charalabidis	1	0	0	1	0	2
Luis Luna-Reyes	1	0	0	0	1	2
Manuel Pedro Rodríguez Bolívar	0	0	0	0	1	1
Adegboyega Ojo	0	0	0	0	1	1

As Table 2 shows, nine scholars appear on at least four of the top 15 indicator lists and three even on all five. It is fair to conclude that when taken together, the frequency of a scholar's appearance in the top 15 indicator lists signals both their influence and the impact of these scholars' work. As an illustration, eight of these nine scholars (except Gil-García) held or are still holding important offices at the study domain's affiliations and top outlets, for example, Editors-in-Chief (Bertot, Janssen/GIQ, Meijer/IP, Reddick/IJPADA, and Weerakkody/IJEGR), HICSS Digital Government Chair/Co-chair (Bertot and Scholl), DGS/DGSNA President (Bertot, Pardo, Scholl), Chair of IFIP WG 8.5 (Janssen, Scholl, and Wimmer), and ACO President (Scholl and Janssen).

In 2018, based on their own polling, the British Think Tank *Apolitical* (https://apolitical.co/lists/digital-government-world100) identified and announced five of the nine as among the 100 most influential individuals in Digital Government worldwide (Gil-García, Pardo, Janssen, Scholl, and Wimmer) missing out on Bertot, Meijer, Reddick, and Weerakkody. However, the Think Tank's ranking confirms in large part also the findings derived from the 2021 data.

5 Practice and Research in Digital Government: Quo Vadis?

As alluded to in the introduction, the second phase of Digital Government, which began in the mid of the second decade of the twenty-first century, promises (and, maybe, as argued, threatens) to be more transformational than the first phase. As stated earlier, deep societal and organizational transformations do not necessarily exclusively result from sudden revolutionary impacts that topple and obliterate previous structures, processes, and relationships, they can also emanate from a large number of smaller incremental changes that reach a critical mass (Scholl, 2005c). These two change mechanisms can also interact with each other.

Smart Approaches (City, Government, and Governance). Human life on this planet is undergoing a major transition from a predominantly agricultural and rural experience to a predominantly post-industrial and metropolitan experience. In the two centuries between 1950 and 2050, the rapidly growing human population has been estimated to transition from a 30 percent to a 75% urban/metropolitan population share (Scholl, 2012). According to the World Bank by 2017, the urban/metropolitan population share has already passed the 55% mark (https://data.worldbank.org/indicator/sp.urb.totl.in.zs.—accessed on January, 2021). With the human experience becoming an increasingly and soon overwhelmingly urban/metropolitan one, large changes are unfolding. Metropolitan areas have become increasingly crowded, and the maximum carrying capacity of urban centers is being reached. With this phenomenon, all kinds of challenges of a new order of magnitude arise: Housing, transportation, safety, energy, health care, clean air and water, safe sewage and waste handling, and food and other life supplies have to be provided via ever more sophisticated, ever more capable, but also increasingly vulnerable infrastructures. As a response to this challenge, the notion of "smartness," for example, smart cities, smart governments, and smart governance, have been developed in academia and practice (Alawadhi et al., 2012).

In smart approaches, advanced technologies like the *Internet of Things (IoT)* based on *5G technologies* are facilitators for organizing and coordinating life and movements via *smart objects* in densely populated areas, for example, by smart sensor grids, which help steer traffic flows with minimal, if any, congestions, or, smart electrical grids, which automatically balance loads and take advantage of low tariffs. Smart approaches, many of which are *data science* based, rely on the use of *artificial intelligence (AI)* and *machine learning (ML)* in combination with big structured and unstructured data to identify patterns and predictive models, which inform and evaluate decisions of human actors or non-human actors in real time. Closely related and also used in combination with the aforementioned smart approaches are *Distributed Ledger Technologies* such as *blockchain*, which are used in smart approaches for guaranteeing unfalsifiable records of transactions, speed, and utmost transparency in transactional procedures. These smart approaches have an enormous potential for transformational uses in Digital Government, for example, in allowing for *smart contracting*, in which contract clauses are automatically executed if the predefined and built-in conditions are met. Greatly lowered transaction costs and high transaction speeds are expected outcomes.

As discussed elsewhere (Scholl & Scholl, 2014), the transformational potential of smart approaches requires smartness in the governance models of the emerging smart landscape. Obviously, with algorithm-based decision making and contracting along with the intelligent joining and sense making of vast arrays of data near real time, the traditional governance models of checks and balances and the division of powers might be challenged or even circumnavigated. The democratic decision-making processes as well as the legislative processes are deliberately slow. Also, the interpretation of the law in the courts deliberately allows for some latitude to be able to address a specific case, and it is slow for several reasons, systemic and caseload related. In contrast, smart contracts execute automatically with no wiggle room only based on pre-designed conditions. In other words, while the digital transformation in society, at large, and, in government, in particular, leads to a dramatic acceleration in transactional and informational processing, the traditional structure and system of governance have remained on a far slower clock. Moreover, neither unintentional nor intentional breaches in the division of powers or the system of checks and balances can quickly be discovered and counterbalanced. This, in and by itself, already enacts a digital transformation, although not necessarily a desirable nor intended one.

It follows that the models of governance also need to adjust more smartly and more flexibly with the rapidly unfolding digital transformation. Governments not only need to be quick and flexible in creating new regulations, which maintain the status quo of democratic governance as we know it, but, which at the same time makes the new regulations adjustable and avoids the stifling of potentially beneficial uses of novel technologies. An example of and role model for smart governance is the worldwide first provider regulation of Distributed Ledger Technology in Gibraltar, which has switched the regulatory paradigm from rule based to principle based (Scholl & Bolívar, 2019). This type of regulation implements detailed regulatory oversight and compliance enforcement in a case-by-case fashion, which allows the regulator to follow the provider's business behavior and transaction history, and it helps identify potential pitfalls in advance even before economic or other harm can result. It has also been argued that recurring reviews of regulatory outcomes are a characteristic of smart governance and smart regulation (Scholl & Scholl, 2014). Statutes, regulations, and even laws come with specified outcomes and mandatory review and expiration dates included, which makes the whole governance process more effective, although it also makes it more elaborate and potentially more time consuming. However, smart governance and smart regulations also benefit from data science-based artificial intelligence and data analytics-informed machine learning algorithms, which are able to automatically track and flag potential compliance breaches in real time.

6 The Looming Threat of Non-democratic Digital Government

Over the years, the leading DGR conference, the HICSS Digital Government Track, has served as an early sensor and bellwether of new trends and novel topical directions in the study domain of DGR. For decades, emerging topics have been tracked, and the track itself emanated from the emerging topics track, which it ultimately replaced in 2006. In recent years, a new minitrack under the name of "Dark Digital Government" was established, which morphed into the minitrack of "Challenged Democracies." Also, minitracks dedicated to "Cyber Deception," "Cyber Psychology," and "Insider Threats" have meanwhile debuted. In other words, it has become clearer than before that novel digital technologies can also be used for transformations toward other ends than those of the Western-style democracy model would support. The aforementioned abuse of social media by foreign powers to meddle with general elections, national referenda, spy on, and massively steal sensitive data is another case in point. While so far DGR has overwhelmingly focused on affirmative and confirmatory research, which demonstrated and discussed the positive outcomes of Digital Government initiatives, it has been understood for some time that also problematic outcomes of type B (successful, but not desirable) and type A (desirable, but unsuccessful) deserve research attention (Scholl & Scholl, 2014, p. 171). Clearly, what are "problematic outcomes" and what are "desirable outcomes" remain in the eye of the beholder. However, from a Western democracy perspective, certain digital government initiatives might be found utterly "problematic" and "undesirable," although very "successful," that is of type B, whereas researchers working from non-Western perspectives might celebrate the outcomes as non-problematic and highly desirable. Two cases in need of attention, investigation, and discussion are China's "Social Credit System" (SCS) and India's "Aadhaar" system. Although envisioned and being built toward slightly different ends, the two systems, once completed and up and running, provide the governments of the two most populous countries an unprecedented, real-time, and sweeping oversight of sensitive data on each and every single citizen. While India's Aadhaar (Hindi for "foundation") is a quasi-obligatory national registry with a unique personal 12-digit identifier, it also collects demographic data, and it stores fingerprints and iris scans for each registered individual (Shahin & Zheng, 2018). By the end of 2017, the registry contained complete records for 99% of the 1.3 billion Indian citizens. Provisions of social and financial services are linked to the citizens' Aadhaar IDs (Shahin & Zheng, 2018). While the use of big data of this magnitude and completeness has been presented as a safeguard against crime and service abuses as well as a guarantor of individual identification and authentication in transactions of all kinds, it also widely opens the backdoor to total surveillance, real-time tracking, and eradication of major elements of individual privacy by government and by private firms, with which the data are shared.

However, China's SCS (Dai, 2018; Hoffman, 2017; Kostka, 2018) has been built with an intention that goes even far beyond even the Indian Aadhaar ID system. The SCS does not halt by identifying, authenticating, and collecting demographic data on each Chinese individual, it also tracks each citizen's government interaction, online commercial (Guo, 2016) and financial activity (Meissner, 2017; Yu et al., 2015), social behavior and action, and judicial and criminal record. The system credits and ranks individuals with points for (government-defined) desirable behavior patterns, and it subtracts credits in case of (government-defined) undesirable behavior patterns (Mistreanu, 2018). A citizen whose social credit index (the SCI) falls below a certain threshold can automatically be barred from moving around by train or airplane, since such "untrustworthy" citizens find themselves unable to secure a ticket purchase anymore. The same holds true for admission to public resources and institutions such as libraries, movie theaters, or other amenities. The system is also combined with other surveillance systems that track individual movements via face recognition systems. The amount of data points collected for each Chinese subject on a daily basis is gargantuan, and SCS has been in full-flung operations for the country's entire 1.3 billion population since 2020 (Botsman, 2017). The intent behind the SCI is to steer Chinese citizens toward compliant as well as acceptable social and financial behaviors. From a Western perspective, this far-reaching extent of surveillance combined with automatic reprimanding and even punitive action against citizens would be a constitutional nightmare. However, in reality the technical capability of combining big, open, and linked government data on citizens with private data on consumer/citizens is not far from becoming as advanced in Western democracies as it is already now in the Chinese SCS (Backer, 2017). It remains left to public debate and decision making to what extent this technical capability can and should be legally exerted, and what constitutional and other regulatory safeguards need re-formulation, amendment, and implementation to maintain citizens' rights as laid down in, for example, the first (free speech and expression) and fourth (secure persons and houses free from unreasonable searches and seizures) amendments of the US constitution. In both, Western democracies and in non-Western models of government, analytics of big data already allow with great precision the accurate prediction of consumer/citizens' preferences, dislikes, and their probable future behaviors and actions. Moreover, the appetite for surveillance and data may not stop at collecting information on movements, utterances, and preferences of citizens. According to US intelligence sources, several countries, and most prominently China, have been collecting not only their domestic but rather the world population's biodata and genome information on a grand scale. When a medical and bio database of such gigantic proportions is used for large-scale AI-based analytical purposes, it can help predict the likelihood of developing hereditary-induced diseases in individuals and design precisely and individually counteracting medications. More generally, such super-big data analyses can revolutionize the pharmaceutical industry and the healthcare systems in their entirety giving the owner of such analyses unprecedented advantages over outcomes and less sophisticated competitors. Finally, such super-big data analyses combined with the aforementioned tools of individual surveillance and behavior control can render citizens with no autonomy, privacy, and ultimately little self-determination. Other threats include superior and ultra-sophisticated weapons for future bio warfare.

When considering the rapidly evolving metropolization and rise of megacities, in which the vast majority of humanity will live soon, the uses of systems like the Indian Aadhaar and Chinese SCS might become not only a possibility but rather also a necessity elsewhere, although the Western model is hard to envision with the integration of any corrective or punitive elements. Incognito human existence and individual privacy as once conceived and promoted will have great difficulty to be maintained in a cashless world, in which every transaction requires identification and authentication, and in which every individual step of the way can be tracked.

How gray this area of opportunities and threats of digitalization is overall, and in Digital Government in particular, has again been demonstrated during the worldwide COVID-19 pandemic, which prompted fairly diverse responses across the globe in both Western-style democracies and autocratic regimes. While some autocracies effectively contained the outbreaks with iron-fisted shutdowns and total individual surveillance, other autocracies utterly failed in controlling the virus spreading for a number of reasons, which are too numerous to discuss here. However, likewise some very sophisticated and highly developed Western democracies in their lack of response ended up in an outright nightmare with regard to both death tolls and infection rates, while yet others coped with the pandemic fairly effectively and contained it completely. It is obvious that both ICT-based tracing methods and sophisticated biotech countermeasures, as described above, have greatly helped mitigate the pandemic threat and will do even more so in the future. The COVID-19 pandemic also had an observable acceleration effect on the digital transformation at large, but also again in particular with regard to Digital Government. More services to citizens and businesses have become available online, or, they even are available online only. Government-internal processes and transactions have been performed by government employees working from their own homes mirroring the "home office revolution" in the private sector to some extent. It is likely that the post-pandemic era will produce even more changes toward transformed and revised Digital Government practices.

7 Concluding Remarks

It has been the object of this chapter to describe and assess the characteristics of, major contributors to, and the overall trajectory of Digital Government Research from its beginnings to the early third decade of the twenty-first century. After 2015, Digital Government has undeniably passed into its second phase, in which digital transformation of major proportions has begun to occur and will predictably continue to occur in society at large, and inescapably, also as a consequence, in government as well. Government will be both a driver and a facilitator of this transformation; however, depending on the model of governance, the safeguards and implementation will differ, despite some stunning convergence. Digital Government Research—and in it—this edited book needs to play important roles to chart out the path ahead and clarify the choices, which societies and communities have.

As it becomes increasingly obvious in the first half of the twenty-first century, the systems of, for example, China and the West compete fiercely and on a broad range of issues. This fierce competition is not only an economic one, but it rather also encompasses ideas and concepts regarding the individual's role as a member of communities and society, and the relationship between the group/collective and the individual: What is the extent, and what are the limitations of individuals' rights, obligations, and expectable contributions to society? What are the roles of government and systems of governance in this, among other related foundational questions? Digital Government Research needs to engage in these discussions and provide insights regarding problematic and unproblematic outcomes of digital initiatives and developments, which require a deep understanding of the technological and algorithmic underpinnings and their projectable and observed impacts on societal governance models, on public and private organizational structures and processes, on communities, and on individuals' lives. Digital Government Research also needs to engage with other disciplines including traditional disciplines such as public administration and political science, which provide a rich tradition of understanding in their respective areas, which overlap with Digital Government as a practice area, but which might lack the forward-looking capabilities, which Digital Government Research at least can provide in part. Along these lines, Digital Government Research might help bridge disciplinary gaps, which traditional disciplines like the aforementioned may not be geared to overcome.

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On the Structure of the Digital Governance Domain

Zoi Lachana, Yannis Charalabidis, and Panagiotis Keramidis

Abstract A science base for digital governance includes concepts, theories and principles derived from established and emerging sciences, with a view to long-term repeatable transformation, as opposed to short-term solution provision. The overall objective in creating and establishing the Digital Governance and Transformation Science Base is to formulate and structure the knowledge gained through pragmatic research in the domain during the previous several decades and beyond. Such a scientific background would document the existing knowledge and open the pathway for systematic and reproducible solutions to identified problems, without the danger of repeating research or missing opportunities for application. Taking as a basis the reference work from researchers in the area along with the results of the Digital Government Reference Library (DGRL), this chapter contributes to the scientific foundations of digital governance and the systematic description of this domain, through setting the overall structure, the research areas and the relations among them. As the DGSB domain structure is simple but flexible enough to be convincingly deep if needed, allowing different analysis levels with different views and myriads of different viewpoints, the present chapter also concludes to ontological documentation and visualisation.

Keywords Digital governance · Science base · DGSB domain structure · Ontologies · Protégé

1 Introduction

Digital governance (DG) is a well-established area of applied research that aims at transforming internal processes, structures, and working practices leading to greater efficiency and transparency by enhancing service delivery and promoting citizen engagement through ICT. Simultaneously, with open and digital governance accompanied by the Internet and other emergent technologies, the engagement between

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citizens and governments is expected to be greater than ever by simplifying citizen and business interaction with government and enhancing evidence-based decision-making. DG has been a strong focus of research in the lasting recent years, by the research community and industry alike. At the same time, digital transformation has emerged as an important phenomenon during the last thirty years, and huge efforts and investments have been made towards the modernisation of societies and industries. In the last decade, rapid steps have been taken in the private sector towards the digital transformation of its whole environment, including its processes and its core activities. Businesses as well as the public sector are trying to provide value-added services to people and modernise their product portfolio, in order to ensure sustainability and economic growth. Aiming at covering customers' and citizens' needs, such innovative approaches could relate both the way these services are designed, implemented and offered to their users, and provide capabilities such as feedback, automation and personalised information. While the private sector's digital transformation practice has more tangible drivers (e.g. profit and market share) and often more immediate results, governments, as well as the public sector's organisations, are still far from reaching the standards that the most leading companies are setting (O.P.S.I., 2019). Governments aim not only to enhance their services' quality but also to follow an open and collaborative government model and ultimately to reach their tremendous potential of enhancing a better quality of life and sustainable growth (O.E.C.D., 2019).

By now, worldwide researchers have been working on main areas that have a direct contribution to DG and transformation (Ronzhyn & Wimmer, 2018). However, in spite of research efforts to date, the proper scientific foundations for DG remain elusive. This lack has been preventing the generalisation and full reuse of the methods and tools that have been developed so far and is threatening the sustainability of DG as a domain for research.

A science base comprises a new set of concepts, theories and principles derived from established and emerging sciences, with a view to long-term problem-solving, as opposed to short-term solution provision. Such a scientific background would document the existing knowledge and open the pathway for systematic and reproducible solutions to identified problems, without the danger of repeating research or missing opportunities for application.

The overall objective in creating and establishing the Digital Governance and Transformation Science Base (DGSB) is to formulate and structure the knowledge gained through pragmatic research in the domain throughout the previous several decades and beyond. This indicates that there is a cohesive and distinct body of scientific information and understanding attributed to that research aiming to build on existing knowledge and to those wishing to use it. Without such a DGSB, there is a danger of repeating research, and missing opportunities for application. To be more precise, DGSB aims to:

(1) document and catalogue domain knowledge. In this context knowledge may embrace factual knowledge, and methodologies for application.

(2) identify application areas for domain knowledge items. This will include a taxonomy of problems addressed by the DG and Transformation domain, and the domain solutions to these problems.
(3) identify approaches for application, which may combine methodologies to achieve integrated solutions for complex problems. These should, if possible, characterise problems in sufficient detail to eliminate inappropriate methods and prioritise those which are applicable.
(4) identify domain related problems which are currently not resolved or addressed in the knowledge base, and which should be prioritised for research.
(5) identify related problems addressed in other sciences, directing attention to the appropriate knowledge in the addressing domain.
(6) support application of DG knowledge by clearly documenting the route from domain problems to domain solution approaches and providing access to the solution methodologies. This may be linked to access to both the knowledge base content and to sources of expertise, consultancy, or training to support application.
(7) identify, structure and document fundamental axioms and consequent theorems of interoperability, to form the foundation for establishment of DG and Transformation as a new and self-standing scientific domain.

The recent efforts in developing a DGSB demonstrate a growing interest in developing the subject of DG and transformation in a more systematic and scientific way.

In this context, the purpose of the current chapter is to contribute to the scientific foundations of the DG and transformation research domain by unfolding the domain, systematising the state of play in DG applied research. Taking as a basis the reference work from researchers in the area along with the results of the Digital Government Reference Library (DGRL, Scholl, 2020), this chapter presents an analysis of the domain structure element.

The present chapter is structured as follows: In Sect. 2, the methodological approach is presented, leading to Sect. 3 that presents the knowledge sources along with the steps of processing the extracted data. Section 4 reveals the DGSB while an analysis of the DGSB domain structure ingredient follows. Section 5 presents the visualisation on the DGSB domain structure. Finally, Sect. 6 concludes this chapter.

2 Methodological Approach

The methodological approach of the analysis of the scientific domain and the relevant research initiatives are structured and while it follows diverse steps in order to enhance the components, the main one is considered to be the literature review. It is the one that provides the current stage concerning the Digital Government Science Base domain structure. Literature findings are not used for a single purpose in this research initiative, but they rather influence the majority, if not the absolute majority, of the divisions of this research initiative. That happens in a different quota in each division. Yet, the literature that was analysed does not originate from a single source of information.

Traditional forms of research initiatives in literature, meaning journal papers, conference papers, and book chapters, are a major share of the sources of information that came together in order to form the knowledge base for this research. More specifically, they are used in order to identify the basic structure of the domain structure of Digital Governance Science Base. For this purpose, the DGRL was used. Using EndNote (2021) in order to search the Library and RapidMiner (RapidMiner Studio, 2020), the enhancement of the Domain Structure was made possible. Examining the title, the abstract, and the keywords of every published paper that were part of DGRL, the existing elements of the domain structure increased on various subcategories.

Those elements increased not only using the DGRL, but they also increased by the research into the tracks and mini-tracks of the dominant conferences related to digital governance. The dominant conferences of the field or even those that have neighbouring domains as a subject, meaning not only digital governance or digital government but also computer science, software engineering etc., were found through the classification of the DGRL. The tracks and mini-tracks were studied on the level of title, description and keywords, if existed. Similarly, to the DGRL, if a title, a description or a keyword provided a term that was not overlapped by another term in the domain structure, it was added to the cluster.

It is also important to identify the connection among the elements of the domain structure and also to identify their dependencies. And that is not only for the elements of the domain structure internally, but also their connections with the other science base elements, especially with those of the neighbouring domains, research roadmap and training curricula.

The neighbouring domains have emerged from the deliberations to conferences related to DGSB. They are the related scientific domains with digital governance and transformation. The research roadmap components are extracted by the Gov 3.0 research roadmap (Ronzhyn & Wimmer, 2018) along with Gartner hype cycle for digital government technology (Moore, 2019), where the scopes that the future research initiatives should focus on are presented, based on projections. Those research components connect the state-of-the-art and the future research initiatives. The training curriculum is the training programme concerning digital governance by the Gov 3.0 project (Viale Pereira, 2019; Wimmer et al., 2020). It provides six thematic categories of courses and each one of them assists different aspects of digital governance. All those categories as well as their elements are included in the ontology. In addition, their associations with the domain structure's Areas are also included. The areas are the epicentre of the domain structure, and hence, they are connected with the rest of the elements.

Lastly, the visualisation of the overall domain structure was accomplished using the visualisation tool named Protégé (Musen, 2015). It is a free, open-source ontology editor and framework for building intelligent systems.

The aim was to represent the ontological graph of the entities and elements inside the science base, providing the semantic relations among them, some comments, and their categorization. The result of the creation of the ontology are in the form of Web Ontology Language (OWL) documents. The ontology classes are the entities of the Digital Governance Science Base ontology. Their examples of research and application subjects are the individuals, and their relationship are the object properties. The actual visualisation was made possible by a Protégé plugin, OntoGraf (Falconer, 2010), where the ontology is presented in a functional and easy to understand form.

The long-term objectives of the methodology include strong community building in order to observe different point of views of the domain structure, which will lead to the development of various ontologies for digital governance terms using different ontology and visualisation tools.

3 Knowledge Sources and Extraction

Data Selection: As is mentioned in Sect. 2, the DGRL, version 16.0, was the used source for the DGSB domain structure enhancement. It has been estimated that the DGRL consistently captures and contains at least 95% of the eligible peer-reviewed DGR literature (Scholl, 2010), which shields against potential topical, geographical, or author-related bias.3.1 Digital Governance Science Base.

Data Extraction and Processing Phase: The multiplatform software tool EndNote X9.3 (Build 13758, see http://endnote.com) was used to export the DGRL's data into an XML format. References were extracted by means of the tags (e.g. the author's name, the title of the scientific paper) and were prepared for further processing and analysis. While data in some cases needed to be harmonised (e.g. data found in different forms, or different spelling variants were detected (e.g.UK versus the US)), a pre-analysis phase was deemed necessary. In order to process the data, the science software platform, RapidMiner v.9.3 along with the "Web Mining" extension that is available within RapidMiner were used. For that purpose, the followed procedure was utilised:

(1) Read XML, (2) Select Attributes, (3) Append, (4) Data to Documents, (5) Transform Cases, (6) Tokenize, (7) Stem (Snowball), (8) Filter Stopwords (English), (9) Clustering (k-Means).

(1) Read XML: The "Read XML" operator was used three times along with the "XPath for examples" parameter as follows:

    (1) //xml/records/record/keywords/keyword
    (2) //xml/records/record/title
    (3) //xml/records/record/abstract

    In cases a value is empty, these XPaths remove the whole row.

(2) Select Attributes: The "Select Attributes" operator was used three times in order to keep only the needed subsets of the extracted DGRL's dataset attributes. More specifically, the title of each scientific paper, the keywords along with its abstract were kept while the other attributes were automatically removed (e.g. year of publication, author's name).
(3) Append: The "Append" operator was used in order to build a merged data set.
(4) Data to Documents: This operator generates documents from values within the given data set.
(5) Transform Cases: This operator was used to transform all characters into lower cases.
(6) Tokenize: This operator split the text to "nonletters split point" into a sequence of tokens.
(7) Stem (Snowball). This operator was used to stem words by applying stemming algorithms written for the Snowball language. In our case, we used the English language, which is already included in RapidMiner.
(8) Filter Stopwords (English): This operator filters English stopwords from a document by removing every token which equals a stopword from the built-in stopword list.
(9) Clustering (k-Means): This operator was used to perform words clustering using the k-means algorithm.

4 Digital Governance Science Base and Domain Structure

As science base of a domain is a structured, ordered and semantically searchable body of knowledge defining the underlying principles, methods and applications of a scientific domain, together with its relationship with knowledge arising from other related domains (Charalabidis et al., 2014). Previous research in other domains (Charalabidis & Lachana, 2020a, 2020b; Charalabidis et al., 2014; Jardim-Goncalves et al., 2013) have identified some important components that the science base should include. More specifically, these are:

1. Rationale: Rationale includes a clear explanation of the importance of the existence of the digital governance science base. It provides a comprehensive analysis and understanding of the objectives of the science base including, also, all the aspects of its development and maintenance.
2. Domain Structure: The second component of the digital governance science base includes the scientific areas that comprise the Digital Governance domain. These areas provide a deep and extensive knowledge and understanding of the field, a decomposition of the domain.
3. Research Roadmap: A research roadmap is needed, which acknowledges the digital governance state of the art and future research challenges/issues. These challenges can be presented in the form of a research roadmap without favouring any specific solutions. An extended look at the future of a chosen

field of inquiry sets the action plan by identifying the research objectives which it aims to meet.

4. Neighbouring Domains: Digital Governance needs to be analysed together with a selection of established and emerging neighbouring scientific domains that can provide useful knowledge and inspire the development of its scientific base. In few words "Neighbouring Domains" refers to the Recognized interdependencies among Digital Governance and other scientific Disciplines.
5. Training Curricula: Training Curriculum for future researchers and practitioners in the domain. Thus, the groundwork for a young generation of practitioners and researchers will be laid, which will advance the practical contribution and the knowledge in the Digital Governance domain.
6. Problem Space: A taxonomy of the spectrum of the main application and theoretical problems and challenges that have to be addressed by the domain, organized so as to be used to characterize the 'real life' application and to link them to elements of the solution space.
7. Assessment Tools: Methods and tools for assessment and identification of existing problems in government agencies concerning the exploitation of ICTs for supporting, transforming and enhancing important functions of them. Problem space and assessment methods and tools components constitute a multidimensional vector which aims to reveal the existing 'as is' and the desired 'to be' situation. Understanding the 'to be' situation is of major importance, as it assists in the identification of solution paths as well as specific solution methods and tools that allow the transition from the 'as is' to the 'to be' situation.
8. Solution Space: It is the converse of the problem space, as it provides a taxonomy of knowledge available that allows the identification of paths—directions for the solution of domain application problems. In turn this assist in identifying links to specific solution methods and tools.
9. Solution Methods and Tools: Elaboration of the above solution paths towards the development of more detailed methods for solution for the identified problem/issue, as well as specific tools for this.
10. Code of Ethics: Code of ethics is a guide of principles designed to help anyone conduct anything honestly and with integrity. A code of ethics document may outline the mission and values, the way of approaching problems, the ethical principles based on the core values, and the professional standards.
11. Rules, Theories and Laws: In any scientific field, laws, rules, and theories are defined as detailed, analytic statements about a phenomenon, an observation, an experiment, etc., usually based on an empirically defined constant. Such scientific laws should always be applied under the same conditions and imply the causal relationship between the elements they contain.

This scientific base aims to bring the digital governance domain to a level of maturity similar to the ones of the established and mature domains, such as the engineering ones, and ideally enable whenever two independent digital governance experts are exposed to the same administration situation—problem, and working separately, to come to the same diagnosis for it, and propose the same set of ICT-based solutions (= sets of actions that the specific government agency has to take in order to overcome the problem and reach the desired state).

To this point, we examine the domain structure element. For the visualisation, we combine each identified sub-element of the domain structure along with the other DGSB ingredients, referred to related research as mentioned above. Regarding the other ingredients, no additional research was conducted.

The domain structures element constitutes the second component of the DGSB. It is essentially a system of axes that correspond to different elements, categories, and relations between them that concern digital governance. It provides in-depth and comprehensive knowledge and understanding of the field, a decomposition of the domain. It is simple but flexible enough to be convincingly deep if needed, allowing different analysis levels or abstractions. The domain structure is not a standard ontology. It is expected to evolve over time with the appropriate usage of collaborative tools. That is determined, inter alia, by the diversity of the academic views on some of the subject's relevant issues under the domain structure. There are different views and myriads of different viewpoints. Thus, experts of the domain could always have different views on some issues concerning the domain structure and its fundamental elements and their relations.

There are many lexicons, several taxonomies, and few ontologies of how the digital governance domain is structured. One of the major components of the domain structure is the "Areas". Areas are specific topics of the digital governance. They might be academic topics, technological solutions, processes, techniques, business orientations and other subjects that comprise the digital governance field of application. The view of areas as a tree corresponds to the Digital Governance Area Taxonomy since they have a title, definition(s), links, etc. The Areas are not stand-alone entities. They interconnect with other Areas and with other components of domain structure. That happens in multifaceted ways. Each area could also contain some sub-areas (for instance, interoperability could be divided into legal, organisational, semantic, technical). Those sub-areas could also be divided themselves. From a specific standpoint, it might be reasonable to consider the areas to be the epicentre of the domain structure (Fig. 1).

The next component of the domain structure that interacts actively with the areas is that of the streams. Streams are elements where areas are thematically classified without them sharing common terms. The areas might involve one or more streams. The proportion of the involvement of each stream reveals differing interpretations of the usage, the extension, the versatility, even the feasibility and the adequacy of an area. Apart from the "Areas", streams correspond but also enlarge to Information Systems elements, (1) Process and Regulation, (2) Data, (3) People, (4) Infrastructure, and (5) Intelligence.

1. Process and Regulation: consist of series of activities, rules, or regulations controlling efforts to achieve a desired outcome or goal.
2. Data: are the evidential elements, either in the form of semantic elements or in the form of information (structured or not). The data might differ on the form

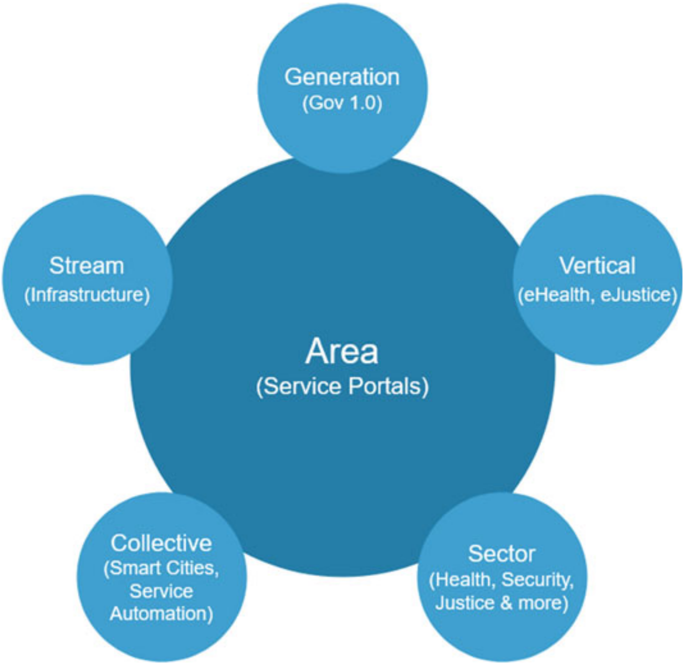

Fig. 1 The digital governance science base domain structure. An example of the "service portals" area

and type; however, the indication of this stream concerns the information on the context of the findings.

3. People: represents the human element. This includes the roles inside the ecosystem where the Area is implemented and their importance. Users, citizens, employees and a plethora of variations.
4. Infrastructure: includes the physical and intangible structures that could be used in order to extract knowledge or public value on the context of Digital Governance. This Stream combines a range of technologies, systems, devices and applications, consisting a synthesis of software, hardware, networks and other information related components.
5. Intelligence: includes specific combinations of processes, data, people and infrastructure that simulates properties of the human mind. It is the one that is abstract on its interpretation. It might have common elements with the "Data", but the distinction between the findings and their transformation into knowledge and cognition is decisive.

This taxonomy, based on literature research, includes 28 areas that are correlated with five Streams with two possible variables, namely "includes" (marked with an X) and "strongly includes" (marked with an XX). That taxonomy is presented in Table 1 and indicates that there is a diversity between the influence of the streams over the

Table 1 DGSB domain structure, areas and streams

Areas	Streams				
	Process (and regulation)	Data	People	Infrastructure	Intelligence
Digital public services	XX				
Business process reengineering	XX				
Dynamic workflow automation	XX			X	
Organisational interoperability	XX				
Semantic interoperability	X	XX			
Technical interoperability	X			XX	
Digital identity (e-ID)	X		X	XX	
Digital security	X	X		XX	
Service portals				XX	
Mobile applications			X	XX	
Metrics	X	XX			
Cloud infrastructures	X	X		XX	
e-Participation			XX	X	
e-Voting	X		XX	X	
Open governmental data		XX	X	X	
Linked data		XX	X	X	X
e-Collaboration	X		XX	X	
Big data processing		XX		X	X
Visual analytics		X		XX	X
Social media		X	XX	X	
Artificial intelligence	X	X		X	XX
Blockchain	X	XX		X	
Internet of things			X	XX	X
Policy modelling and simulation		X			XX
Opinion mining and sentiment analysis		X	XX		XX
Service API-fication	X			XX	
Text mining		X		X	XX

(continued)

Table 1 (continued)

Areas	Streams				
	Process (and regulation)	Data	People	Infrastructure	Intelligence
Evidence-based decision-making		XX	X	X	XX

areas of the domain structure. “Infrastructure”, for instance, is the most influential stream with 12 correlations and 9 strong correlations, while “Intelligence” is the least influential Stream with 4 correlations and 5 strong correlations.

A more thorough look at the above table reveals that “Infrastructure” is included in most correlations. It is also the most areas’ associated stream. “Process and Regulation”, “Data” and “People” are associated with common areas to “Infrastructure”. “Data” is the second-most influential stream, with the same overall correlations with “Process and Regulation”.

Another useful element is that of the correlations—strong correlations ratio. It is roughly interpreted as the number of correlations for each strong correlation in the same stream. “Process and Regulation” has the most significant number of strongly correlated areas, counting a ratio of 2.75. On the contrary, “Intelligence” has the lowest ratio, calculating a ratio of 0.8 strong correlated areas. That ratio’s purpose is slightly more apparent in the next element, the percentage of strong correlations within each stream, where the rate acts conversely. “Intelligence” has a 0.55 ratio, and that is the greatest one, while “Process and Regulation” possess the lowest, of only 0.26. That might indicate the importance of the inclusion of this stream in the areas applied to. In other words, the number of areas that involve “Intelligence” might be the lower, but those that do, involve it more actively.

But as a matter of fact, the comparison between streams on this ratio, e.g. “Process and Regulation” and “Intelligence”, does not signify that either of them is more important. The percentage of the strong correlations might favour the “Intelligence”, but the overall correlation number is significantly greater in the “Process and Regulation” Stream. The apparent observation on this reasoning would be that given that the number of the correlations is equal, then the percentage of strong correlations would indicate the necessity of the one stream against the other. Yet, this is still not a deterministically solid presupposition since the objective necessity of each stream is not easily quantified. Furthermore, the importance, the complexity, the obscurity, the innovation and the organisational particularities of the given area are significant variables in the importance equation, henceforward making it delicate to determine the general stream’s importance. As a result, the domain’s research community could only speculate by examining every stream’s element and composing a projection based on the overall table. Nonetheless, the area–stream correlations are not the only ones that characterize an area.

Four additional domain structure elements were identified. Among them, the digital government’s generations known as Government 1.0 (Gov 1.0), Government 2.0 (Gov 2.0) and Government 3.0 (Gov 3.0) could not be missing. The element

"**Generations**" is an identifier of the digital governance field's big movements, corresponding to the field's evolution over the years (Table 2). Evolutions in the needs and problems of modern societies, in combination with technological evolutions, have given rise to evolutions in digital governance research and practice, and the emergence of new generations of it. It is therefore important to identify these digital governance generations, and also analyse their main features. Some first research that has been conducted in this area (Charalabidis et al., 2019; Lachana et al., 2018) has identified three main digital governance generations, and also developed a framework

Table 2 DGSB domain structure generations

Areas	Streams					Generations		
	Process (and regulation)	Data	People	Infrastructure	Intelligence	Gov 1.0	Gov 2.0	Gov 3.0
Digital public services	XX					X		
Business process reengineering	XX					X		
Dynamic workflow automation	XX			X		X		
Organisational interoperability	XX					X		
Semantic interoperability	X	XX				X		
Technical interoperability	X			XX		X		
Digital identity (e-ID)	X		X	XX		X		
Digital security	X	X		XX		X		
Service portals				XX		X		
Mobile applications			X	XX		X		
Metrics	X	XX					X	
Cloud infrastructures	X	X		XX			X	
e-Participation			XX	X			X	
e-Voting	X		XX	X			X	
Open governmental data		XX	X	X			X	
Linked data		XX	X	X	X		X	
e-Collaboration	X		XX	X			X	

(continued)

Table 2 (continued)

Areas	Streams					Generations		
	Process (and regulation)	Data	People	Infrastructure	Intelligence	Gov 1.0	Gov 2.0	Gov 3.0
Big data processing		XX		X	X		X	
Visual analytics		X		XX	X		X	
Social media		X	XX	X			X	
Artificial intelligence	X	X		X	XX			X
Blockchain	X	XX		X				X
Internet of things			X	XX	X			X
Policy modelling and simulation		X			XX			X
Opinion mining and sentiment analysis		X	XX		XX			X
Service API-fication	X			XX				X
Text mining		X		X	XX			X
Evidence-based decision-making		XX	X	X	XX			X

for analysing them, which included seven main analysis perspectives. A generation may include several areas and vice versa. Each area corresponds to one or more generations.

The areas are almost equally distributed, with Gov 1.0 and Gov 2.0 having 10 Areas each and Gov 3.0 having 8. This table is in line with the literature. It is visible that Gov 1.0 generation includes more areas related to interoperability, processes, business and service digital transformation etc. Those areas signify the first attempts to adopt the fundamentals of the digital governance. Gov 2.0 is mostly about e-collaboration, e-participation, e-voting, social media, so it is visible that the communal aspect of the digital governance possesses a more dominant role. Finally, Gov 3.0 is more technologically enabled, including artificial intelligence, Blockchain, Internet of things, opinion mining and generally disruptive technologies. This is the attempt of the initiatives to insert intelligence and data handling into the policy making and the decision-making process.

An additional element is collectives (Table 3). Collectives are arbitrary, well-coined and recognised, identifiers that act as sets of digital governance areas. One area might be included in more than one collective. Smart cities constitutes a typical

Table 3 DGSB domain structure collectives

Areas	Streams					Collectives		
	Process (and regulation)	Data	People	Infrastructure	Intelligence	Smart cities	Data-driven entrepreneurship	Service automation
Digital public services	XX							X
Business process reengineering	XX							X
Dynamic workflow automation	XX			X				X
Organisational interoperability	XX							X
Semantic interoperability	X	XX						X
Technical interoperability	X			XX		X		X
Digital identity (e-ID)	X		X	XX		X		X
Digital security	X	X		XX				X
Service portals				XX		X		X
Mobile applications			X	XX		X		
Metrics	X	XX						
Cloud infrastructures	X	X		XX		X		
e-Participation			XX	X				
e-Voting	X		XX	X				
Open governmental data		XX	X	X		X	X	

(continued)

Table 3 (continued)

Areas	Streams					Collectives		
	Process (and regulation)	Data	People	Infrastructure	Intelligence	Smart cities	Data-driven entrepreneurship	Service automation
Linked data		XX	X	X	X		X	
e-Collaboration	X		XX	X			X	
Big data processing		XX		X	X	X	X	
Visual analytics		X		XX	X			
Social media		X	XX	X				
Artificial intelligence	X	X		X	XX	X		
Blockchain	X	XX		X		X		
Internet of things			X	XX	X	X		
Policy modelling and simulation		X			XX			
Opinion mining and sentiment analysis		X	XX		XX			
Service API-fication	X			XX		X	X	
Text mining		X		X	XX			
Evidence-based decision-making		XX	X	X	XX			

example of collectives since it contains several areas. The next table presents three exemplary collectives.

There are a few points to observe in Table 3. Firstly, it is visible that "Smart Cities" collective is more widely influential than the other collectives, listing the number of its correlations with the areas. Another aspect is the fact that some collectives are more widespread across the areas matrix. For instance, "Smart Cities" has correlations in the whole spectrum of areas, while "Data-driven Entrepreneurship" and "Service Automation" are more or less accumulated in specific subsets of areas. That could signify the association of the collectives with the government generations. More notably, it is visible that "Service Automation" correlations set almost coincides with the one of the Gov 1.0. That signifies the importance of "Service Automation" as a concept in the first generation of digital government. There are plenty of other observations that could be conducted in order to associate the collectives with the generations or even with the streams. For example, almost every "Service Automation" implies the involvement of "Process and Regulation", or that all "Smart Cities" correlations coexist with the "Infrastructure" ones. The analysis could be exhaustive until every element of the domain structure is connected with all the others.

Verticals, the third additional element, are sets of areas in the same sector of the economy or society (e.g. eHealth, eJustice, each containing several areas). Lastly, sectors are well-known economy or society sectors, where verticals are classified. In order to understand the difference, picture the sector of "Law and Justice", one of the most important parts in our societies and one of most involved with governmental institutions. That includes "eFinance" as a vertical in order to enhance its efficiency and its effectiveness. These five elements are totally linked to each other and describe the digital governance and transformation field's aspects totally (an example can be seen in Fig. 1).

The taxonomy also serves in the context of the expansion. Meaning, the definitions and the structural choices of the formation assist the expansion of the domain structure without significant modification to the structure itself. Another valuable characteristic of the taxonomy is the fact that the components are related to each other, forming semantic connections and describing one another. For instance, an area, which is the part of the largest group in the structure is sufficiently described by the correlations with the several elements. This is fitting, since the areas are the fundamental element of inspection.

Studying the fundamentals of the Digital Governance Domain Structure, there are some points of interest for the research initiatives further structuring the digital governance as a scientific domain. Firstly, the importance of the areas is preeminent. Areas play a leading role in the structure's delineation, since they are the ones that are connected with everything else. Secondly, even if some of the components focus on different aspects of digital governance comparing with some others, they are all equally cardinal in order to provide a crystal-clear overview of the academic context of digital governance. Also, the particularities in the connection of some elements with some others indicate their position in the research agenda. The number of the correlations with other elements indicates an element's relevance and orientation in the digital governance research. Of course, that is not always attainable, because some elements are mutually exclusive, for instance generations, where it cannot belong in both Government 1.0 and in Government 2.0.

5 Ontology Development and Visualisation

After developing the main concepts of the DGSB domain structure, the need to create a more ontologically-enabled visualisation emerges. This way, the investigation of the elements is not one-dimensional, but it rather approximates the connectivity of a network, where all the relevant nodes and objects are interconnected with each other, providing the semantic identifying characteristics of the links between them. Additionally, the modelling of the ontology does not include only the domain structure elements, even though they are the most crucial for the implementation of the Digital Governance Science Base.

One potential solution on this scope came from Stanford Center for Biomedical Informatics Research (BMIR, 2019). The research team provided the academic community a free and open-source platform that includes a suite of tools to construct domain models and knowledge-based applications with ontologies. The name of the platform is Protégé (Musen, 2015), and it is provided in both desktop application and Web application. In the case of the conduction of this chapter, the desktop application was used.

Protégé assisted the formation of the Digital Governance Science Base. Starting the modelling, the first step was to define the classes of the Science Base. Those are the categories of the elements that include the objects and their relations. The classes are generic, and they are the core elements of the ontology. They inherit their characteristics to their representative object elements. Those are instances of the classes that are real-life examples of the categorization. They are entities that construct the ontology, since it is them that the research community meets in the most endeavours and are called individuals. They are often studied in relation with their relationships that usually represent some conceptual connections. These relations are called object properties. They are defined as the semantic notion that connects two classes, consequently two or more objects.

Examining the previous list (Fig. 2), it is obvious that the spatial recesses indicate the sub-classes. That is due to the tree-form of the final ontology. The components of the "What?" are the ones that are analysed in this paper, and some of them are being divided into sub-classes.

One of the functionalities that complements the class definition is that the one of the commenting, in order to clarify some key characteristics of the class and to make the ontology easier to understand to observers (Fig. 3).

The next fundamental aspect of the ontology is the relations between the entities, namely the object properties. The semantic representation of the correlations between elements is enhanced, based on the relations between the entities. A convenient way of presenting one property is the one of an arrow, meaning an implication symbol

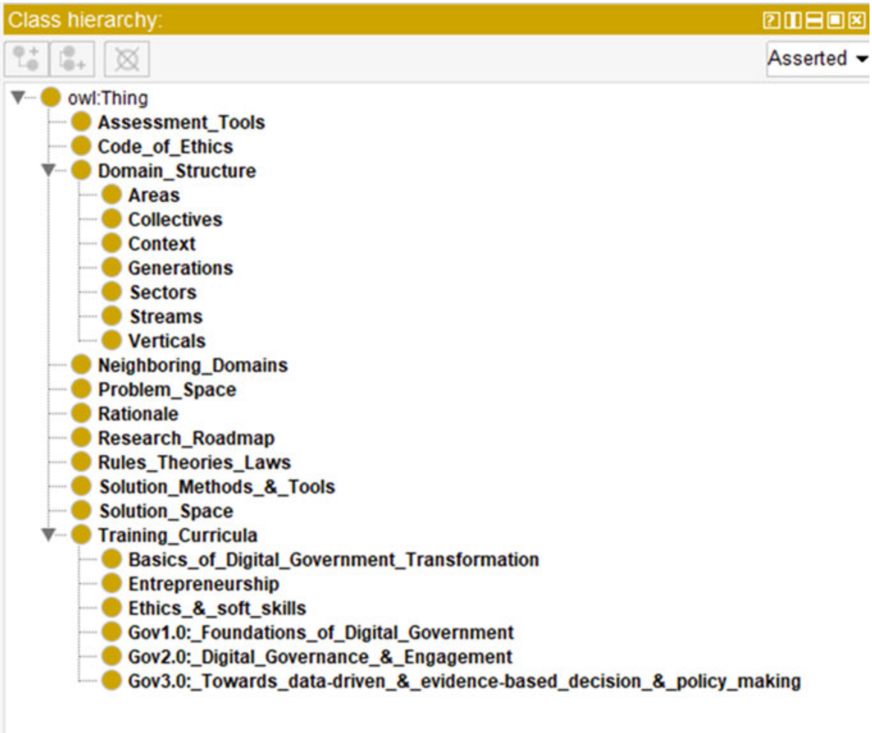

Fig. 2 The classes of the science base

Fig. 3 The class comments

(→). Just like in the case of a sentence that has three parts, meaning subject, verb, object, property signifies the verb that characterizes the correlation between the two elements that connects. Table 4 presents all the object properties with their inverse counterparts, their domains and their ranges, meaning the two (or more) connecting

Table 4 The object properties

Name of object property	Name of inverse object property	Domain/domains	Range/ranges	Description
assists	assisted_by	Areas	Verticals	An area assists the vertical, which are a set of areas in the same sector of the economy or society
augments	augmented_by	Verticals	Sectors	A vertical application augments technologically a sector of the economy or the society
belongs_to	includes	Areas	Generations	Areas belong to certain digital governance generations
focuses_on	utilized_by	Training curricula	Areas	A training curricula object, which is not a part of the domain structure but it is connected with the areas, focuses its educational purpose in one or several areas of application
grouped_to	group	Areas	Collectives	Areas are grouped into collectives, which are large thematic groups of applications and research objectives

(continued)

Table 4 (continued)

Name of object property	Name of inverse object property	Domain/domains	Range/ranges	Description
involves	participates_in	Areas	Streams	The areas involve several factors in their applications (e.g. data, human factor) and those are the streams
pertains_to	perinent_to	Areas	Research roadmap	The areas are deeply connected with the research roadmap findings; hence, each area pertains to one or several research roadmap elements
related_with	relates_to	Area	Neighbouring domains	The areas are related with the neighbouring scientific domains, since they are not stand-alone entities
strongly_involves	strongly_participates_in	Areas	Streams	Some areas are heavily dependent of some streams, so they are connected with them through a stronger relationship

entities and a short description. In each of the inverse object properties the domain and the range exchange values.

For instance, following there is the property of "involves" (Fig. 4). That is the property that connects an area with a stream. The areas involve streams in a way that a stream, which is a set of factors in the implementation of an initiative, plays a role in the implementation of an area, which is an entity that concerns the application that enhances digital governance.

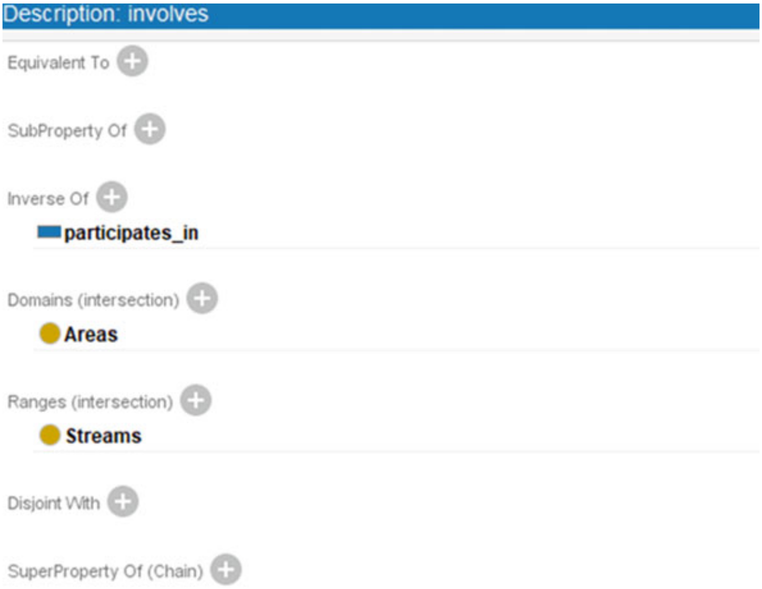

Fig. 4 Object property example

In this Figure, the fields of the description are visible and each of them represent a separate part in the semantic analogy of the correlation. The domains are the elements that could play the role of the subject in the semantic analogy. It is the node where the correlation begins. The ranges are the ones that represent the object. It is the "target" node of the arrow. Another part that it is intriguing is the one of the inverse. There the inverse, or the arrow with the exact opposite direction, is defined. In this example, the "involves" property has the "participates_in" property. That means that if the domains—ranges reverse each other the appropriate property that connects them in that order would be the "participates_in". It is plausible that the inverse properties, in the most cases, have inverse meaning. In this case, the involves is the inverse verb of the participates. The first one is used by the wider group for the sub-groups, while the other is used by the smaller entities that lead to the bigger ones. In other examples, the inverse entity is described by the same verb, just used in the contrary voice, meaning in the passive voice if the initial is used in the active voice or in the active voice if the initial is used in the passive voice. For instance, a "Sector" is "augmented_by" a "Vertical", while a "Vertical" "augments" a "Sector". That underlines the clausal nature of the semantic representation.

Moving forward, the next step is the definition of the exact objects, meaning the records that are not classes or properties, but they are the actual examples of the classes that the properties apply to. They are called individuals. They belong to classes are described by the properties and are presented organised by their class. The individuals are the ones that comprise the essence of the domain structure ontology, inheriting their classes' characteristics and following the rules, meaning the properties that the relevant classes follow, as it is visible in the list below (Fig. 5).

The properties that they have depend on their class. That happens because some classes connect with only one other class, while others might have multiple types of properties for different connections with classes. In this case, the collectives as a class interacts only with the areas. Consequently, the properties of the collectives individuals will be consisted only by "group", meaning area (Fig. 6).

Another, more complex example of individuals might be that of an area (Fig. 7).

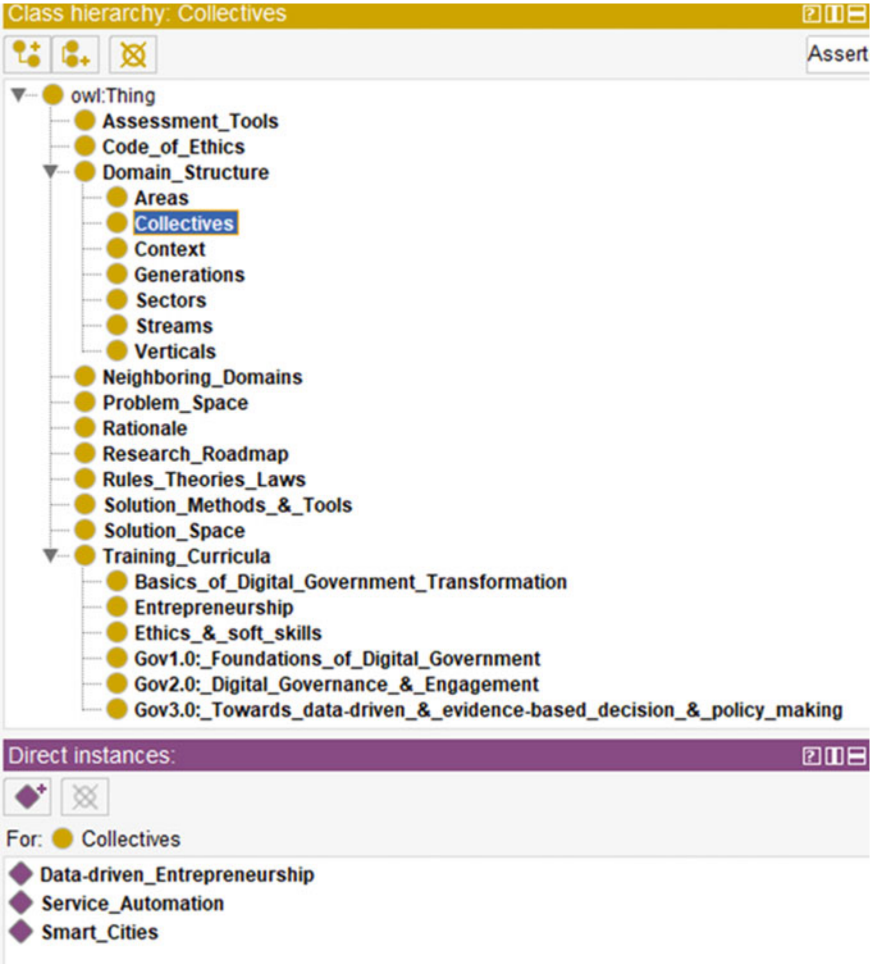

Fig. 5 Individuals presented based on their class

Fig. 6 Individuals' characteristics

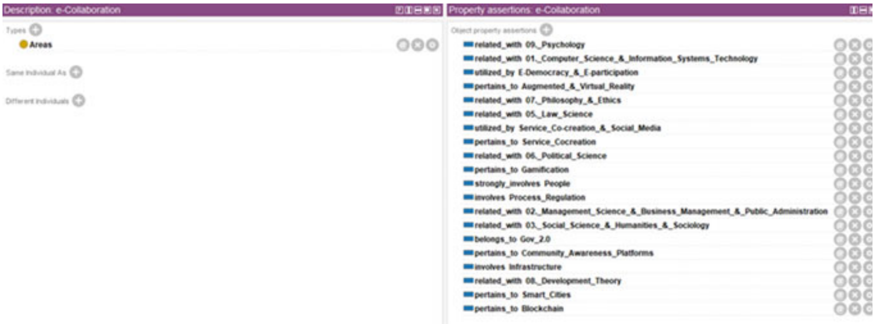

Fig. 7 More complex Individuals' characteristics

Another important aspect that needs to be clarified is that even if the domains and ranges might be the same in an object property, the correlations' semantics might differ, depending on the name itself. For instance, a stream can either "participate" in an area or it can "strongly_participate" in an area (Fig. 8).

Finally, with the usage of the OntoGraf, which is a Protégé plugin, the ontological visualisation was made possible. The final view provides the user with the ability to open the exact classes needed, to visualise the ontology in a plethora of schemas (horizontal tree, vertical tree, spiral, network etc.) providing the exact individuals and their correlations. The correlations are presented as arrows between the nodes and

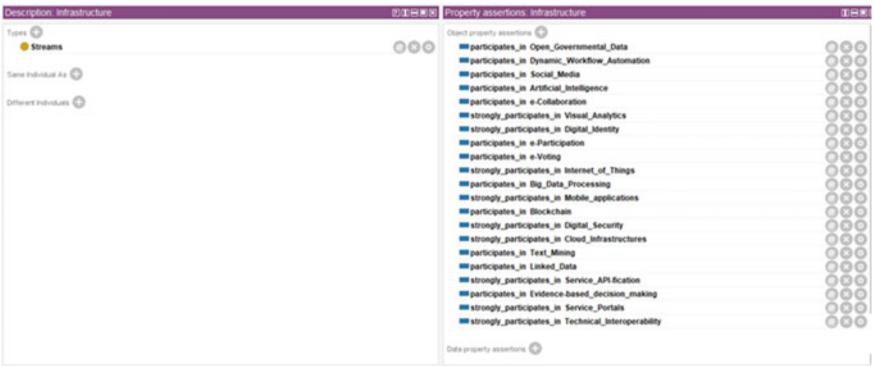

Fig. 8 Semantic differences between properties

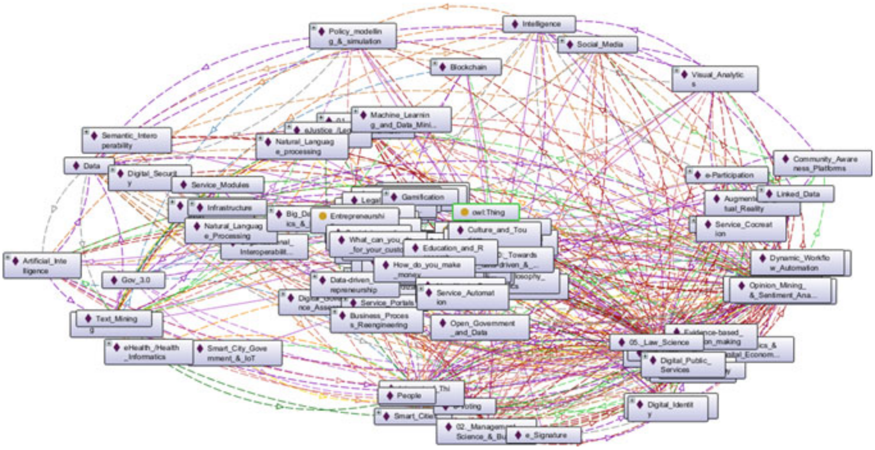

Fig. 9 Network overview of the digital governance science base using OntoGraf

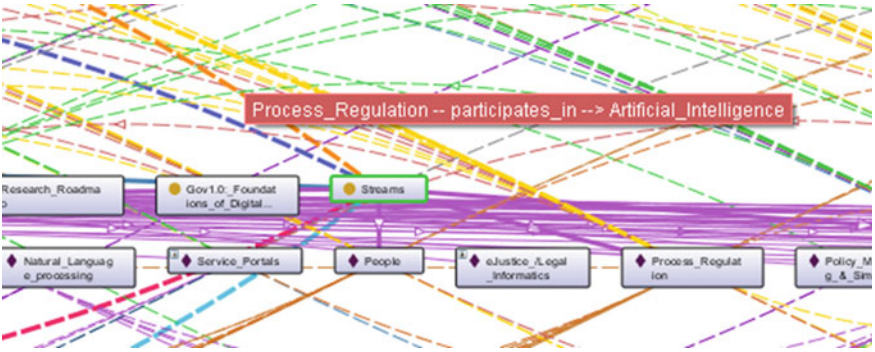

Fig. 10 The properties presented as arrows

one could see the name of the correlation, as well as the types of classes it connects. Hovering over an individual, one could also see its class and all the properties of this particular individual. The exploration of the ontology is accomplished through careful examination of the objects, since the overall number of individuals and properties is quite extensive and increases the visual complexity of the schema. Luckily, the visual representation is dynamic, and the observer can move objects in order to make the schema more appealing. The OWL code of the schema created with the Protégé is free and open source and it is available at Github.[1]

The OntoGraf ontologies are presented below (Figs. 9, 10 and 11). They are presented in different modes in order to simulate the variance of appearances that could emerge using OntoGraf. More conveniently, the user could experiment the ontology if it would be uploaded in the Web application of Protégé.

[1] https://github.com/panos-keramidis/DGSB_OWL.

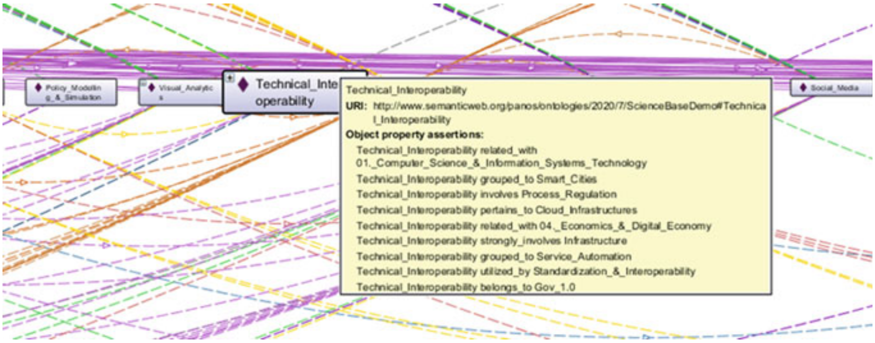

Fig. 11 The individual properties

As it is visible, the purple diamonds are the individuals, the yellow circles are the Classes, and the multicolour arrows are the Properties between them.

The number of objects in the ontology does not allow them to be readable if the ontology possesses the whole canvas presented as a horizontal or vertical tree, which are structured by class-level hierarchies. Fortunately, using Protégé with OntoGraf plugin or a Web application that is capable of visualising OWL documents, the user is able to zoom in and out in order to specify the canvas in any point. Another useful functionality of Protégé is the ability to search specific objects and entities in OntoGraf.

Generally, the ontology presents the components of Digital Governance Science Base, their objects and correlations with semantic representation. Protégé provides a Reasoner, meaning a tool that checks the logical correctness of the ontology created, and that Reasoner indicates that this ontology does not include any logical inaccuracy.

6 Conclusions

Developing a DGSB that has recently emerged has led some academic agents to seek to systematize domain knowledge. Still, these efforts have been looking to organise and aggregate information from very fragmented and disparate sources in the embryonic stages and with different granularities of detail, distinct epistemology origins, and disparate academic fields. Creating a DGSB requires a more structured approach from academics towards organising existing research work and knowledge. In this context, the purpose of the current chapter is to contribute to the scientific foundations of the DG and transformation research domain by unfolding the domain, systematising the state of play in DG applied research. Starting from the core sub-ingredients of the DG and transformation domain, and by analysing the current technological trends and the background knowledge of the domain, the first DGSB ingredient, the DGSB domain structure, is formulated. While domain structure is one of the core components, these sub-ingredients are of significant importance in digital governance and transformation. However, these are incapable of solving all domain-related problems, as the domain is constantly becoming more complex, with disappearing boundaries, loosely coupled architectures, and virtual resources (e.g. new technologies, the evolution of the Web).

Concerning the literature findings, the goal is to include the findings of the DGRL and the conference tracks after a classification comparing the existing individuals. That needs deliberation and careful examination. The next version of the ontology will include those alongside their semantic relations. Also, the next version should include the data attributes, and as a result, there will be a re-evaluation of the object properties. Finally, having the findings of the "What?" region of components of the Digital Governance Science Base, it is crucial for them to be used in order to identify the "How?" region of components, meaning the "Problem Space", the "Solution Space", the "Assessment Tools" and the "Solution Methods and Tools". Those components are related to the more pragmatic aspects of the problem–solution factors in digital governance. Yet, it is essential to have the research foundations been clarified in order to move on to the problem definitions, the solutions, the tools available, and the methods. So, the results of this study need to be cross-examined with a more practical approach in order to identify the structural factors that lead to the problems and the solutions concerning digital governance.

Finally, taking into account the main science base components shown and explained in Sect. 4, in order for these to be achieved, research is required mainly along with the following main directions:

(a) Analysis of existing methods and tools for digital governance-related assessments and problems identification, development of new methods and tools for this purpose, as well as concepts and theories that can be useful for this.
(b) Analysis of existing approaches, as well as methods and tools, for the solution of the above problems (concerning the development of digital governance), development of new methods and tools for this purpose, as well as concepts and theories that can be useful for this.
(c) Analysis of concepts and theories, as well as solution-oriented approaches, from neighbouring scientific domains, such as computer science, management, political science, sociology, law, economics, which could be applied in the digital governance domain; and also the opposite as well: analysis of concepts, theories and solution-oriented approaches from the digital governance domains, which can be used in the neighbouring scientific domains. Recognition of such knowledge sharing provides the opportunity for domains to advance by absorbing methodological and technical advances from related ones.
(d) Envisioning a roadmap for future research to tackle broader governance problems via ICT applications combined with innovative approaches from the above neighbouring scientific domains.
(e) Enrichment of the above components of the science base of a domain with additional ones that are important for the digital governance domain.

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Digital Governance Education: Survey of the Programs and Curricula

Demetrios Sarantis, Soumaya Ben Dhaou, Charalampos Alexopoulos, Alexander Ronzhyn, and Francesco Mureddu

Abstract This study investigates the number and nature of e-Government programs available in different types of educational institutes. An analysis of 57 programs provides evidence regarding the geographical distribution of the programs, the degree level of each program, the e-Government topics and courses, the aims and learning goals, the knowledge areas, the institution type and department hosting the program etc. This study initiates a general dialogue on the nature, content, objectives, and delivery of e-Government education. An exploratory review and content analysis of the 57 e-Government programs, representing different type of institutes world-wide, reveals that they offer courses emphasizing a broad range of skills, objectives, perspectives, teaching methods, and cognitive content. However, many common structures, topics, and courses have emerged. The issues addressed in this study should help educational institutes better prepare the e-Governance programs for the future challenges, especially concerning the progress of the disruptive and emerging technologies in the public sector.

Keywords e-Government · Digital government · Education · Training · Curriculum · Course · Teaching

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1 Introduction

e-Government is reshaping society's needs and public administration's practices, yet many have expressed concerns over the e-Government education and training provided to the students. The government and public administration face significant challenges in their implementation of e-Government, particularly in emerging countries. These challenges are not only related to technology but encompass multiple aspects. Thus, the development and implementation of the e-Government require multiple skills and competencies beyond technical skills of adopting and using technology (Hunnius et al., 2015).

With the COVID-19 pandemic situation, technology, ICT, and digitalisation are thoroughly adopted at all levels and all the sectors. It became the main channel for government and public administration. It is also transforming tremendously and becoming fundamental for the government to function. Consequently, ICT-related competencies and related skills are becoming critical for all public service managers and employees (Estevez & Janowski, 2013). The current situation with the actual number of e-Government project failures indicates the significant lack of competencies, knowledge, and skills (Anthopoulos et al., 2016).

These aspects highlight the needs and increase the concerns over the e-Government education and training provided to the students. The research is more and more aware of the importance of the needed skills and competencies. Research output demonstrates that in some cases, there is a lack of specific competencies. Studies have investigated in different ways how to address the education and programs for reaching the adequate needs in term of skills and competencies for the e-Governance field. The topic of e-Government remains rare in information systems management. Information systems and public administration programs are slowly integrating topics related to digitalization of the government and public services. Master degree programs on the field of e-Government already exist. However, it is not entirely clear how these programs, the teachings, the topics, and the learning objectives are defined. These questions are even more relevant nowadays, considering the multidisciplinary nature of the current trends and needs in the e-Government research field (Sarantis, 2020). To address the above issues, it is important to portray and clearly describe the landscape of the education programs in e-Government. The above landscape depicts the areas that the current education programs focus.

Therefore, this study investigates the number and analyses in detail the nature of e-Government programs available in different educational institutes. Drawing upon a quantitative approach, a sample of 57 programs provides evidence regarding the programs' geographical distribution, the degree level of each program, the e-Government topics and courses, the aims and learning goals, the knowledge areas, the institution type and department hosting the program etc. This study discusses the nature, content, objectives, and delivery of e-Government education to reach the government and public services organizations' expected needs in terms of knowledge and skills. The purpose is to clearly define the current situation of the education in e-Government and discuss it in order to propose the adequate programs enabling each role and responsibility in the government to acquire and develop the adequate knowledge and understanding of e-Government and ICT for public service and government.

This chapter contributes to the Digital Governance and Transformation Science Base (Charalabidis & Lachana, 2020) second wave (hypothesis and experimentation) identifying relative training curricula. The chapter is organized as follows: the first section is reviewing the literature on the topic. The second section presents the research methods to explore education programs worldwide in the field of e-Governance. The third section describes the research results regarding the geographical distribution of the programs, programs topics, programs classifications, programs allocations of knowledge areas, degree types, admission requirements, and course compositions. The fourth section discusses the findings and highlights the contributions. Finally, a conclusion is summarizing the findings, the limitations and the next steps of the research.

2 Literature Review

Knowledge capital is considered by United Nations (UN) a fundamental factor in achieving high rates of digital transformation. This capital is measured by UN through the Human Capital Index (HCI), consisting of four components: adult literacy rate, the combined primary, secondary and tertiary gross enrolment ratio, expected years of schooling, and average years of schooling (United Nations, 2020). These four components represent various facets of educational attainment as a reliable proxy of human capital (Pérez-Morote et al., 2020).

Chohan and Hu (2020) argue that information and communication technologies (ICT) enable public sector reform through the essential consideration of ICT training as an enabler. Specific ICT training programs offered to citizens are essential to implement e-Government services aligning with the concept of leaving no one behind. Proper training approaches make citizens confident, knowledgeable, cognizant, and empowered to use e-Government services and, most significantly, they bridge the digital divide through ICT inclusion in society. Study results provide also useful evidence for public administration that appropriate education e-Government programs increase the probability of e-Government services consumption by the citizens.

Lee and Porumbescu (2019) confirm in their study that government IT training programs represent one type of intervention that can play a key role in increasing e-Government acceptance among all stakeholders. They also find that there is a sound relationship between participation in government IT training programs and e-Government use, especially in old or disabled people. Government IT training programs can play a key role in initiatives to mitigate the digital divide and they can inhibit marginalization of vulnerable segments of the population. Lee and Porumbescu highlight the need of further research to explore the different curriculum styles and training formats of e-Government training programs. Since the general curriculum that is applied at the moment is not tailored to the current educational needs, it is important for future research to provide better insight into ways of enhancing the effectiveness of these programs (Lee & Porumbescu, 2019). Customized training program for senior government officers has been implemented to moderate their skills deficiencies (Gregor et al., 2020).

McQuiston and Manoharan (2020) find that Asian public administration programs do not offer adequate training in the information technology area. More specifically, Master of Public Administration (MPA) and Master of Public Policy (MPP) programs in South Korea and India focused comparatively more on information technology in their coursework than those in Cambodia, Indonesia, Laos, or the Philippines. Graduate public policy programs throughout Asia offered very few courses that go beyond an introductory or survey approach to information and communication technologies. Advanced IT courses in Asian public administration programs did exist, but they were offered irregularly as electives. The majority of the universities analysed in this research; however, leave on students' discretion to identify where information technology coursework was being offered and to add them in their curriculum.

Salajan (2019) examines the ideational construction and definition of the European Digital Education Area (EDEA) as a policy space and mechanism for the mainstreaming of digital technologies in Europe's education and training systems. The study argues for EDEA's formal acknowledgment as a political European priority and key policy area enforceable through tools similar to those existing under the Bologna Process for a coherent, concerted and strategic approach to digital education at EU level.

After studying several e-Government education programs, Scholl (2020) argues that the methodological competence of the students is improved by the acquisition of knowledge, skills, and abilities, extending through to software support and technical tools. He also finds that students are not interested on experimental methods and prefer a traditional style of presentation. He also ascertains the need of consolidation of technical and organizational aspects. e-Government education programs should integrate interdisciplinary aspects into various courses. Scholl (2020) concludes that a few studies deal with e-Government competencies, although information technology (IT) is becoming an essential professional skill in public sector. Research output demonstrates that in some cases, there is a lack of specific competencies. Integrative understanding of IT and e-Government processes is particularly important, and it is not covered adequately in education programs.

3 Research Method

The method applied in the present research contains three parts: the identification of the research keywords regarding the data collection of current education programs in the e-Governance area, the classification of the geographical search areas, and the specification of a metadata scheme for data collection.

The first phase consists of the research step to collect the data. A list of concepts and combinations of keyword are identified to search for education programs worldwide. The following terms were used in the subject search: digital governance, digital government, electronic governance (e-Governance, e-Governance), electronic government (e-Government, e-Government), public administration information systems, digital transformation, public sector innovation, digital government transformation, and public sector digital transformation. The following terms were used in the degree search: bachelor, capacity building, certificate, continuing professional education, diploma, education, executive masters, graduate, higher education, masters, MSc, PhD, program, specialization, training, undergraduate, joint master, and Massive Open Online Course (MOOC). Google search engine was the key search source. Researchers have been motivated to use additional search engines on their discretion, as they considered appropriate. Websites of higher education institutions (public and private) and foundations have been analysed. Researchers, speakers of diverse languages, participated in the present study, so that an extensive range of educational programs could be identified aiming to record all of them. Educational programs data have been manually gathered through the institutions' webpages. The search incorporates two types of concepts. The first type covered the subject (e.g. digital government) and the second type covered training/educational degrees (e.g. BSc). The search integrated one term of the subject group and one of the training/educational group (e.g. digital government and BSc).

The second phase consists on filtering, organizing and classifying the data. A group of researchers has been allocated to cover all continents worldwide. The classification was based on the United Nations (UN) world's geographical segmentation: Western European and Others Group (WEOG) except the USA and Canada, USA and Canada, Asia–Pacific Group except China, African Group, Latin American and Caribbean Group (GRULAC), Eastern European Group, China.

The key goal of the third phase was to determine the instrument to retrieve and assess current e-Governance training/education programs' data. The training program description worksheet (TPDW) has been designed to collect the proper information, containing all the education programs' related data. Using the taxonomy provided by the TPDW, a comprehensive view of education programs on the world level has been acquired, including numerous educational features, such as the academic level of a program, the program name, and the institutional type. The TPDW, described in the subsequent paragraphs, also dives into details, such as the aims of the program and/or learning goals, the program knowledge area, the admission requirements, and the provided courses.

There are four groups of elements for an education program, which have the purpose to describe specific features of a program in a systematic and coherent way that facilitates the structure of the current e-Governance education programs into a taxonomy. The objective of this taxonomy is dual: (i) to provide the means—based on its structure—for the systematic analysis of the existing programs to extract conclusions regarding, for example, the type of provided courses and the targeted participants; (ii) and to enable the identification of possible training gaps with the use of specified e-Governance training needs. To this end, each group that has been identified describes in a straightforward way specific defining features of the education program, specifically.

The Program Description group depicts the generic view of the education program. It includes data records, such as the program name, the academic level, the aims of the program and/or learning goals, the area of program specialization, the program overview and the admission requirements.

The Program Content group includes information regarding the courses provided within the program. It consists of the following data records: the course code, the course name, the course type, the course description, the course credits, the learning outcome/goals, the course supporting material, the course URL, and the comment.

The Program Administration group provides some additional information about the programs. It includes the degree title, the credits-ECTS, the teaching method, the program cost, the program duration, the language, and the program URL.

The Institution group states the main features of the body that offers the education program. It includes the name of the institution, the country of institution, the institution type, the department of the program, and the comment.

4 Survey of e-Government Programs: Results

Based on the descriptive analysis realized on the data collected, different aspects presenting the nature of the education program on e-Governance were studied: the programs allocation by continent, programs topics, programs classifications, programs allocations of knowledge areas, degree types, admission requirements, and course compositions.

Through detailed desktop research on official webpages of universities and education providers, 57 e-Government related programs were identified, using the TPDW metadata. Identified programs are strictly focused on e-Governance area, mainly combing public administration and technological aspects. Thereinafter, the features of the education programs are illustrated following the facets that have been defined in TPDW. These include general information (country, institution, and department offering a program), information about the form of programs (degree type, duration, teaching method, program topics, aims and learning goals, knowledge areas), accessibility of programs (admission requirements, cost), and the content (courses offered within the programs). The aim of the description in this section is to provide a broad overview of the programs offered in the domain of e-Government.

The present review (openly provided in GOV3.0 project deliverable 1.2: World-wide training needs on electronic governance) identified 57 education programs (Table 1), from 30 countries. Europe (54%) and America (30%) (Fig. 1) provide most of the 57 identified e-Government education programs (22 undergraduate, 35 postgraduate). The USA lead the race with 6 programs, followed by, Mexico (5), Estonia (4), Germany (4), Romania (4), UK (3), Italy (3), Argentina (2), Belgium (2), Canada (2), Colombia (2), India (2), Netherlands (2), Poland (2), South Africa

Table 1 Sample of e-government education programs

ID	Program name	Type	Institution	Level	Country
302	Master's degree E-government	M	Koblenz Lendau Universitat	Postgraduate	Germany
199	Digital transformation in government	E	Harvard	Postgraduate	U.S.A.
214	Nordic master programme in innovative governance and public management	M	University of Agder	Postgraduate	Norway

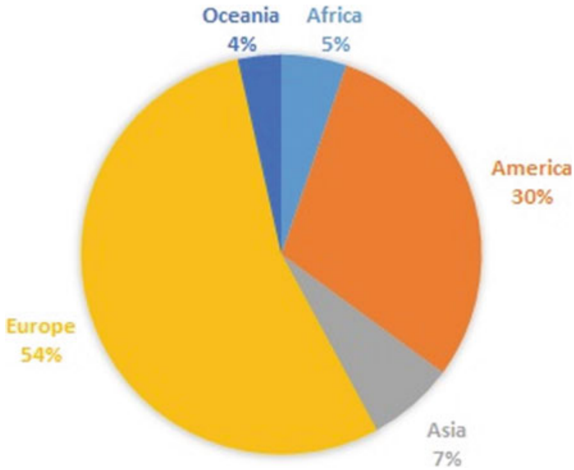


Fig. 1 Programs allocation in continents

(2), and 1 program from Armenia, Australia, Austria, Barbados, Belarus, Bosnia and Herzegovina, China, Hungary, New Zealand, Russia, Serbia, Singapore, Sweden, Switzerland, and Uganda.

The considered e-Government programs' curricula clearly recognize both technological aspects and public administration needs. They provide exposure to topics such as: application of ICT for delivering government services, exchange of information, communication transactions, integration of various standalone systems and services between government and users, management of the public service transition to electronic government, smart city governance.

Analysis of the educational program descriptions provides the main topics that educational programs emphasize (Fig. 2). Most of the programs concentrate on government transformation (34), focusing on various aspects of the use of computer-based information and communications technologies (ICT) to change the way governments work. Many consider e-Governance technologies and services (9), largely focusing on IT solutions at a governmental level and emerging technologies application to services provision. Four of them have leadership in e-Governance

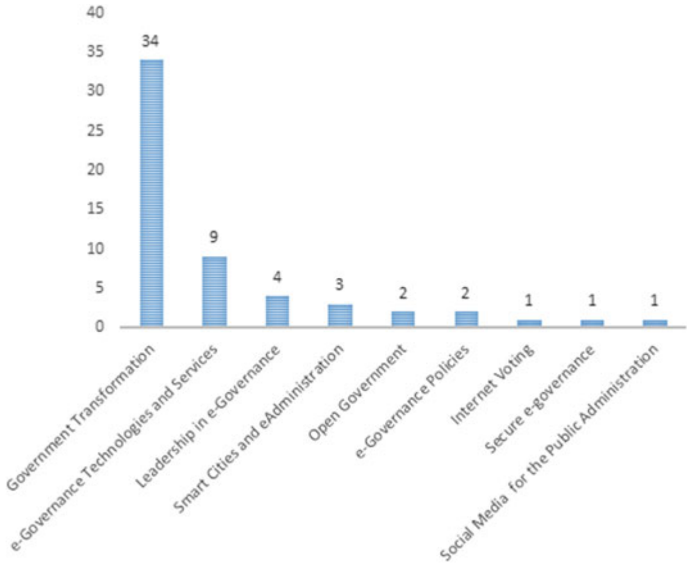


Fig. 2 Programs' topics

as main topic. They study the formation of leadership potential of civil servants and officials, civil society and business towards implementing e-Government.

A few of them (3) consider smart cities and e-Administration, concentrating on the smart city concept and how city administration should be interpreted and what it can mean in practice. Two programs deal with open government, a governing doctrine that holds that citizens have the right to access the documents and proceedings of the government to allow for effective public oversight and two other study e-Government Policies, concentrating on specifics and challenges of e-Government policy, and discuss the various aspects of policy implementation in e-Government. They draw attention to aspects in national e-Government policy and practical policy implementation. Specific issues like internet voting, secure e-Government, and social media for the public administration are also among the considered topics.

e-Government educational programs cover a wide variety of **aims and learning goals**. Among others, they include the understanding of the major paradigms and perspectives on e-Government, consideration of policies and practices in e-Government, training leaders to be sensitive to social problems and visionaries of effective and modern public administration, designing, developing and improving governmental systems and implementing e-Government components, provision of emerging technologies applications skills to practically apply e-Government solutions etc. The aims and the learning goals of the programs vary and have been classified in six clusters. According to the revised version of Bloom's taxonomy (Anderson & Krathwohl, 2001), the programs' aims and learning goals vary and have been classified into six clusters. There are six major cognitive processes categories, starting from the simplest to the most complex (Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation). The allocation of the identified programs (Fig. 3) to different categories is the following: Knowledge (47%), Comprehension (19%), Application (10%), Analysis (13%), Synthesis (9%) and Evaluation (2%).

Each program concentrates on specific **knowledge areas** (Fig. 4). The allocation of training programs in areas of knowledge is the following: e-Governance

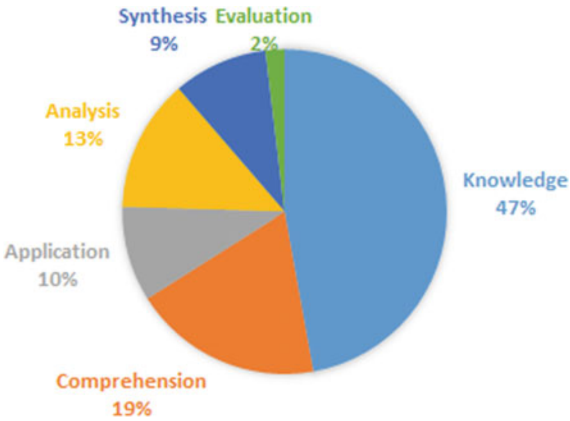


Fig. 3 Programs' classification based on Bloom's taxonomy

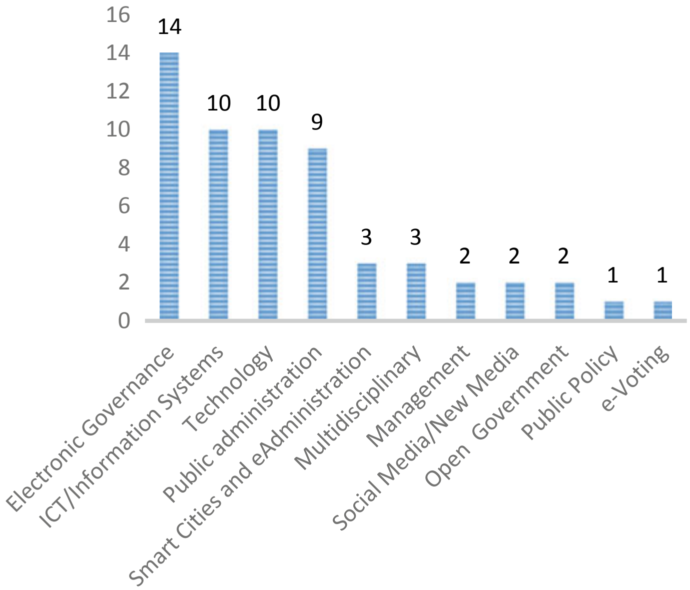
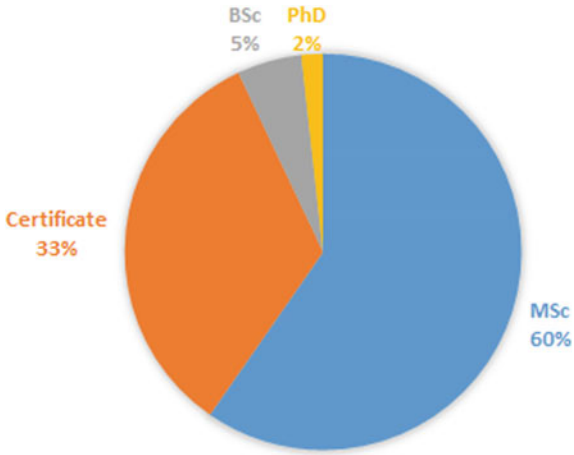


Fig. 4 Programs' allocation on knowledge areas

Fig. 5 Programs' degree types



(14%), ICT/information systems (10%), technology (10%), public administration (9%), smart cities and e-Administration (3%), multidisciplinary (3%), management (2%), social media/new media (2%), open government (2%), public policy (1%), and e-Voting (1%).

The degree types that the different e-Government related programs award can be classified in four main categories (Fig. 5): Certificate (19), BSc (3), MSc (34), PhD (1).

The vast majority of education programs (93%) are offered by higher education institutions (HEI): universities (44 programs), institutes (7), academies (1), and colleges (1). Non-HEI offering e-Government programs include international centres (2) and organizations (2). Some e-Government courses are offered at institutions specialized in governance education like Hertie School of Governance (Germany), Monterrey Technological School of Government and Public Transformation (Mexico), while two institutions specifically focus on digital government (Institute for Digital Government in Romania, Centre for Studies on Digital Government in Poland).

Different types of departments offer e-Government education programs. The majority of the departments that provide programs in e-Government are technology-oriented (e.g. Information Technology, Computer Science and Informatics). They are accountable for 38% (13) of the programs for which the information was available. Related Systems and Information Sciences Departments are responsible for a further 11,8% (4) of programs. Public Administration and Management departments host nine of the programs, while Political Science and Governance department host two more. Other departments offering e-Government programs include Social Sciences and Humanities (3) and Law (1). Three programs are offered at departments specific to the digital government (including digital transformation). Interestingly, some hosting departments can be classified into two groups, like Science, Technology, Engineering, and Public Policy department at University College London or Faculty of Humanities, Learning Information Networking Knowledge Centre at University of the Witwatersrand (South Africa).

The **admission requirements** indicated by the programs can be classified into several categories: Academic requirements indicate the need to possess a specific certificate (e.g. High School certificate) or degree (bachelor's degree for postgraduate courses). Some programs require a certain average grade for admission. The admission requirements indicated by the programs can be classified into several categories: Academic requirements indicate the need to possess a specific certificate (e.g. High School certificate) or degree (bachelor's degree for postgraduate courses). Some programs require a specific bachelor's degree or a certain average grade for admission. Assessment requirements include the requirement to possess a specific certificate or proficiency test result. In this case, the English language proficiency certificate is often required (IELTS, TOEFL, and others), but sometimes, another specific test result is needed. Work experience requirements encompass the need to have a specific amount of professional experience. An example of such a requirement would be having at least X years of work experience in the public sector or occupying a specific position (e.g., "Middle and senior-level staff"). Such requirements are more common for postgraduate-level programs. For some programs, it is explicitly mentioned that no previous experience in the sector is required. This is more common for short-duration or undergraduate programs. Research interest requirements include defining one's interest in the course by outlining a research proposal or providing a motivation letter. Knowledge requirements are usually less strict and include familiarity with a specific research field or business area (e.g. "background in economics", "practice of IT", "background in politics"). Other requirements indicated include a specific age limit or the need to provide references for admission. Often the programs distinguish between strict requirements (often a prior degree in the relevant field) and indications what the "ideal candidate" should have (often work experience in the domain). The vast majority of programs (76%) are taught in a class setting, where students have to be physically present during the course. A total of 29 out of 38 programs indicated this **teaching method**. The percentage is likely even larger, as the programs whose description do not clearly state the teaching method are likely offered only offline. A minority of programs adopt online or distance teaching methods (7) with two programs offering a combination of different teaching approaches. Additional teaching methods mentioned in the context of the programs were group discussions (3) and workshops (2) along with the study program. Interactive teaching was mentioned in relation to the e-Government program once.

All e-Government programs can be divided into traditional university programs with a **duration** measured in semesters and offering a university degree at their completion and short-term courses, measured in weeks or days, offering a certificate as an evidence for passing the course. University programs account for 75% of all collected e-Government programs, while the short-term programs form 25% of the sample.

The **cost** of the program depends on the country and whether the university is public or private. Most European and South American countries traditionally have relatively low tuition fees, especially on the undergraduate level. In contrast, North American and British programs are the most expensive, reaching more than 20 thousand euros per year. A total of 11 programs (25% of all programs with duration information) are short-term programs, lasting from as little as two days (Social Media and Storytelling for the Public Administration offered at the Institute for Digital Government in Romania) to 12 weeks (Diploma in Open and Electronic Government at Universidad de Tecnología Nacional in Argentina). Shorter programs are frequently offered as online courses, while none of the postgraduate programs is offered entirely as an online program.

Looking at the program's course composition, it is possible to classify the offered courses in 14 different clusters, depending on their content (full courses clustering is presented in GOV3.0 project deliverable 1.2: "Worldwide training needs on Electronic Governance"). **e-Governance** cluster. The courses in this cluster are specific to e-Government programs and focus on the application of ICT for the delivery of government services. Courses in this category include, application of ICT in public administration and governance; smart cities; digital government interoperability; development of government website; open government, e-Democracy etc. **Public Policy** cluster. The courses in this category focus on the systematic analysis of public policy issues and the related decision processes. Public policy cluster includes courses on the role of economic and political factors in public decision-making and policy formulation, microeconomic analysis of policy options and issues, resource allocation and decision modelling, statistical methods in public policy, and others. Among the offered courses are: policy analysis, policy studies, innovation in society, public policy, political economy, public affairs, public management, etc. **Governance** cluster. These courses deal with the processes of governing relating to a specific sphere of human social existence. Governance courses cover public sector, public organizations, the concepts of leadership and governance, and specific issues in the process of governance (risks, evaluation, re-engineering of processes). Courses in this cluster consider aspects such as: the political system and regime, state institutions, political parties, civil society, directions and problems of economic and social policy, the principles of good governance, risk assessment and governance, and governance ethics. **Project Management** cluster. This category encompasses the courses focused on managing the technology and innovation projects in public sector. The courses include different aspects of management of public sector projects: effort management, project portfolio management, program management, project risk management, financial management, project workforce management, etc. **Software Engineering** cluster. Software engineering courses consider the systematic application of scientific and technological knowledge, methods and experience to the design and development of software used in public sector. The cluster includes computer programming, mobile application development, visualization, data storage and analysis, and systems analysis. **Information Systems** cluster. The courses in this cluster deal with aspects such as management of information systems, design and development of information systems, systems analysis, systems design, data communications, and enterprise architecture. **Business Administration** cluster. This cluster deals with the functional aspects of an organization and their interconnection. The courses focus on the issues of overseeing and supervising business operations and related fields including accounting, finance, and marketing. Business administration courses also consider the performance or management of operations and decision-making, as well as the efficient organization of people and other resources in an organization. **Management** cluster. Management courses consider the administration of an organization, whether it is a business, a not-for-profit organization, or government body. Courses in this cluster are aimed to provide a foundation in organizational behaviour, human resource management, labour-management relations, negotiation, conflict resolution, compensation systems, and organizational development. **Public Administration** cluster. Public Administration courses focus on the aspects, specific to the administration of organizations in public service. They cover aspects of economics, public finance, research methods, policy analysis, public management, and performance measurement. **Legal Issues** cluster. The courses in this cluster deal with legal aspects of governance. These courses educate about legal organization of public administration, administrative law, fundamentals of IT and digital law, cybersecurity and the overall regulation of e-Governance. **Scientific Research and Statistics** cluster. Scientific research courses concentrate on the fundamentals of research method and the theory of science, offered primarily, but not exclusively, at the postgraduate level. Statistics courses study the collection, analysis, interpretation, and presentation of quantitative and qualitative data and include courses like Statistics in administration, Statistics for analytics, Probability and statistics. These courses teach about the methods (both qualitative and quantitative) and tools necessary to conduct scientific studies in the domain of e-Governance. **Economy** cluster. Economy cluster covers different aspects of the economy related to the public sector: microeconomics, macroeconomics, econometrics, economic statistics, political economy, public budgets, and finance. These courses relate closely to the Business administration courses, however, provide a higher-level view of the economic issues. **European Institutions** cluster. The courses in this cluster provide structured knowledge of the European Union fundamentals and priority issues in the EU including EU funds management, European integration and EU governance. These courses are often offered at the European Universities both at undergraduate and postgraduate levels. **Other** courses. This cluster includes all the other courses that are part of the e-Government programs but were not classified in the clusters listed above. These include practice-oriented courses like internships, project development courses as well as initial undergraduate courses like General Ethics, Basics of Mathematics and English academic writing. Looking into the most important courses (listed in the highest number of programs), the following five has been identified: Digital Government and Service Innovation, Foundations of Cyber Security, Impact and Measurement of e-Government, Information Society Principles, and Public Administration Information Systems. While the most frequent modules include e-Government Strategy, Data Analytics, Smart Government, e-Government Assessment, Big Data, Smart City, Interoperability in Public Administration, Transparency and Trust in Decision-Making, Open Data and Customized Public Services.

5 Discussion

The development of digital government education programs is not new, as we have seen through the results previously presented. The first programs have been implemented over a decade ago, targeting mainly high-level officials in the government to develop senior government officers' role and responsibilities (e.g. Government Chief Information Officer). Progressively, with the increasing demand and involvement, training generalized, including a diversity of public civil servants. We can also notice that the e-Government program initiatives are diverse in terms of disciplines and hosting departments. However, the findings show a strong concentration in the information technology, and computer science departments.

Our analysis showed no correlation between the country's development level (developed, developing) and the education program type (BSc, MSc). On the one hand, countries with high e-Government maturity levels may provide only undergraduate courses within their study programs (e.g. Singapore, Austria). On the other hand, countries with lower maturity e-Government level may offer advanced training programs (e.g. Romania offers three MSc programs). Regarding the geographical region coverage, most of the programs are offered in a single country. Defining and developing this type of program can be challenging regarding cost, risks, and performance to be adopted or developed by a single institution. Few are offered at transnational mode. Given that a multidisciplinary perspective could certainly lead to well-rounded knowledge, skills, and competencies, the development of a joint program at inter-regional or international level would highly contribute to reach this objective and facilitate the required sophistication. This can be realized through the partnerships between existing programs or by developing an e-Government regional/international multidisciplinary program, and it will bring more balance between countries given that different countries present different digital government development needs according to their level of maturity. The consideration that transnational programs are sparse lead to the natural recommendation of implementing joint digital government masters programs, which could designed and proposed through Erasmus Mundus context in Europe.

Development and review of the digital governance education program, given the growing complexity of the field, is an important need and a critical challenge. As presented previously, technology is closely driving the power of the digital governance evolution. International experience shows that taking advantage of these great capabilities offered by ICT, a complex and interdisciplinary task, requires the close collaboration of different scientific fields, in both technology and public administration, inside and outside of the public sector (public officers, citizens, businesses, consultants, practitioners etc.). So far, the studies examining education development of the digital government field have not integrated this complexity. Overall, the studies on the topic remain rare and more specifically, most of the existent research in the domain focuses either on a specific region or country (Anohina-Naumeca et al., 2013; Biasiotti & Nannucci, 2004; Shareef et al., 2012; Yildiz et al., 2016) or a specific domain of study and do not propose a holistic or a transdisciplinary perspective of the digital governance (Abu-Shanab, 2013).

The majority of the identified and described programs are generic and lack specialization, which is consistent with the fact that most of them focus on political sciences and public management fields. This also explains the lack of holistic programs in digital governance encompassing different disciplines relevant to a variety of roles and responsibilities. This is a great challenge concerning the existent dichotomy between a specialized program of e-Government and a program that will bridge various fields. We have observed a specialization of the roles and responsibilities in the e-Government professionalization. The majority of the existing programs focus on one domain per program. Only three programs could be categorized as multidisciplinary and able to fulfil the competencies of the current e-Government roles and responsibilities. The e-Government development and operation is becoming more and more complex requesting different capabilities and a thorough international viewpoint.

The vast majority of e-Government programs are offered by the HEIs. Only 7% of all the programs in the sample are offered by institutions other than HEIs. This differentiates e-Government programs from business education where ratio of companies, private organizations and training centres is higher. e-Government education is oriented towards training professionals for the public sector; thus, it appears that private sector has relatively little interest in it. Still, the importance of e-Government education is apparent, as some cases institutes dedicated to digital government have been established (as in Poland and Romania).

The placement in the specific departments naturally affects the available lecturers and thus the content of the programs. As most of the e-Government programs are offered by technology-oriented departments, there is a prevalence of technology courses. This is also evidenced by the program names that often underline the technological orientation (“technology for e-Government”, “e-Service Delivery in the Public Service”, “ICT in the Public Sector”, “Smart Cities and eAdministration” and similar ones). For the programs hosted by the public administration and management departments, the focus lies more on the issues of governance and management, here naming often includes “digital governance”, “e-Governance” or “policy making” and relatively more courses deal with governance and managerial issues.

Reflecting the placement of the programs within the specific department the most common postgraduate admission requirement is a bachelor degree in the related field, which in case of e-Government include ICT, public administration, sociology, political science and management. Some programs specifically target the practitioners either requiring or valuing their work experience in the public sector. This is particularly true for short-term programs.

Only 12% of the programs is offered online, with further 6% using long-distance or dual-mode teaching method. All of the e-Government programs taught exclusively online are short-term programs, and none of the postgraduate programs in the sample is delivered online. In terms of the future research, an interesting avenue to pursue would be to study the adaptation and changes implemented during the

COVID-19 pandemic. Transition to online learning resulted in creation of additional materials (videos, online assignments) that might be adapted for use in the future offline courses. It is conceivable that this would have an effect on the teaching methods of the e-Government programs in future. It is likely that some of the study programs (including undergraduate and postgraduate ones) will retain the online teaching method after the pandemic.

It should be noted that a wide range of courses offered within the e-Government programs are stemming from different disciplines such as public administration, management, economy, computer science, system sciences, political studies, and law. Such diversity underlines the difficulties of establishing an e-Government program as it requires interdisciplinary collaboration and involvement of scholars from different departments. With that in mind, very few programs offer the courses across all the 14 clusters discussed in the results section. Most of the programs tend to focus on two main clusters. For example, typically the administration and management courses are coupled with ICT courses (like development of smart city solutions, data management) with a handful of additional courses covering legal or ethical issues in e-Government. In other cases, e-Government program may be oriented more towards policy making and include more courses from governance and public policy clusters coupled with European institution and law courses, with relatively little attention paid to pure technological issues outside the data governance and innovation management. In general, it should be noted that technology courses are usually offered as foundation courses, aiming to introduce the topic to the students and provide the understanding of the basic principles, rather than in-depth knowledge in the area. Examples of typical technology courses include: foundations of cyber security, introduction to information technology, introduction to distributed systems, and similar. Thus, while e-Government courses provide significant training on managerial and administrative issues in the IT of the public sector, their applied potential is rather limited: often the alumni of these courses are more of e-Government managers than e-Government solution developers.

In principle, e-Government education is a very interdisciplinary domain, as it encompasses ICT courses, together with administration, management, economy, computer science, system sciences, political studies and law. This clearly makes it difficult to develop coherent programs, and requires a certain degree of adaptation on the students' side. Concerning curriculum design, this is influenced by the underlying objectives of the e-Government education. On one hand, such an education aims to help public sector officials to develop their capacity to recognize how they could use e-Government to create a positive impact in society. On the other hand, the objective of e-Government education is to prepare a set of new professionals that provide support to public administration operations, and in certain cases are able to develop new tools for public administration (e.g. GovTech). To achieve this goal, the curriculum has to be designed to be harmonized with the students' capabilities, as well as to meet priority learning needs of public servants and needs of public administration in terms of support. Another point to be taken into account, is the fact that training in soft domains such as administration, management and ethics should not be neglected despite the importance of technological aspects for e-Government. In fact, in order to exploit the full potential of disruptive technologies such as artificial intelligence and big data, it is necessary to implement a complete overhaul and restructuration of organizational and production processes in public administration. Finally, for what concerns the policy implications, there are three main relevant points. The first one consists of the development of partnerships between the academic institutions and the public administrations that will in the future hire the individuals which finish their degree. Specifically, to be sure that the courses are consistent with the needs of public administrations, the latter should be consulted in the definition of the content. A second related point is to favour the implementation of traineeships of graduated individuals in public administration departments, so they apply in practice the concepts that they have learned theoretically. The final recommendation is to implement a swift certification system of the degrees, in order to be sure that they are recognizable at European Union level. This certification system can be implemented by means of blockchain technologies, which serves as a peer-to-peer network and digital ledger of all transactions provide an incorruptible and immutable audit trail that eliminates counterfeiting in certifications.

6 Conclusion

A systematic data review was conducted in the paper, resulting in a comprehensive analysis of the e-Government courses worldwide. The current research covered 57 programs offered in 30 countries, contributing in the fifth component (Training Curricula) of the Digital Governance and Transformation Science Base (Charalabidis & Lachana, 2020). A broad number of e-Government-related programs has been analysed to identify the number of aspects related to the program's organization, duration and content. The analysis highlighted a significant variety of e-Government programs. Programs in e-Government are most offered often by information technology and computer science departments, followed by public administration and management departments. Despite the importance of the digital government in the national and international public strategies, only in 3% of all cases educational institutions have a separate department of e-Government.

The analysis allowed to identify the courses forming the e-Government programs and classify them into 14 different clusters based on the content. Governance (both specifically electronic and more general), Public policy and management courses were found to form the core of most e-Government program offerings. Besides, a great percentage of students of such programs are primarily originated from these disciplines. The targeted audience could develop or start careers either in the public sector or in the private sector be part of consulting or development businesses operating in the domain of digital governance. The role of this specialized personnel is critical in both the public and the private sector, since relevant markets, in the area of digital governance, are massively emerging.

The above complexity necessitates a more sophisticated set of knowledge and competencies. To develop a digital program aligned with these fast-growing changes in the e-Government field and respond to the new set of skills, roles and responsibilities, the training programs need more specialization and expertise than the generic studies observed in the majority of the programs worldwide. A variety of learning opportunities could be integrated into the emerging field. Thus, a dedicated set of courses could be offered where a set of strengths are identified in a specific country.

Finally, the programs need to be constantly updated taking into consideration the emerging technologies. The latter should be integrated into the training programs. Emerging fields and technologies such as data science and big data, robotics, artificial intelligence, cyber-physical systems or quantum computing technology evolve e-Government, moving towards its third generation (Charalabidis et al., 2019). As the domain of e-Government evolves, the required capabilities are evolving as well. It is crucial to follow the trends and technology progression as well as benchmarking the adoption rate from the private sector and integrate the adequate modules and courses in the digital governance training programs to face the future needs of the Government.

The next step of the research will be to identify the current educational needs in e-Government area and compare them with the present study results to identify the training gaps that e-Government training curriculums should cover. This inquiry would define a common vision of the type of roles and responsibilities, competence and skills that government at the different level will require in e-Government fields, as well as the specificities of each country or region. The identified competencies and training needs for specialized personnel would concern the full spectrum of understanding and management of the multiple dimensions of programs and development tasks in digital governance such as administrative, legal, political and technological.

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Discussing the Foundations for Interpretivist Digital Government Research

Keegan McBride, Yuri Misnikov, and Dirk Draheim

Abstract As the research domain of digital government continues to develop as an important body of scholarly research, it is important to understand the core theoretical and philosophical basis of the discipline. Yet, in the domain of digital government, such an understanding does not exist. Therefore, there is currently a need for critical discussion about the concrete role of research philosophy in digital government research. This paper makes a first step in driving such a discussion by presenting arguments and discussion on the relevance of an interpretivist research philosophy for the domain of digital government. This paper provides a comprehensive overview of an interpretivist ontology and epistemology for digital government, discusses relevant theories and methods, and concludes with an overview of what is essential for conducting and carrying out interpretivist digital government research. This paper's contributions represent one of the first concentrated efforts to lay out initial foundations for the role of interpretivism, and research philosophy more generally, for digital government research.

Keywords Digital government · Interpretivism · Methodology · Theory · Public administration

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1 Introduction

There has been a rapid growth in the interest and study of digital government[1] since it originated in the 1990s. At its earliest stages, digital government was viewed primarily as an object, or focus, of study with research on the topic being carried out in the study domains of either Public Administration (PA) or information systems (ISs) research. However, as, interest in the topic began to grow, and the volume of research published on the topic expanded, there was rising interest in whether or not digital government was truly just an area of research, or, rather, was a domain on its own (for an overview of the history of the field, see: Grönlund, 2010; Scholl, 2020). Many authors and practitioners supported the former view, rather than latter, pointing out that there was no, and will not be, a stand-alone domain known as "digital government." Jochen Scholl pointed out that digital government "fails the test" as being a "legitimate" discipline as "there is no unifying theory or competing theories, no accepted standards of methods and procedures of inquiries have been established, and no shared vision of digital government Research's long–term impact has emerged" (Scholl, 2007, p. 26), furthermore claiming that there are no "structural elements on a university level, researcher self-identification with the discipline, [or] icons/visible leading scholars" (Scholl, 2010, p. 17 citing Scholl, 2007). However, signs have begun to emerge that these criticisms have been and are currently being addressed.

First, there has been an increased emphasis on obtaining definitional clarity about what "digital government" means. While, earlier on, definitions were techno-centric, often focused on specific technologies, such as the Internet or email, what has become clear is that technology changes, and therefore, any definition of digital government must be able to account for such change. Though there is still some ambiguity with the conceptual definition of digital government, what appears to be clear is the importance of information: its availability and the flow of information between stakeholders via digital means (government, society, organizations, citizens) (Norris, 2010a; McBride, 2020). Second, there have been new and targeted efforts toward theorizing on the nature of digital government (this book is a prime example). Third, there are now devoted study programs to digital government, you can get a degree in

[1] Though the area of research started with the name "e-Government," there has been increased movement to refer to it now as "digital government." So, for this reason, this paper will use the term "digital government." Though they are used colloquially to mean the same thing, fundamentally, e-Government is more commonly associated with "out-dated" (e.g., email and the Internet) technologies and techno-centrism, whereas "digital government" is meant to be more all-encompassing and future-oriented, able to include new and rapid technological developments under its umbrella. Similarliy, digital government and digital governance are used synonymously but are slightly different. Digital governance is concerned with the steering and organization of processes, institutions, regulations, etc., of, for, or with the *digital*. Digital governance is not focused only on the "government" but is inclusive of other stakeholders such as civil society, businesses, and citizens. Digital government, on the other hand, is rather concerned on the digitalization of government itself, for example, for service delivery or internal digitalization. The domain is named *digital government*, it encompasses research on both digital governance and digital government, favoring neither over the other, acknowledging the importance and relevance of both.

the domain, there are funding opportunities specifically for scholars of digital government, academics do self-identify as scholars of digital government, it is possible to find lists of top digital government scholars (Apolitical, 2019; Scholl, 2014, 2016), there are numerous indices devoted to the study and ranking of digital government initiatives, there is an agreed upon body of literature that can be described as belonging to the domain of digital government (the digital government reference library), there are digital government specific conferences, and there are digital government focused research centers. Thus, it can be argued, that there are, at the very least, clear markers that we are witnessing the development of a new stand-alone study domain. Indeed, this point of view has also been highlighted by Charalabidis and Lachana (2020a, 2020b) who argue that there is a necessity for a domain and science base for digital governance. In their research, Charalabidis and Lachana identified ten core components of such a structure, these include the basic foundational aspects (e.g., definitional and philosophical grounding) for the domain, as well as relevant rules, theories, or laws.

While one would expect there to be a strong philosophical basis for research that focuses on understanding and interpreting complex digital government phenomena, especially due to the social and qualitative nature of digital government; this is not the case. In fact, it is one of the largest streams of criticisms against digital government research. Heeks and Bailur issued one of the earliest critiques of digital government, accusing the field of having "an arid monoculturalism" without any "role for research philosophy in e-Government research" (p. 251) with papers being techno-centric, ignoring evidence about negative aspects of technology, and contain a "naïve optimism […] which simply seems to regard IT as a "good thing" for government" (Heeks & Bailur, 2007, p. 248). Continuing on, the authors noted that digital government will largely remain underdeveloped because of "the absence of interpretivist or critical work" (Heeks & Bailur, 2007, p. 251). Similar criticism and findings have also been offered by Yildiz (2007) and Joseph (2013); there is little to no interpretivist research and an overemphasis on positivist research. In a first attempt to theorize the digital government research body of knowledge, in 2015, Meijer and Bekkers authored a paper titled "A metatheory of e-Government: Creating some order in a fragmented research field" that attempted to generate a "metatheory" of digital government by creating understanding on the different theoretical and philosophical approaches to digital government research. In this work, the authors found that 87.9% of analyzed papers were positivist, with a focus on explaining digital government through the usage and creation of new theoretical models and that a majority of the papers ignored the behavior, values, and beliefs of individual actors and rather focused more on "holistic systems" (Meijer & Bekkers, 2015).

Thus, it appears to be the case that digital government research, as a domain and scientific body of knowledge, while growing in quantity, suffers from needed theoretical and philosophical development. The consequence of such theoretical and philosophical stagnation for research within this domain is laid out quite clearly in Norris (2010b), where he argues that initial e-Government research "had no basis whatsoever in the prior relevant literature" that many who "speculated wildly and optimistically about e-Government was doomed to get it wrong" that "they mostly did" so and that early research was entirely based around the idea that "if we build e-government, really good things (and only good things) will result" (p. 344).

Acknowledging such consequences and the importance of theory and philosophy for the development of the domain, this chapter aims to contribute initial foundational work to the structure of a digital government domain by arguing for the relevance and importance of interpretivist philosophy, discussing the ontological and epistemological aspects, highlighting potential methodologies, and discussing relevant theories for the domain. In doing so, this chapter represents one of the first concentrated efforts to provide an overview of an interpretivist philosophy for digital government research and subsequently lays the initial groundwork for future development of interpretivism as a digital government research paradigm.

2 Positivism, Interpretivism, Pragmatism: Ontology and Epistemology

The starting point for discussing research philosophy is ontology, and can then be followed by epistemology and methodology.

First, ontology: Taking the first dictionary definitions of ontology, it can be seen that it is either "a branch of metaphysics concerned with the nature and relations of being" or "a particular theory about the nature of being or the kinds of things that have existence" (Merriam-Webster, 2021). Those from more technological domains may also have an understanding of ontology as "a set of representational primitives with which to model a domain of knowledge or discourse" (Gruber, 2009). In the context of philosophy and more so related here to research philosophy, ontology can simply be understood as the core beliefs about the nature of reality, or as discussed by Hay (2011), "what's out there to know about?" (p. 169).

Second, epistemology: Epistemology is highly dependent on ontology; in the context of a research philosophy, epistemology encapsulates what knowledge or understanding can be generated about a specific ontological reality.

Finally, there is methodology. Methodology mediates between ontology and epistemology, it is about the steps or processes that must be undergone in order to generate new understanding about the world.

Every research philosophy will have some combination of these, each leading to a different and unique way of viewing the world, what constitutes reality, the sorts of knowledge that can be obtained, and how this knowledge can be gathered.

The first research philosophy to be presented will be **positivism**. Positivism aims at repeating the success of the scientific method of the natural sciences. Within the positivist paradigm, there is one true and objective reality, and this reality can be measured, studied, and understood via methodologically rigorous studies, the results of which are independent of the researcher. Positivist research aims to lead to the generation of testable and repeatable results, which eventually should lead to theories that allow researchers to make predictions or gain understanding about said objective reality. In concrete endeavors, positivist research is essentially deductive in nature; where, in order to assess hypotheses and theories, it often draws on quantitative methodologies. In other words, "positivists assume that reality is fixed, directly measurable, and knowable and that there is just one truth, one external reality" (Rubin & Rubin, 2011, p. 14). Starting as early as in the nineteenth century with Auguste Comte and Émile Durkheim, positivism has now become a leading research philosophy within the social sciences. Consequentially, we find it also prominently in the fields of public administration, information systems, and digital government. In digital government, positivist research may aim to help understand core factors that predict whether or not services will be used or aim to explore whether there is statistically significant associations between identified or selected dependent and independent variables.

In contrast to positivism, one would encounter the broader "anti-positivist" and "postmodern" philosophies, one of which is **interpretivism**. Interpretivism has become popular in social science inquiry and is heavily related to the Weberian tradition of "*verstehen*" (Gregor, 2006; Schwandt, 1993). *Verstehen* is directly related to Max Weber's sociology and concerned with "how social actors understand themselves and their world" (Samier, 2005, p. 63) and "an abiding concern for the life world, for the emic point of view, for understanding meaning, and for grasping an actor's definition of a situation" (Schwandt, 1993, p. 221). In contrast to positivism, interpretivism trends toward inductive rather than deductive research, viewing reality as rather socially constructed, focusing less on trying to identify an "objective" reality, but more on understanding and reconstructing how the subjects of the study have come to make the decisions that they did. Importantly, "interpretive approaches do not merely study beliefs, ideas, or discourses. They study beliefs as they appear within and even frame, actions, practices, and institutions" (Bevir & Rhodes, 2003, p. 17 cited in Hay, 2011). Which implies, then, that an interpretivist researcher would hold the belief that:

> To understand this world of meaning one must interpret it. The inquirer must elucidate the process of meaning construction and clarify what and how meanings are embodied in the language and actions of social actors. (Schwandt, 1993, p. 222)

Thus, when it comes to the epistemological aspects, interpretivism views the generation of knowledge, understanding, and explanation as being inseparable from the researcher or the subject's lived experience. Methodologically, interpretivist research would cater toward methods such as hermeneutics, case studies, phenomenology, and discourse analysis (though there are numerous other applicable methods as well). Interpretivist research in digital government could include research that aimed to explore and understand why certain policies failed or succeeded, explore the motivations for creating a specific service, or analyze the discourse and motivations in digital government strategies.

Somewhere in between positivism and interpretivism, but rather closer to the latter, is the idea of **pragmatism**. For pragmatists: "a theory for a pragmatist is true if and only if it is useful […] Pragmatists are not looking for the essential and timeless truths of the positivists and logical empiricists" (Marshall et al., 2005, p. 4). Pragmatism can trace its philosophical foundations to philosophers such as Charles S. Peirce and John Dewey (Wicks & Freeman, 1998); it is empirical in nature, but "goes beyond a pure orientation to observation of a given reality" and is rather focused "toward a prospective, not yet realized world" (Goldkuhl, 2004, p. 13). In pragmatism, it is argued that the "meaning of an idea or a concept is the practical consequences of the idea/concept" (Goldkuhl, 2012, p. 139). Thus, in this way, pragmatism is slightly different than other philosophies in the sense that, action must come before theory, knowledge, or understanding, as it is only possible to attain these via action. Ontologically, pragmatism is focused on "actions and change; humans acting in a world that is in a constant state of becoming" (Goldkuhl, 2012, p. 139). Pragmatism lies somewhere in between the ontological extremes of positivism and interpretivism. Consequentially, when it comes to methodology, pragmatics often shows in the application of mixed-methods research. As epistemologically pragmatism is primarily concerned with knowledge that allows it to enact change and believes that this knowledge can only be obtained through action, pragmatic research is methodologically focused on doing. This would oriented pragmatism toward methods that encourage change and action, such as action research, design science, systems architecture, and systems dynamics, as well as other methodological approaches focused explicitly on enacting change. Pragmatic digital government research may try to influence the performance of a digital government service or experiment with different policies to achieve certain levels or performance in digital government ecosystems.

In order to demonstrate more clearly the differences between these research philosophies, Table 1 has been composed and highlights the core attributes and makeup of each.

Table 1 Comparison of positivism, interpretivism, and pragmatism

	Ontology	Epistemology	Methodology	Examples research question formulation
Positivism	Objective reality	Knowledge is real and objective, obtainable via measurement and statistics (reductionism)	Surveys, experiments, statistical analysis	What is the effect of X on government e-service usage?
Interpretivism	Subjective reality	Knowledge is dependent on beliefs, values, and lived experience (constructivism)	Field studies, case studies, hermeneutics, phenomenology	How did policy makers in city X come to support the creation of service Y?

(continued)

Table 1 (continued)

	Ontology	Epistemology	Methodology	Examples research question formulation
Pragmatism	Objective/subjective	Knowledge is obtained by doing and acting	Mixed-methods research, action research, design science	How to improve the performance of country X's open data ecosystem?

3 The Ontological and Epistemological Nature of Digital Government

In order to better ground the relationship between digital government and interpretivism, it is important to first start with a discussion about the nature of digital government and how it potentially relates to other already theoretically grounded concepts. Digital government can understood as a good example of what Webster (2014) defines as the "generalizing terminology" that attempts to qualify a certain social, technical or economic construct or phenomenon, such as "pre-industrial," "emerging democracy," "advanced capitalism," and "authoritarian populism" (Webster, 2014, p. 1). However, there is a need to understand the meaning of the foundational term that describes the respective grand concept, i.e., "industrialism," "democracy," "capitalism," "totalitarianism," or in the context of "digital government:" what is "government?" This is a necessary question to ask if one wishes to avoid being trapped in semantics and discussions about terms and definitions alone.

To start, the notion of government belongs to an extensive domain of political philosophy and science scholarship, which is beyond the scope of this text. Yet, it is essential to discern its ontological origins in order to understand the theoretical foundations of digital government. In general terms, government is closely associated with the concept of "the state." Some commentators view it (government) as a highly abstract concept, broader than the state itself, encompassing "political institutions through which political authority is exercised, such as the cabinet of ministers, parliament, courts of law, police, armed forces, and so forth" including rules, practices, institutions that guide the society's lives (Miller, 2003, p. 4).

While others agree that the state is a "conceptual abstraction," not a material object, they tend to include government as a part of the state itself, defining it as a set of governmental institutions responsible for "the process of making rules, controlling, guiding or regulating," which is synonymous with the elected officials in charge of public offices (Dunleavy & O'Leary, 1987, p. 1). The state in this understanding is responsible for the "public system of rule" over societies within specific territories (King, 1986, p. 31). In effect, this narrower definition of government that is subordinated to the state in the form of a specialized organizational and functional apparatus is semantically similar to government viewed in broader institutional sense, as described above.

We concur with this interpretation that theorizes the state rather than government, since it could provide a convenient entry point to conceptualize digital government as well. However, the available scholarship discussing theories of the state—and government, for that matter—do not appear interested in theorizing digital government from this philosophical angle. For instance, such theories of the state as pluralism, corporatism, elitism, public choice, institutionalism, feminism, poststructuralism, green theory do not include digital government within their vocabulary (Dunleavy & O'Leary, 1987; Hay et al., 2006). This is a serious obstacle for theorizing digital government for scholars who may try to draw from such foundations.

One closely related aspect to government, is that of governance, with state theorists claiming that there has been an ongoing shift from government to governance which diminishes the centrality of government in the governing of society (Peters & Pierre, 2006). This shift is marked by the expanding base of actors and networks, such as societal actors, that are becoming increasingly involved in the process of governing. Governance theory claims that "the formal institutions of government have been largely replaced by the capacity of social actors such as networks and markets to govern;" and this is due to the changed nature of operations of government in the newly changed governing conditions (Peters & Pierre, 2006, p. 211). A similarly informed change has occurred also in the digital realm, as civil society has become a stronger governance actor, with the term "e-Governance" spreading and being used to reflect upon a somewhat ambiguous relationship to the concepts of "e-democracy" and "e-participation" (Norris, 2010b). However, these concepts also suffer similarly from the same inadequate theorizing, as digital government does.

When it comes to the societal dimension of digital government in the state-society relationship, it appears better theorized from the information society viewpoint. The focus on the notion of "information" in relation to "society" is remarkably similar to the centrality of information in some of the current leading definitions of digital government. In some way, the term information society (or digital, e-society) is seen as a "new way of conceiving contemporary society" (Webster, 2014, p. 2), thus invoking the inevitable analogy with the notion of digital government with its hope to radically change the state's modus operandi when it comes to public service provision by government institutions. When it comes to the theorization of information society, one can look to scholars such as Manuel Castells, Howard Rheingold, Frank Webster who are among the most prominent theorists (Castells, 1996, 1998, 2002; Rheingold, 1993; Webster, 2014). The striking feature of these scholars' works is the notable absence of discussing digital government in conceptual terms. For example, Frank Webster in his comprehensive review (and healthy critique) of the information society theories lists as many as nine-related theories,[2] but none of them explicitly or implicitly include government or state-related theories. A first attempt to depict

[2] These are: post-industrialism (represented by Daniel Bell); postmodernism (represented by Jean Baudrillard, Mark Poster, Paul Virilio); flexible specialization (represented by Michael Piore, Charles Sabel, Larry Hirschhorn); the information mode of development (represented by Manuel Castells); neo-Marxism (represented by Herbert Schiller); regulation theory (represented by Michel

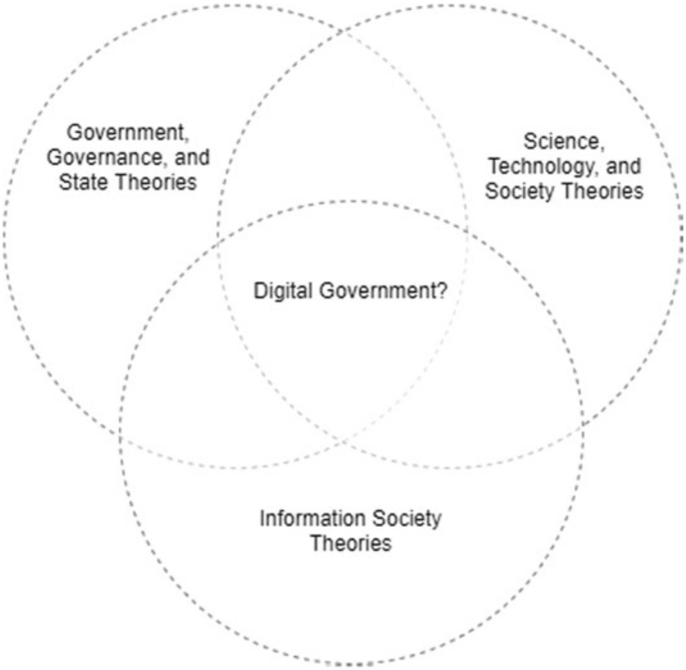

Fig. 1 Theoretical foundations of digital government?

the theoretical underpinnings of digital government as a domain can be seen below in Fig. 1, drawing on a mixture of government, governance, and state; science, technology and society; and information society theories, but how these come together is still ambiguous and needs further discussion.

Thus, we arrive at a major conceptual disconnect when, on the one hand, theorizing the state (and/or government) does not account for the role of information technologies in general, and for digital government specifically, and on the other hand, theorizing the information society, including its democratic aspects, demonstrates little interest in addressing the role of information in government; thus, scholars are left with either one side of the coin or the other, but never both. There is also scarce evidence that digital government research has benefitted from a vast domain of science, technology, and society (STS) studies either which is a branch of study that focuses explicitly on the relationship between technology and society from a more constructivist or postmodern standpoint. In our view, these are serious foundational bottlenecks that make digital government research agenda less convincing in terms of its epistemic and heuristic value. However, it is apparent that there are indeed linkages between these areas, and further, research is needed to mesh them together and

Aglietta, Alain Lipietz); flexible accumulation (represented by David Harvey); reflexive modernization (represented by Anthony Giddens); the public sphere (represented by Jurgen Habermas, Nicholas Garnham).

untangle their relationship. So, while in consequence, theorizing digital government as a distinctive domain of scholarship currently struggles to draw on the existing conceptual foundations borrowed from government-related theories or from those pertinent to society, there is a discernible path on how to proceed. It must be noted that by outlining this idealized model, we are also fully aware that such relationships are not static, but dynamic with the parts being in complex and continual interaction, thus supporting the need for continual and ongoing study and interpretation.

Frank Webster offers some useful reasoning in his analyzes of the information society theories that may be applicable in informing such a conceptualization of digital government. He contrasts the roles of quantitative and qualitative changes of social systems that form the information society and he questions whether more information actually leads to an information society, arguing that it "is not that there is more information today (there obviously is), but rather that the character of information is such as to have transformed the way we live" (Webster, 2006, p. 9). In a few words, it is not the amount of information that has changed us, but rather the nature of information has changed, and has thus both changed and been changed by society. To understand what is being changed in social terms, and how the social change other is being affected, one must account for the respective social actors and ask whether we already live in a fundamentally changed *digital* government. Is it different from the previous form of governing, or are we just witnessing an ongoing *digitalization* of the already established relationships? The answers to such questions could help accumulate some initial theoretical knowledge about digital government.

Interpretivism appears to be a suitable philosophy for driving such a discussion, and this discussion can then serve as a starting point for developing and exploring the ontological and epistemological nature of digital government. Thus, it is important to set out, concretely, some initial and fundamental beliefs on the nature of ontology and epistemology for interpretivist studies of digital government. Ontologically speaking, it could be said that interpretivist digital government research is constructivist in nature, arguing that beliefs, traditions, and environmental contexts heavily influence our actions, and yet, do not determine them. Rather, this information provides actors with the necessary information to interact with others, make decisions, and overcome problems; furthermore, the actions taken may influence the beliefs, traditions, and environment. In practice, this would mean that one would expect there to be a change in how digital government is understood across contexts and that so too the conceptualization will change as technology and society continues to development. Thus, it is the role of the interpretivist researcher to understand these interactions, how they influence and are influenced by each other, and how these interactions and exchanges bring digital government into reality. Epistemologically, interpretive digital government studies focus on generating explanation through understanding. This requires in-depth knowledge about the context and environment where the given object of study takes place within, and the different beliefs, traditions, and values held by stakeholders involved in the process.

In order to generate this understanding, interpretivist digital government research would rely heavily on more qualitative methods, the nature of which are discussed further on in this chapter. Similarly, though interpretivist research tends to be inductive in nature, there are relevant theories for scholars who are looking to undertake interpretivist digital government research; these too are presented in this chapter.

4 Interpretivist Digital Government Theory

As one of the core aspects of a domain is related to the use and development of theory, it is important to highlight which theories would be compatible with, and have been used for, digital government research. There are a number of definitions that have been offered, but one simple proposal was put forth by Doty and Glick (1994), which states that, at a minimum, theory must: identify constructs, specify relationships between these constructs, and these relationships must be falsifiable (Gregor, 2006 citing Doty & Glick, 1994). However, theory in the interpretivist paradigm is rather different in the sense that it focuses primarily on "understanding the complex world of lived experiences from the point of view of those who live it" (Schwandt, 1993. p. 221). Writing on a taxonomy of theories for information systems research, Gregor (2006), highlighted five core types of theories: (T1) analysis, (T2) explanation, (T3) prediction, (T4) explanation and prediction, and (T5) design and action. Relating back to Table 1, T1, T3, T4 would relate more closely to positivism and T2 would be associated with interpretivism; whereas (T5) would be associated, in first place, with pragmatism, although T5 can appear very well also with a positivist stance; and sometimes also with an interpretivist.

As there is still a gap when it comes to explaining both how theories can and should be used for digital government research, and furthermore, clarifying how these theories relate to their given philosophical paradigm, this section will introduce theories relevant to the conduction of interpretivist digital government research. While interpretivism is often viewed as, perhaps, theoretically inferior due to its emphasis on subjectivity, there are a number of theories (e.g., T2 theories) that are applicable for interpretivist research. For this chapter, we will present some of these relevant theories: actor-network theory (ANT), structuration theory, and technology enactment theory.

4.1 Actor-Network Theory

Though ANT has not been used widely in digital government research, there are some examples of its use in the literature. One of the most known examples is a 2007 paper by Heeks and Stanforth, who aimed to use ANT to understand a specific digital government development project that was taking place in Sri Lanka's Ministry of Finance. In this paper, the authors find that there are some limitations with the application of ANT to digital government, but even still, note that their approach has allowed them to fight back against "technological determinism" and also encompass many different perspectives and levels of analysis (Heeks & Stanforth, 2007). ANT is highly valuable in that it places an "emphasis on the socio-technical middle ground" (Andrade & Urquhart, 2010, p. 353); it "makes no analytical distinction between the social and the technical" (Stanforth, 2007, p. 54); and views both human and non-human actors as having the same influence on a network (Heeks & Stanforth, 2007).

ANT is a theory that is recognized for its unique approach to the world, viewing both technological objects, machines, and other technologies as conceptually having equal status of humans. It was developed initially by Michel Callon, Bruno Latour, and John Law—though most associate ANT with Latour—and views "the social and the technical as inseparable" (Walsham, 1997, p. 467) and aims to understand how "relatively stable networks of aligned interests are created and maintained, or [why] such networks fail to establish themselves" (Walsham, 1997, p. 469). In ANT, actors can be either social (humans) or technical (machines), so long as they influence the network. Networks are conceptualized differently than in other fields, with Latour highlighting that an "actor-network is an entity that does the tracing and the inscribing" and that "literally there is nothing but networks" (Latour, 1996, pp. 370–372). Another concept that needs to be understood is that of translation, which is how new actor-networks are created, via "a process of translating their interests to be aligned" (Walsham, 1997, p. 468) and is often conceptualized as consisting of a four-step process: (1) problematization; (2) interessement; (3) enrollment; and (4) mobilization (Callon, 1984). This concept of translation is also important to understanding the role of technology in ANT, as "technical objects participate in building heterogeneous networks" and that these objects "define actants and the relationships between actants" (Akrich, 1992, pp. 206–207). When discussing digital government, which can be viewed as a complex socio-technical phenomenon (Lips, 2012; McBride & Draheim, 2020), a holistic ecosystem comprising of an endless number of disparate components of both human and material nature, ANT may well be a useful theory. In general, while it is relatively easy to describe technological aspects of digital government by focusing on particular objects, it is almost impossible to capture its social side in the same way, thus in this context, ANT might prove to be a useful theory to counteract this.

4.2 Structuration Theory

A second theory which is likely to be of high relevance for conducting interpretivist digital government research is that of "structuration theory" which underlines the significance of information in organizing social institutions through the process of "reflexive modernization" (Giddens, 1984, 1987). Structuration theory was conceptualized within the domain of sociology by Anthony Giddins and advances the core argument that "social structure exists in the actions of human agents as they use existing structures and create new ones in the course of everyday life" and that "structures exist as actors apply them" (Poole & DeSanctis, 2011, pp. 6–7). Structuration theory is of an interpretive nature and provides a way of thinking about the world, in this sense, it does not allow one to make predictions about the future, but rather provides a way for investigating and understanding a given object of study. Giddens' structuration theory would argue that in the social sciences, "generalizations are necessarily historical" and that universal laws are likely impossible (Jones & Karsten, 2008, p. 133). Studies that utilize structuration theory will be those that are more qualitative in nature and that offer the researcher the most room for interpretation, for example, field work or case studies. When it comes to the application of structuration theory, it can be said that there are three primary structural dimensions (signification, domination, and legitimation), three methods of interaction (communication, power, and sanctions) and three modalities that link structure and interaction (interpretive schemes, facilities, and norms) (Jones & Karsten, 2008 citing Giddens, 1984).

While structuration theory has found much use in information systems research and may well be one of the most popular theories used in that field, it has not seen a large amount of usage for digital government research. However, in two separate accounts about the use of theory in the field of digital government (Bannister & Connolly, 2015; Molnar et al., 2015), structuration theory was mentioned as being explicitly relevant for the domain. There has, additionally, been digital government specific research published using such theory. In Devadoss et al. (2003), structuration theory was used to explore the development and introduction of an e-procurement system and as a result of this analysis also began to put forth propositions about the structure digital government. In a separate paper, Puron-Cid (2013) also used structuration theory, but in this instance conducted an embedded case study focused on a Mexican digital government project on IT-enabled budgeting.

4.3 Technology Enactment Theory

Technology enactment (TE) is one of the first and most influential theories developed specifically with digital government in mind. TE and its framework first emerged in Jane Fountain's 2001 book titled "Building the Virtual State: Information Technology and Institutional Change." TE started from the understanding that theory was needed to increase understanding about the "deep effects of ICTs on organizational, institutional, and social rule systems in government which is not ordered by the invisible hand of the market" and, at its core, "emphasizes the influences of organizational structures (including "soft" structures such as behavioral patterns and norms) on the design, development, implementation and use of technology" (Fountain, 2006, pp. 153–154). TE is, by its nature, an interpretive theory that encourages scholars to understand how different rules, structures, values, beliefs, norms, etc., influence the use and development of technology in government organizations. In other words, it creates a set of guidelines that should help scholars to understand why the exact same technology may be used differently or have different effects in different contexts.

TE consists of five core aspects: objective information technologies, organizational forms, enacted technologies, outcomes, and institutional arrangements (Fountain, 2006). The theory then explores the relationships between these aspects. The theory has been used in digital government-related research, but it has also been subject to much criticism. In a work titled "Building the Virtual State... or Not?" Donald F. Norris argues that TE is rather nothing new to scholars in public administration or information systems and is, rather, just a simple repackaging of socio-technical systems theory (Norris, 2003).

Socio-technical systems theory argues that organizational systems and technology co-evolve with one another (Trist, 1981) and is used to study this relationship between organizations and technology. In digital government research, it has been used by authors such as Dawes et al. (2016) who explore open government data initiatives as socio-technical systems. Though there is much to be said about the validity of this criticism, TE still represents one of the best attempts at creating theory for the domain of digital government, provides practical and relevant guidelines for investigating technologically-driven institutional change, and is clearly relevant for digital government scholars conducting interpretivist research.

5 Interpretivist Digital Government Methods

As methodology is used to mediate between ontology and epistemology, it is important to cover and discuss potential methodologies for interpretivist research. There are a number of different methodologies that have been utilized for digital government research, inclusive of both quantitative and qualitative methods. For example, papers may use structured literature reviews (Tursunbayeva et al., 2017), grounded theory (Lee & Kim, 2007), case study research (Anthopoulos et al., 2016), survey (Ganapati & Reddick, 2012), Delphi methodology (Niehaves, 2011), discourse analysis (Yildiz & Saylam, 2013), design science (Goldkuhl, 2016), TAM (Shyu & Huang, 2011), UTAUT (Wang & Shih, 2009), statistical analyzes (Nam, 2014), and indeed a number of other methods, depending on the researchers' experiences and preferences, as well as the suitability for their given subject of research. While both quantitative and qualitative methods are used, it is argued here, that, from an interpretivist point of view, methods of the more qualitative nature are likely to be of use. While it is out of scope of this chapter to cover the entirety of relevant interpretivist methods, a small subset has been selected to provide an overview of what may well be some of the most relevant methods for conducting interpretivist research. The methods to be discussed in this chapter below are case study research, discourse analysis, and grounded theory.

5.1 Case Study Research

The first method to discuss is one that many authors are familiar with case study research. There are a number of different approaches to case study research, such as those offered by Yin, Eisenhardt, or Merriam.

For Yin, a case study could be understood as "a contemporary phenomenon within its real-life context, especially when the boundaries between a phenomenon and context are not clear and the researcher has little control over the phenomenon and context" (Yin, 2018, p. 13) and is particularly appropriate when it comes to answering "how" or "why" questions (Yin, 2018). For Yin, a case study is something that can be methodologically rigorous and can provide relevant empirical information when there is either a lack of theory or an under-exploration of a given phenomenon. Yin describes four primary forms of case studies, single or multiple-case design, with each option also allowing for either a single or multiple units of analysis; furthermore, Yin highlights that a case can be either descriptive, exploratory, or explanatory. While each aspect of case design and the type of case study selected is dependent on the goals of the research, what is common throughout is the emphasis on data triangulation, academic rigor, and objectivity of the researcher.

For Eisenhardt, a case can be understood as a "a research strategy which focuses on understanding the dynamics present within single settings" (Eisenhardt, 1989, p. 534) and while Yin's work is primarily on case study design to ensure validity and rigor, her work is focused primarily on the use of case study research for the development of theory. In Eisenhardt's, 1989 paper "Building Theories from Case Study Research," the author outlines and argues about the relevance and applicability of case study research for theoretical development. More specifically, the author notes that case study research for theory building may be ideal when there is "little known about a phenomenon, current perspectives seem inadequate because they have little empirical substantiation, or they conflict with each other or common sense" (Eisenhardt, 1989, p. 548). When it comes to conducting the actual development of theory from case research, Eisenhardt proposes an eight-step process, namely: getting started, selecting cases, crafting instruments and protocols, entering the field, analyzing data, shaping hypoheses, enfolding literature, reaching closure (Eisenhardt, 1989). This sort of research is inductive and bottom-up in nature and more within the lines of an interpretivist philosophy than the approach argued for by Yin.

The third approach to case study research is that offered by Merriam, who has the most interpretivist approach to case work of the three authors presented here. Merriam views a case study as an "intensive description of a phenomenon or social unit such as an individual, group, institution, or community" (Merriam, 2002, p. 8) and when it comes to case study research, it is the unit of analysis itself that defines the case, rather than the topic itself. Merriam argues that, as a result of this, case study research is often combined with other methods such as narrative analysis, grounded theory, or ethnographic studies (Merriam, 2002). When it comes to the core building blocks of case research, it could be said that there are three primary attributes: particularistic, descriptive, and heuristic (Merriam, 1998 cited in Yazan, 2015). In other words, a case needs to have a specific focus with a specific unit of analysis must yield a "rich thick description of the phenomenon" (Yazan, 2015, p. 139), and it must generate knew understanding about the object of study. Merriam's insistence on the importance of having a rich and thorough description of the case sets it apart from other case research, however, this emphasis on description and understanding also makes it of higher interest for interpretivist research.

Though there are different approaches and understandings to case study research, the scholars are also complementary in the sense that they provide a clear framework and approach for conducting case study research to achieve different aims, e.g., generating theory, exploration, description, explanation, etc. Additionally, in each instance, clear steps and efforts are devoted to ensuring increased levels of internal and external validity, such as by ensuring triangulation of data, emphasizing the importance of description, clear data analysis protocols, offering clear frameworks for case analysis, and providing clear ways for the research to declare any potential subjectivity in the work.

In the current digital government research community, case-based research is quite common, however, it often is missing direct links and ties to an interpretivist, or any research philosophy. Although case study research more naturally lends itself to interpretivist research, it can appear anywhere on the positivism-interpretivism spectrum. For example, Robert Yin writes: "Much of case study research as it is described in this book appears to be oriented toward a realist perspective, which assumes the existence of a single reality that is independent of any observer. However, case study research also can excel in accommodating a relativist perspective [...] acknowledging multiple realities and having multiple meanings, with findings that are observer dependent." (Yin, 2018, "Ch. 1. Applicability of different epistemological orientations," para. 2) In the field of digital government, case studies rather often have a positivist perspective; then, this is typically paired with an optimistic technological determinism that is widespread in digital government research. Still, the elements of all three approaches described here are of great value for scholars to help anchor their research concretely within an interpretivist research paradigm, especially within the approach and context offered by Merriam.

5.2 Critical Discourse Analysis

Discourse analysis (DA) is a broad domain of critical discourse studies (CDS) that also includes critical discourse analysis (CDA). DA qualitative research methods are widely applied across many disciplines in the social sciences and humanities, linguistics, media and communication studies, etc. The object of the analysis is any type of utterances—written and spoken texts, images, sign language. CDS examine the mutual relationship between semiotic structures and material institutions, which is relevant to digital government research focused on transmitting symbolic information between institutions and parties.

CDA is a "problem-oriented interdisciplinary research program" that focuses on "social phenomena, which are necessarily complex" and thus implies "a dialectical relationship between a particular discursive event and the situation(s), institution(s), and social structure(s) which frame it" (Wodak, 2014, p. 303). CDA is focused on understanding the constructive relationship between a given discourse and the relevant environmental societal factors that shape it, but, also, how those have been shaped by the discourse. CDA is commonly applied in social and qualitative research but primarily in fields such as journalism or media studies. However, it also has a high relevance for scholars in the digital government community as it provides a clear and understandable approach to understanding topics or "discourses" that are currently relevant, such as "digital government," "information society," "digital Europe," or "open government." CDA claims that these discourses are influenced by societal or historical contexts, that these give the discourse meaning, and that the meaning ascribed to these discourses influence those who use them, as well as the institutions that shaped them.

In order to conduct CDA, there is a clear framework consisting of three primary dimensions: "the object of analysis […] The processes by which the object is provided and received by human subjects […] and the socio-historical conditions that govern these processes" (Janks, 1997, p. 329). Furthermore, each of these dimensions requires a separate sort of analysis, either description, interpretation, or explanation (respectively) (Janks, 1997). While this framework does not provide a methodology for analysis on its own, it does provide a clear way to frame CDA research. Methodologically, CDA can be seen as a four-step process: identifying an object of interest, understanding in which way society has influenced this object of interest, exploring the necessity or "inhereitness" of the object, and then providing a discussion on how to change the object of interest, if needed (Fairclough, 2013).

When it comes to the use of CDA in digital government explicitly, there is not a large volume of work. One paper, by Yildiz and Saylam (2013), aimed to explore and understand core discourses that were associated with digital government; though it does not explicitly use CDA. As digital government is a rather new topic, it is important to understand the different ways in which its meaning has been and is currently being influenced by societal practices. In that work, the authors discuss a number of different identified discourses, and then further explain how these discourses influenced the ideas and actions of actors. Similarly, in a more recent paper, Draheim et al. (2020), used CDA to identify core discourses and narratives in the field of digital government, identifying four main narratives that appear to influence the work of digital government scholars, namely democratic, technocratic, tech-savvy, and implementation. What this provides, then, is a clear way to relate digital government research, with the beliefs and values that inform their beliefs as scholars.

CDA is likely to be of high interest and relevance for interpretivist digital government research as it provides a clear framework and approach to identifying the meanings and values associated with core phenomena in the field. Due to this, CDA may well also serve as a core starting point for native theoretical development in the field by providing the means to critically explore and understand the most basic and fundamental discourses, beliefs, and values associated with core constructs or phenomena within the field.

5.3 Grounded Theory

Grounded theory was started as a systematic program in the late 1960s to complement a perceived mainstream of deductive social research. Glaser and Strauss, initiators of grounded theory, write: "Most writing on sociological method has been concerned with how accurate facts can be obtained and how theory can thereby be more rigorously tested. In this book, we address ourselves to the equally important enterprise of *how the discovery of theory from data—systematically obtained and analyzed in social research—can be furthered*." (Glaser & Strauss, 1967, p. 1). Grounded theory does not break with positivism completely, actually, it mediates between positivist, pragmatic, and interpretivist positions: "Most important, it works—provide us with relevant predictions, explanations, interpretations, and applications." (Glaser & Strauss, 1967, p. 1). The interpretivist elements of grounded theory are significant, not to say dominant, which makes it fair to assign grounded theory to the realm of interpretive research. Still, positivist rigor is present in grounded theory, e.g., in making qualitative data analysis less informal. Methodologically, grounded theory essentially enacts a rigorous focus shift from testing theories (via deduced hypotheses) to generating theories, combined with several innovations and elaboration of best practices at the level of research techniques. Epistemologically, grounded theory shares the premises of Blumer's symbolic interactionism: (Blumer, 1969) (i) "human beings act toward things on the basis of the meanings of things have for them" (Blumer, 1969, p. 2), (ii) "the meaning of such things derives from the social interaction one has with one's fellows" (Blumer, 1969, p. 2); and (iii) "these meanings are handled in, and modified through, an interpretive process used by the person in dealing with the things he encounters." (Blumer, 1969, p. 2) This can be further compared with Glaser and Strauss (1967) and Aldiabat and Le Navenec (2011).

Qualitative data gain more importance in grounded theory, but quantitative data are also systematically considered. In service of qualitative data analysis, grounded theory elaborates a system of mutually dependent practices based on open, axial, selective coding (Strauss & Corbin, 1998, pp. 55–242). Consequentially, also with respect to quantitative data, grounded theory elaborates an inductive strategy "that facilitates the generation of theory from quantitative data. It is a variation of Lazarsfeld's elaboration analysis of survey data (Lazarsfeld & Rosenberg, 1955)" (Glaser & Strauss, 1967, p. 186).

Grounded theory has been applied successfully in a series of digital government research endeavors. In Lee and Kim (2007), the authors conducted interviews with stakeholders of twenty-six government authorities interviewed to understand perceptions of digital government initiatives, in Reinwald and Kraemmergaard (2012), the authors reveal perceptions of stakeholders involved in a transformational government case study, and in Mergel et al. (2019), the authors exploit grounded theory to develop a framework for digital transformation in the public sector. The examples demonstrate the suitability of grounded theory for digital government research efforts.

6 Interpretivist Digital Government Process

With the interpretivist digital government paradigm laid out in terms of ontology, epistemology, theory, and methodology, it is also important to highlight and outline what and how exactly interpretivist research may be conducted. It should be pointed out that there is not one "correct" way of doing interpretivist research, and this will vary depending on the selected methodology, but there are some core "building blocks" that could be identified and serve useful as a starting point for interpretivist research.

The first step will be to identify a given object of study or a phenomenon of interest. With this object identified, the next step is to decide on the appropriate methodology. The next step, depending on the selected methodology, is to decide on the use of theory (if needed) and which theory to be used. As described by Walsham (1995), in interpretivist research, there is primarily three ways that theory is used: firstly, it could be used to help with the initial design of the search; secondly, it may be used during the actual analysis of the data itself; finally, it could be the actual result of the research itself. For example, if one was to be conducting grounded theory research, then, it is imperative that no theory "is looked at" before the start of the research (the researcher needs to create awareness for any kind of bias stemming from knowledge of existing theories). In the case of other methods, for example, case study research, it is dependent on the given situation how theory is to be used. With the research question and object of study identified, the methodology selected the process of research and interpretation can begin; a rough and abstract view of the core building blocks of this potential process are shown below as Fig. 2.

This figure shows six essential components of interpretivist digital government research: *identify object of study*, *context and history*, *object of study*, *beliefs about object of study*, *examine the decisions made*, and *interpretations*. These components interact with each other through causalities as indicated by the arrows in Fig. 2. There is a dominating strand of causality between the components as indicated by the bold arrows, however, there exist potential feedback loops among and across all of the components, paying tribute to the highly iterative nature of research endeavors.

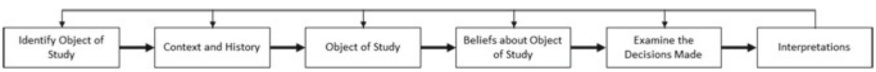

Fig. 2 Interpretivist research building blocks

Component 1 *(Identify Object of Study)*: In the this component, the research identifies some sort of problem, current event, or other interesting phenomena that they wish to research or gain a better understanding of. In digital government research, this may include why or how digitalization has happened, why a certain project has or has not "succeeded," or look comparatively between different digital government initiatives (this list, of course, is just a sample and not exhaustive). *Digital government example: Participatory budgeting in country X.*

Component 2 *(Context and History)*: The second component is related to gathering an initial understanding about the unique context and history of the object of study. This can be done via desk work, field research, interviews, a survey, or some combination of other methods, but what is important, is that a thorough, rich, and in-depth understanding must be gained about what contextual and historical factors may influence the object of study. *Digital government example: have there been previous examples? What is the political history and tradition? How do citizens traditionally interact with their government? Is their previous experience with similar initiatives?*

Component 3 *(Object of Study)*: After this has been done, it is only then possible to research more the actual object of study. The idea here is to learn as much as possible about the concrete object being studied, what it is, how it happened, what are the important steps, who was involved, and other similar types of questions. *Digital government example: How did the initiative start? Who is involved? What is the expected benefit? What is the main ecosystem surrounding such an initiative?*

Component 4 *(Beliefs about Object of Study)*: The next step is to understand stakeholders' beliefs about this object of study and then reflect back on how these beliefs have been influenced by and influence the context and history and also the object itself. *Digital government example: Why were they involved in the project? What were their experiences? Was it well received?*

Component 5 *(Examine the Decisions Made)*: Generally speaking, some decisions will have been made by individuals being studied, and these decisions have been influenced by their beliefs. These decisions and how the beliefs influenced them are key to gaining an understanding about the object being studied. *Digital government example: Citizens mainly chose not to use the participatory budgeting opportunity.*

Component 6 *(Interpretations)*: This is the result of the study, the interpretations. Here, the researcher aims to demonstrate in a narrative or interpretive manner how the object of study unfolded or came into being, weaving together the previous five steps into a coherent argumentation that allows a reader to understand better the object being studied. *Digital government example: The government has a history of oppressing citizens and wanted to appear more open so it launched a participatory budgeting opportunity, yet, citizens felt that their votes would not be counted and therefore decided not to participate due to historical experiences.*

You can think of the components as forming a process. Such a process is malleable and can be adjusted based on a researcher's primary goals. However, taken as a process, it also provides clear guidelines and structure so that, when followed, other researchers would be able to both understand the validity of the research and also follow and agree with how primary researchers made their interpretations. As the process of interpretation is also subject to subjectivity, some efforts have been made by scholars to provide a list of criteria or guidelines that may well help to improve the validity and reliability of results for different interpretivist methodologies. For example, in Klein and Myers (1999), seven core principles for interpretivist field work are highlighted: the fundamental principle of the hermeneutic circle, the principle of contextualization, the principle of interaction between the researchers and the subjects, the principle of abstraction and generalization, the principle of dialogical reasoning, the principle of multiple interpretations, and the principle of suspicion (p. 72). While these principles were discussed in the context of field research, these core principles are applicable to other interpretivist methodologies a well. In a similar fashion, Butler, 1998 citing Madison, 1988 presents the importance of 10 key principles for conducting hermeneutic interpretivist research: coherence, comprehensiveness, penetration, thoroughness, appropriateness, contextuality, agreement (1), agreement (2), suggestiveness, and potential (p. 292).

Building off of these best practices, it is clear to see a number of important concepts for well-conducted interpretivist research. Firstly, the context that affected the research and which the research takes place in must be made clear to the reader, thus allowing for the interpretations and results of the research to be better understood. Secondly, acknowledge the subjective role of the researcher in the process and present this to the reader. Thirdly, be thorough and concise, i.e., interpretive research requires rich, thorough, and comprehensive description, not only of the context, but of the process and phenomenon itself; the only way to ensure higher levels of internal and external validity of the research is via a thorough description. Fourthly, the interpretation should make sense; while this seems fairly straightforward, it implies that the interpretation can be backed up and supported by evidence; and furthermore, if the proper context and description has been provided, it should be clear to others how this interpretation was made.

7 Conclusion

While digital government has, for the most part, remained under-theorized and under-philosophized, this book chapter has attempted to provide some initial input into rectifying this situation. Though this work simply aimed to start the discussion and make an initial contribution about the importance of interpretivist research for digital government scholars, it is hoped that, in future, it could serve as a foundation for others who are interested in interpretivist digital government research. However, it is also important to note that while this chapter argues in favor of an interpretivist approach to digital government studies, this is not the only view, and therefore, future research from scholars identifying and presenting the pragmatic and positivist philosophies of digital government would be of much benefit and interest for the field. While on its surface this chapter may appear to be rather oriented only toward students and scholars, there is likely to be a high level of relevance for other stakeholder groups, such as NGOs, policy makers, and other government officials as well. On the one hand, the chapter discussed core theories and methodologies related to digital government, the utilization and understanding of which could help to drive certain changes in a given digital government-related context or could help to pre-emptively address and rectify negative or “unwanted” emergence behavior associated with a given digital government phenomenon.

In regard to the concrete contributions of this work, it is argued that there are primarily three. First, the work provides an introduction and overview of the core ontological, epistemological, and methodological beliefs of positivist, interpretivist, and pragmatist research philosophies. Second, the paper provides a comprehensive theoretical and philosophical discussion about the interpretivist nature of digital government research, identifies potential anchoring points to ground it as a domain, and highlights how interpretivism may help solve the currently existing theoretical ambiguity. Finally, the work lays out a potential ontological and epistemological stance for interpretivist digital government research, discusses potential relevant theories and methodologies for such research, and provides an overview of an abstract process, or building blocks, for conducting interpretivist digital government research.

By utilizing the initial foundational work in this chapter, it should be possible to begin to address core questions needed for further developing the domain of digital government. Some of these questions and issues have been discussed in the third section of this chapter, for example, how can we better integrate the relevant streams of theory from governance, STS, and sociology? How can we theorize the role of technology in government? What are the core ontological and epistemological beliefs about digital government? These questions are important for understanding the nature of digital government and interpretivist approaches may well help to answer them. By utilizing the process provided in section six, clear guidance has been provided on how to conduct such digital government studies and exploration, thus encouraging replicability, rigor, and validity of studies; as these increase so too should the scientific nature of the digital government domain.

Furthermore, taking into account the proposed interpretivist philosophy for digital government, it is possible to offer some initial insights into the core concepts or research areas for interpretivist digital government studies. These following insights are not meant to be all-encompassing, but rather should offer a starting point for future discussion and investigation:

1. Interpretivist digital government research is systemic in nature, and therefore, it is important to understand the systemic interactions at play.
2. Digital government means something different to different people, it is only by talking, studying, and understanding the beliefs associated with digital government that one can begin to explain specific actions associated with digital government. This would imply that there is a different understanding about the actual nature of digital government across contexts, and indeed, across stakeholder groups.

3. Digital government is in a constant state of co-evolution. As the environment changes it influences the beliefs and values of humans, similarly, as humans make choices and actions it influences the environment. Thus, digital government is not something static, but rather, it is a dynamic and constantly evolving object.

Looking toward the future, it is likely to be the case that digital government will continue to evolve as society and technology both change digital government and are simultaneously changed by it. The job is up to us, as scholars of digital government, to ensure that our theoretical and philosophical knowledge is able to provide the necessary and needed ability to understand these changes and generate new knowledge for the benefit of society. Here, it is important to emphasize that for *understanding*, it is not enough to simply describe changes or actions; as researchers, it is paramount that we strive to truly *understand* that which we study. It is only through this understanding that knowledge and explanation can follow, and this happens via a process of analyzing, researching, and interpreting. As technology becomes increasingly important in our modern day society, and as government continues to evolve toward a more digital form, having researchers with the necessary capability to interpret and understand these changes can only be of a benefit. Thus, it is hoped that, moving forwards, there will be increased interest and development of the interpretivist paradigm of digital government research.

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Digital Governance Problem and Solution Space

Understanding Digital Transformation in Government

Frank Danielsen, Leif Skiftenes Flak, and Øystein Sæbø

Abstract The term "digital transformation" has captured the attention of practitioners and academics over the past few years. However, while the term is increasingly being used, conceptual clarity is still needed, especially in the context of government and public organizations. While public and private organizations share several similarities, they also differ in important areas. Public organizations' goals, values, and strategies are often focused on increasing public good instead of increasing revenue. Therefore, more research is required to understand digital transformation in the context of government and public organizations. In this chapter, we explore digital transformation and, based on a literature review, we conceptualize the terms "digitization", "digitalization", and "digital transformation" and discuss how these can be understood in the context of the public sector. Finally, we propose a model of digitization, digitalization, and digital transformation and suggest how these terms are conceptually related.

1 Introduction

The transformation of organizations through their use of digital technologies is increasingly gaining attention in the information systems (IS) field (Vial, 2019). This also specifically applies to government and public organizations (Loukis et al., 2017). Even though they have lately been more focused on organizational change and innovation (Wimmer et al., 2020), public organizations are technology-intensive and have been for decades (Charalabidis & Lachana, 2020b). This development was

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accelerated with the introduction of the Internet (Lyytinen & Rose, 2008). In the 1990s, the term “eGovernment” was coined, much in response to the private sector’s “eBusiness” (Lenk, 1994). Since then, research on eGovernment and related terms has been plentiful. A number of more or less conceptually overlapping terms, such as “smart government”, “transformational government”, “electronic governance”, “open government”, “joined-up government”, and “digital government”, have since been used by scholars in the eGovernment field. Parallel to developments in the eGovernment field, the information systems field has developed similar terms to describe technological development, i.e., “digital transformation” (Kutzner et al., 2018), “information technology (IT) governance” (De Haes & Van Grembergen, 2009), “IT-enabled transformation” (Vial, 2019), and “digital innovation” (Svahn et al., 2017). Contrary to the eGovernment field, however, the information systems field is more general, covering both private and public contexts. Taking this into account, along with the fact that the eGovernment field has been argued to be limited in its use and development of theories (e.g., Bélanger & Carter, 2012), we argue that concepts developed in the information systems field could be relevant and valuable for eGovernment scholars.

Digital transformation has gained increased attention in the information systems field over the last few years (Kutzner et al., 2018; Voß & Pawlowski, 2019). However, one challenge researchers and practitioners face is obtaining a clear understanding of what digital transformation is (Demlehner & Laumer, 2019; Osmundsen et al., 2018). To do this, it is important to understand the associated family of terms. Examples of similar terms used in information systems research include “digitizing”, “digitization”, “digitalization”, and “digital transformation” (Lindgren et al., 2019; Vial, 2019). Some of these terms have been used for many years already, with their concepts and meanings developing and changing over time.

Government and public organizations share many similarities with private organizations, but they also differ. While private organizations often aim for competitive advantage and economic benefits (Danielsen et al., 2021; Rai & Tang, 2010), public organizations have other priorities, for instance, ensuring better services, openness and collaboration, societal problem-solving, citizen well-being, and the optimization of resources (Charalabidis et al., 2019; Lindgren et al., 2021). In the context of these goals, the structure, power relations, and stakeholders of public organizations also differ (Bozeman & Bretschneider, 1994; Flak & Rose, 2005).

Based on the above, we argue that, to investigate and build cumulative knowledge, it is necessary to have a clear and consistent understanding and usage of digital transformation and its associated terms. It is also important to understand the contexts within which such terms are used. Therefore, we analyze past and present terms (digitizing, digitization, digitalization, and digital transformation) and suggest a set of terms and how they conceptually relate to each other in order to explain the phenomena of public organizations going digital.

Following these arguments, we developed the following research questions: (1) What is digital transformation? (2) How is it different from digitization and digitalization? (3) How is digital transformation in a public context different from digital transformation in a private context? Our results show a lack of research specifically targeting the public field. Therefore, to gain an understanding of digital transformation and its associated terms in the context of public organizations, we study it in a general context and then suggest how our findings can be used to inform research related to public sector issues.

The rest of the chapter is structured as follows: Sect. 2 describes the methodology for the literature review. Section 3 explains the results of the analysis. Section 4 discusses the findings, providing answers to the three research questions. Finally, Sect. 5 presents the conclusion and several suggestions for further research.

2 Method

To obtain an overview of existing knowledge on digital transformation, we conducted a systematic literature review. The authors undertook this literature review between January 2020 and May 2020. For a review to be of scientific value, it must be thorough and fair (Kitchenham, 2004), and systematic literature reviewing consists of several steps (Albino & Souza, 2019). We followed Okoli (2015) in this regard and implemented the following steps: (1) planning the literature review, (2) searching the literature, (3) screening papers, (4) analyzing the selected papers, and (5) writing the review.

In Step 1, or the planning phase, we prepared guidelines for collecting the literature. This included identifying appropriate research questions, constructing search words and phrases, selecting databases, and developing inclusion and exclusion criteria (Table 1). We did not limit our search to a specific research domain, and, since we focused on a concept that is of a recent origin, we did not limit the search by providing a date range.

Table 1 Systematic literature review overview

Research questions	Search words	Databases	Inclusion criteria	Exclusion criteria
– What is digital transformation? – How is it different from digitization and digitalization?	– Digital transformation – Review	– Scopus – Web of science – AIS eLibrary	– Identified in the search process through the selected search phrase – Peer-reviewed – Defined as a conference paper journal paper or book chapter	– Authors' names are absent – Not in English – Duplicates – Not limited to a literature review – Does not contribute to answering the research questions

In Step 2, we searched the databases for journal and conference papers. We collected a total of 440 papers based on our search words ("digital transformation" AND "review") from the database engines of SCOPUS, Web of Science, and AIS eLibrary.

In Step 3, we began discarding papers based on our exclusion criteria. This exercise consisted of four phases. In Phase 1, we removed papers without author names, papers not written in English, and duplicates. In Phases 2 to 4, we excluded papers that (a) were not limited to a literature review or (b) did not focus on or were related to digital transformation in some way. Phase 2 involved scanning the papers' titles. In Phase 3, we scanned the papers' abstracts. Phase 4 involved scanning the papers fully. In Step 4 and 5, we analyzed the papers using NVivo and Excel as organizing tools and discussed our findings as well as how to disseminate the research. Figure 1 provides

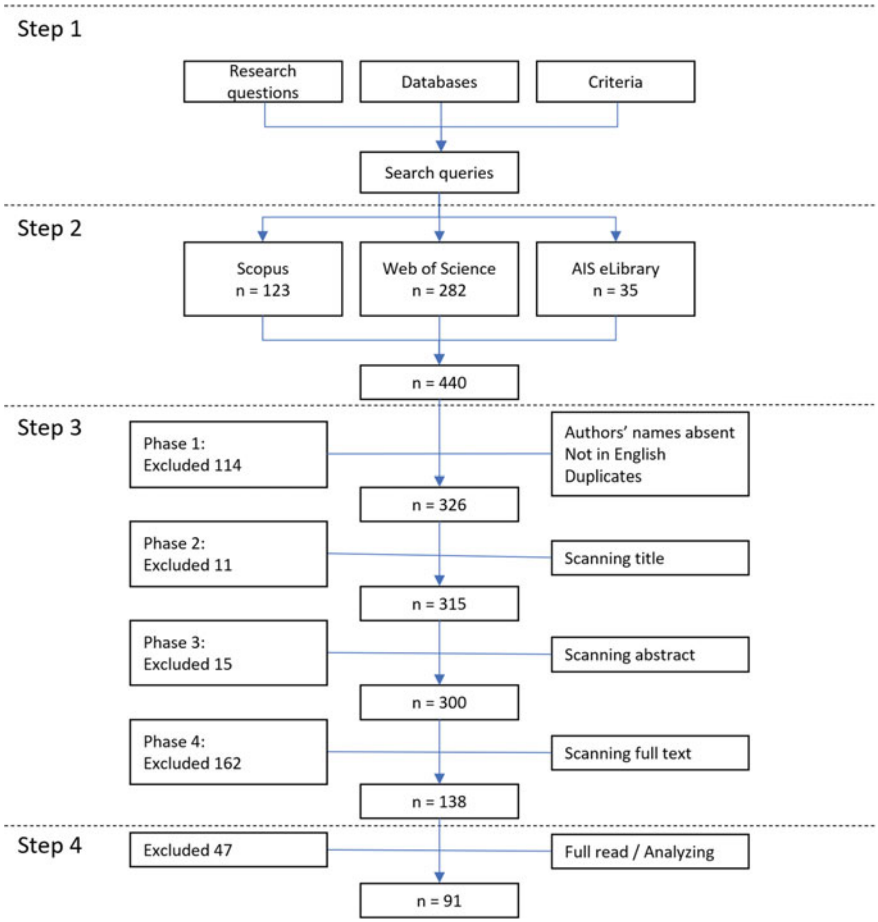

Fig. 1 Phases of the literature review undertaken in this study

an overview of the process. A total of 440 papers contained the search words, 91 of which were literature reviews related to digital transformation.

3 Digital Transformation in Research

3.1 Study Demographics

The literature review papers we identified were published from 2014 to 2020, and about half of them were published in 2019 (Fig. 2).

Only a few of the literature reviews focused on digital transformation and public organizations, with most focusing either on private or not any specific type of organization (Fig. 3). The papers focusing on public organizations were published in 2016 (1), 2018 (2), and 2019 (4). Upon examining these, we found that three focused on technology (Internet of Things, big data, and artificial intelligence) (Reis et al., 2019; Sarker et al., 2018; Sidek & Ali, 2019), while Reis et al. (2019) examined the relationship between these technologies and digital transformation. Of the papers focusing on public organizations, two contained definitions or descriptions of digital transformation (Reis et al., 2019) or associated terms (Bernhard-Skala, 2019; Reis et al., 2019). This confirmed the lack of research on digital transformation in the public context.

The papers were published in journals (38) and conferences (53) and represented a multitude of different research fields. While many were published in the information systems field, several were also related to computer science, management, business, and industrial research (Fig. 4). Since some journals and conferences were multi-

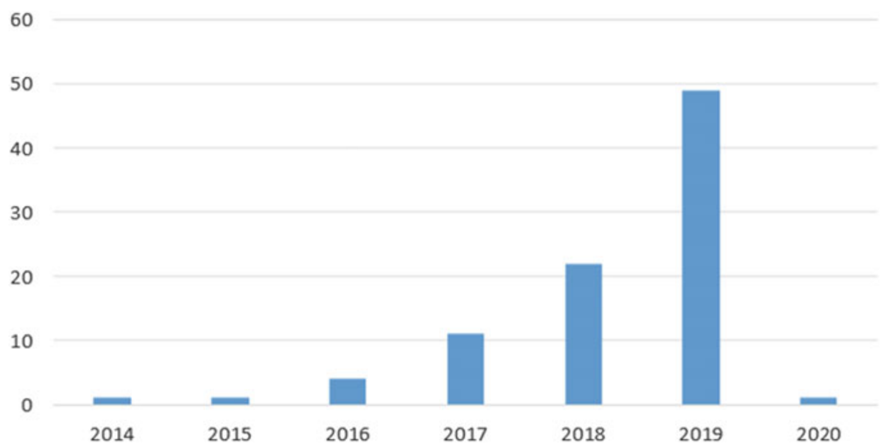

Fig. 2 Papers ($n = 91$) published per year

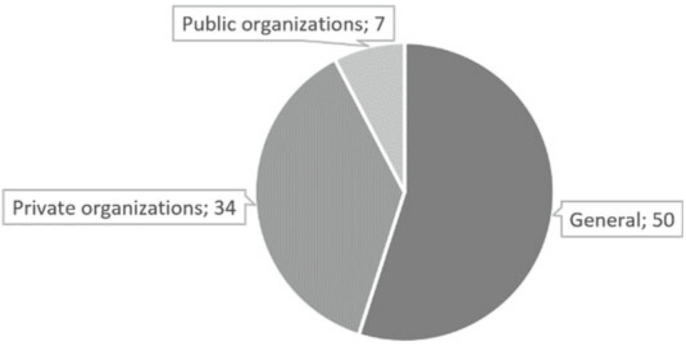

Fig. 3 Organizational context

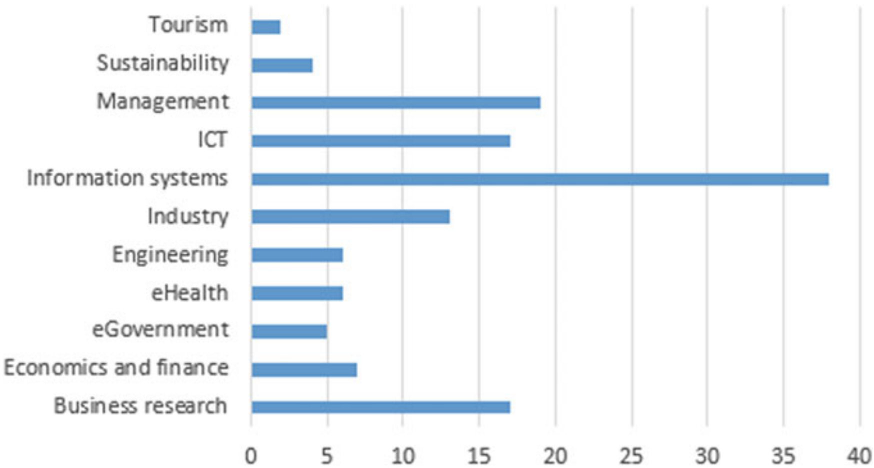

Fig. 4 Published papers sorted by fields of origin

disciplinary and covered several fields (e.g., information systems and management), some papers were considered as representing several fields.

The foci of the literature reviews were diverse, with a majority of papers related to digital transformation, technologies, and Industry 4.0,[1] often in addition to other concepts (e.g., business models, education, innovation, and governance).

[1] According to several papers, the manufacturing field uses the term "Industry 4.0" as a synonym for digital transformation.

3.1.1 History of the Usages of the Terms

To build some historical context around these terms (digitizing, digitization, digitalization, and digital transformation), we conducted another separate search for them and their use in scientific papers. We used Scopus and Web of Science for this purpose.[2] The results showed that the term "digitalization" has been used for the longest amount of time, beginning in as early as the 1920s. Its usage gained some momentum in the 1950s. Use of the terms "digitization" and "digitizing" began in the 1950s, but their usage did not increase before the 1960s before finally gaining popularity in the 1970s and 1980s. "Digital transformation" was first mentioned in the 1960s but gained momentum only around the 2000s. All the terms have seen significantly increased usage since the 2010s (Fig. 5).

3.2 Digitizing (Digitization), Digitalization, and Digital Transformation

3.2.1 Digitizing and Digitization

"Digitizing" and "digitization" are often used and explained as synonyms. While "digitizing" can be regarded as a verb and "digitization" can be classified as a noun, both describe the same phenomenon. Therefore, we grouped these terms together. Our literature sample included four papers presenting definitions of the terms "digitizing" and "digitization" (Table 2). Five papers described the two terms (Table 3). Bockshecker et al. (2018) and Demlehner and Laumer (2019) discussed and described these terms by examining, comparing, and presenting the views of different researchers. Reis et al. (2019) and Sanchez (2017) also presented their definitions but did not include a discussion or mention the sources that inspired their definitions. Below, we present the references used in these four reviewed papers.

Definitions

Several researchers argue that digitization involves the conversion of atoms into bits (Gobble, 2018). Some propose that it concerns digital infrastructure development (Freitas Junior et al., 2016), includes processes and artefacts (Jackson, 2015), is used to connect people, systems, companies, products, and services (Coreynen et al., 2017), drives innovation (Echterfeld & Gausmeier, 2018), or creates digital processes (Loebbecke & Picot, 2015). Several do not distinguish digitizing from digitalization (Mocker & Fonstad, 2017) or digital transformation (Loebbecke & Picot, 2015). This multifaceted use of the term leads to ambiguity, making the two terms broad and multifaceted (Echterfeld & Gausmeier, 2018).

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[2] We did not use Google Scholar, since the search results provided too many errors (e.g., certain papers were being shown as having been published in the 1920s, while, in reality, they had been published in the 2000s or later).

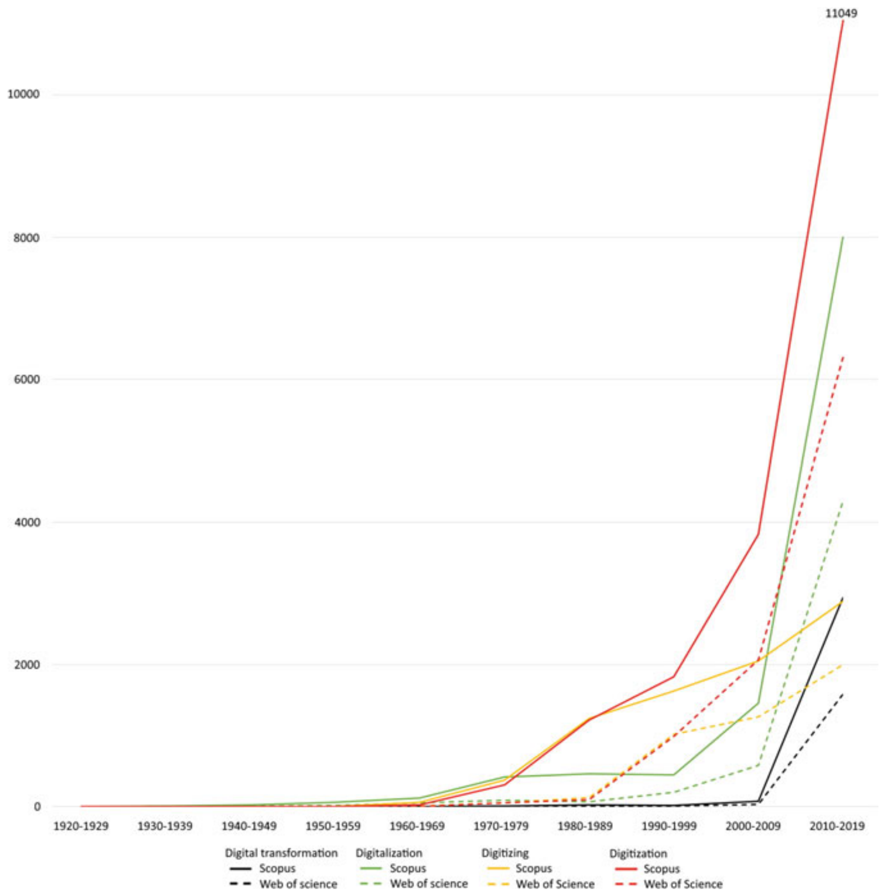

Fig. 5 Papers including the different digital terms sorted by 10-year periods (when published)

Table 2 Concepts included in the definitions of "digitizing" or "digitization"

Concepts	Bockshecker et al. (2018)	Demlehner and Laumer (2019)	Reis et al. (2019)	Sanchez (2017)
Analog to digital	x	x		
Atoms to bits			x	
Digital technologies	x	x		
Innovation	x	x		x
Technical	x	x		
Change				x

Table 3 Concepts included in papers when describing "digitizing" or "digitization"

Concepts	Bockshecker et al. (2018)	Gölzer and Fritzsche (2017)	Osmundsen et al. (2018)	Reis et al. (2019)	Sanchez (2017)
Analog to digital	x	x	x		
Atoms to bits				x	
From printed to digital	x			x	
Optimize processes					x
Social change	x				
Change business models					x
Increase quality					x
Increase efficiency					x
Cost reduction					x

While Reis et al. (2019) and Sanchez (2017) referred to the definitions offered by others, Bockshecker et al. (2018) and Demlehner and Laumer (2019) developed their own definitions. Bockshecker et al. (2018) concluded that these terms should be defined mainly for technical reasons, and Demlehner and Laumer (2019) defined them as the conversion of analog to digital signals.

Descriptions

Both the terms "digitizing" and "digitization" can be described as the process of converting information into a digital format (Bockshecker et al., 2018; Gölzer & Fritzsche, 2017; Osmundsen et al., 2018; Reis et al., 2019), e.g., replacing paper with document files or music with MP3 files (Gobble, 2018). This digital representation of a formerly physical product can be reprocessed by computers and shared digitally in a more efficient and convenient way without the restrictions that come with physical representations. In this manner, data that was previously unavailable for digital data processing becomes available (Gölzer & Fritzsche, 2017).

Today, digitizing and digitization contribute to creating new ways of working, communicating, and cooperating (Sanchez, 2017). The improvements that derive from digitizing and digitization facilitate changes in processes and can affect business models, since they improve the efficiency of data collection, communication, and control activities in making them more manageable and less costly (Sanchez, 2017). Importantly, even though digitizing might lead to these outcomes, "digitizing" and "digitization" are both still recognized as the process of converting physical objects into digital data (Bockshecker et al., 2018; Gölzer & Fritzsche, 2017; Osmundsen et al., 2018; Reis et al., 2019).

3.2.2 Digitalization

A significantly greater number of papers described and defined "digitalization" than "digitizing" and "digitization" (Appendix Table 9). Bernhard-Skala (2019) and Bockshecker et al. (2018) were the only sets of authors to propose their own definitions of "digitalization".

Definitions

Six papers presented a definition of the term "digitalization" (Table 4). While all these papers used references from other sources to help define this term, two presented their own unique definitions. Most papers referred to other works on digitalization. An exception was Demlehner and Laumer (2019) which referred to several definitions, although the authors' main focus was on a different term—"digital transformation".

While digitizing and digitization revolve around product conversion into a digital format, the concept of digitalization is broader. One could say that digitization converts atoms into bits, and digitalization transforms those bits into values (Reis et al., 2019). Often, researchers view digitalization as a sociotechnical process (Tilson et al., 2010) that involves people and society in addition to technical elements (Hausberg et al., 2019).

Besides focusing on products and services (Denner et al., 2018; Klötzer & Pflaum, 2017), digitalization is associated with processes (Denner et al., 2018), including the potential to affect the process of controlling, managing, and improving material and information flows from suppliers to end users (Klötzer & Pflaum, 2017). Moreover, some argue that digitalization can either improve or disrupt business models (Denner et al., 2018) or even an entire business (Hausberg et al., 2019). Others claim that digitalization not only describes digital development in an organization but could also be used in a societal (Bockshecker et al., 2018) or institutional (Tilson et al., 2010) context. Digitalization was further referred to as the current state of an organization, institute, or society with reference to its current digital development (Bockshecker et al., 2018) or as the process of connecting machines with information and digital technologies (Lenka et al., 2017). The term has also been described as the process of adopting or increasing the use of digital or computer technology (Brennen & Kreiss, 2016) or simply as implementing digital media (e.g., computer- and internet-based media) (Bernhard-Skala, 2019).

Descriptions

While digitalization was reported as a much broader concept than digitizing or digitization, only six papers actually described this term (Table 5). Digitizing and digitization mainly consider technical conversion aspects, whereas digitalization involves sociotechnical factors (Bockshecker et al., 2018), in which the social (e.g., human

Table 4 Concepts included in papers offering a definition of "digitalization"

Concepts	Bernhard-Skala (2019)	Bockshecker et al. (2018)	Demlehner and Laumer (2019)	Hausberg et al. (2019)	Piccinini et al. (2016)	Reis et al. (2019)
Affect business				x		
Affect society				x		
Change				x		
Convert material to new products		x				
Digital media	x					
Digital technologies			x			
Digitizing techniques					x	
Disrupts business models			x			
Improve business models			x			
Improve material and information		x	x			
Increase use of technology			x			
Intelligent connected machines	x					
Organizational digital development		x				
Societal digital development		x				
Sociotechnical					x	
Transform data into value						x

interactions, relationships, and norms) and the technical (e.g., technology, tasks, and routines) structures are altered (Osmundsen et al., 2018).

Today, new digital technologies are rapidly emerging and boosting digitalization processes (Denner et al., 2018). This increases competition within organizations, industries, institutions, and governments (Brennen & Kreiss, 2016), since digitalization enables the automatization and optimization of processes (Savastano et al.,

Table 5 Concepts included in papers describing "digitalization"

Concepts	Bockshecker et al. (2018)	Kutzner et al. (2018)	Lammers et al. (2019)	Osmundsen et al. (2018)	Reis et al. (2019)	Savastano et al. (2019)
Achieve cooperation			x			
Alter business models		x				
Alter processes				x		x
Alter product/service		x		x		
Alter user experience				x		
Automation						x
Beyond technical				x		
Bits to value					x	
Cost reduction					x	
Digital data						x
Digital development	x					
Digital technologies		x				x
Do not change business					x	
Efficiency					x	
Innovative			x			
Organizational change		x				
Reduced error rates					x	
Social	x					
Sociotechnical	x	x				
Strategies			x			
Technical	x					
Technical change		x				
Technologies	x					x
Transformative			x			

2019). Since digitalization is the process of adopting information and communication technology in organizational and societal contexts (Bockshecker et al., 2018), it could lead to competitive performance through cost reduction, increased efficiency, reduced error rates, greater cooperation, and other related benefits (Lammers et al., 2019; Reis et al., 2019).

Digitalization is an innovative process (Kutzner et al., 2018; Lammers et al., 2019) involving the transformation of processes through digital technologies (Kutzner et al., 2018). These digital technologies (e.g., cloud computing, big data, and artificial intelligence) enhance innovation, disruption, and competition for an organization (Kutzner et al., 2018).

3.2.3 Digital Transformation

Regarding digital transformation, several papers presented definitions and descriptions. Some presented their own definitions while others constructed definitions based on examining existing definitions. Many referred to definitions from other sources. Surprisingly, several papers presenting definitions of digital transformation did not describe or explain digital transformation any further (Appendix Table 9).

Definitions

We identified 22 papers presenting definitions of "digital transformation" (Table 6). While digitizing and digitization are associated with converting information into data, and digitalization is concerned with implementing digital technologies in processes, the function of digital transformation goes beyond the above-mentioned concepts (Albino & Souza, 2019).

Digital technologies (e.g., Demlehner & Laumer, 2019; Morakanyane et al., 2017) or technologies in general (e.g., Bockshecker et al., 2018; Vial, 2019) form the core of digital transformation. Several researchers have underscored that digital transformation concerns new technologies (e.g., Reis et al., 2018; Vial, 2019), including cloud computing, big data, Internet of Things, artificial intelligence, machine learning, social media, mobile-, and embedded devices (Brown & Brown, 2019; Cortellazzo et al., 2019; Demlehner & Laumer, 2019; Vial, 2019).

Of the 22 papers, 18 defined digital transformation as being involved with processes, arguing that digital transformation affects existing organizational processes (e.g., Hausberg et al., 2019; Reis et al., 2019; Wiedenmann & Größler, 2019) or creates new processes (Pihir et al., 2019). Others referred to digital transformation as a process in itself (e.g., Bogéa Gomes et al., 2019; Teichert, 2019).

Change is considered a key term in regard to digital transformation (e.g., Albino & Souza, 2019; Henriette et al., 2015; Wolf, 2019). While some authors focused on organizational change (e.g., Osmundsen et al., 2018; Voß & Pawlowski, 2019), others put emphasis on societal change (e.g., Bockshecker et al., 2018; Demlehner & Laumer, 2019; Vial, 2019). Certain studies stressed that these changes are major (Osmundsen et al., 2018) as well as significant and unique (Vial, 2019), a position supplemented by

Table 6 Concepts included in papers presenting definitions of "digital transformation"

Author	Albino and Souza (2019)	Bockshecker et al. (2018)	Bogéa Gomes et al. (2019)	Brown and Brown (2019)	Cortelazzo et al. (2019)	Crowley et al. (2017)	Demlehner and Laumer (2019)	Gebayew et al. (2018)	Hausberg et al. (2019)	Henriette et al. (2015)	Lammers et al. (2019)	Lammers et al. (2018)
Automation							x					
Business models	x	x		x			x	x		x	x	x
Capabilities								x				
Change	x	x			x		x	x	x			x
Customer experience	x					x	x	x			x	x
Digital technologies	x	x	x	x	x	x	x	x	x	x	x	x
Evolution												
Improvement (business)	x			x		x	x	x			x	x
Innovation		x	x	x			x	x				
New technologies		x									x	x
Organization			x									
Organizational change		x					x		x			
Organizational structure	x	x							x			
Processes	x	x	x	x			x	x	x		x	x
Products/services		x					x		x			

(continued)

Table 6 (continued)

Author	Albino and Souza (2019)	Bockshecker et al. (2018)	Bogéa Gomes et al. (2019)	Brown and Brown (2019)	Cortelazzo et al. (2019)	Crowley et al. (2017)	Demlehner and Laumer (2019)	Gebayew et al. (2018)	Hausberg et al. (2019)	Henriette et al. (2015)	Lammers et al. (2019)	Lammers et al. (2018)
Radical (improvement)							x					
Societal change		x					x	x	x			
Strategy		x	x					x				

Author	Morakanyane et al. (2017)	Osmundsen et al. (2018)	Pihir et al. (2019)	Reis et al. (2018)	Reis et al. (2019)	Teichert (2019)	Vial (2019)	Voß and Pawlowski (2019)	Wiedenmann and Größler (2019)	Wolf (2019)
Automation	x			x			x			
Business models	x			x	x	x	x	x	x	
Capabilities	x			x		x	x		x	
Change	x	x			x	x	x	x		x
Customer experience	x			x	x	x	x		x	
Digital technologies	x	x	x	x	x	x	x	x	x	x
Evolution						x	x		x	
Improvement (business)	x			x	x		x	x		x
Innovation			x			x				x
New technologies				x	x		x			

(continued)

Table 6 (continued)

Author	Morakanyane et al. (2017)	Osmundsen et al. (2018)	Pihir et al. (2019)	Reis et al. (2018)	Reis et al. (2019)	Teichert (2019)	Vial (2019)	Voß and Pawlowski (2019)	Wiedenmann and Größler (2019)	Wolf (2019)
Organization	x	x	x				x			
Organizational change		x		x			x	x		
Organizational structure	x						x			
Processes	x		x	x	x	x	x	x	x	x
Products/services	x		x				x			
Radical (improvement)	x				x		x			
Societal change	x			x	x		x			
Strategy	x						x			

researchers defining digital transformation as a radical improvement (Demlehner & Laumer, 2019; Morakanyane et al., 2017; Reis et al., 2018, 2019; Vial, 2019).

Digital transformation was also seen as a way of creating new business models (e.g., Crowley et al., 2017; Lammers et al., 2019) or improving existing ones (Demlehner & Laumer, 2019). This indicates that digital transformation is a wider concept than digitalization, since it is also described as a significant component of business strategy (e.g., Bogéa Gomes et al., 2019; Vial, 2019).

In addition to streamlining operations and improving products (Bogéa Gomes et al., 2019; Culot et al., 2020), digital transformation is used to enable business improvements in organizations by enhancing the customer experience (e.g., Gebayew et al., 2018; Morakanyane et al., 2017; Teichert, 2019).

Descriptions

Out of 91 papers in total, 27 described digital transformation (we did not view definitions as a way of describing digital transformation, and therefore did not include those) (Table 7). Digital transformation was found to be a more extensive concept than digitizing, digitization, and digitalization, as it focused, to a larger extent, on organizational and societal changes (Loonam et al., 2018; Vial, 2019).

Digital transformation is about transforming organizations and societies through the implementation of digital technologies (e.g., Reis et al., 2018; Teichert, 2019). These technologies can be established or new (e.g., cloud computing, Internet of Things, social media, and artificial intelligence). Digital transformation often leads to changed, improved, or even new business models (e.g., Culot et al., 2020; Osmundsen et al., 2018), thereby making businesses rethink and modify their strategies (Crowley et al., 2017). Thus, digital transformation can change entities at the organizational level (e.g., Kutzner et al., 2018; Vial, 2019). Digital transformation can also impact customers and the customer experience (e.g., Loonam et al., 2018; Pihir et al., 2019), which explains why it is said to cause societal change (e.g., Reis et al., 2018; Vial, 2019).

Digital transformation and digitalization share one feature: In both cases, digital technologies are used to change or improve processes—not only the products. These processes are restructured and improved to create new capabilities (Brown & Brown, 2019; Teichert, 2019) as well as increase financial performance (Osmundsen et al., 2018; Vial, 2019). However, digital transformation and digitalization differ in that the former is a more holistic approach (Kutzner et al., 2018; Teichert, 2019) and the changes it brings about are more radical, significant, or intense (e.g., Babar & Yu, 2019; Drieschner et al., 2019).

Other incentives for initiating digital transformation include the promise of offering better products and services (e.g., Babar & Yu, 2019; Loonam et al., 2018) through more effective processes (Morakanyane et al., 2017). Most of the authors agree that digital technologies are a significant driver of digital transformation (e.g., Vial, 2019).

Digital transformation is organization-centric, with potential for external consequences (e.g., Osmundsen et al., 2018; Pihir et al., 2019; Voß & Pawlowski, 2019). However, one recent study offers a novel understanding of digital transformation. Vial

Table 7 Concepts included in papers describing "digital transformation"

Concepts	Albino and Souza (2019)	Babar and Yu (2019)	Bockshecker et al. (2018)	Bordeleau et al. (2019)	Brown and Brown (2019)	Crowley et al. (2017)	Culot et al. (2020)	Drieschner et al. (2019)	Götz et al. (2018)	Hausberg et al. (2019)	Henriette et al. (2015)	Hilali and Manouar (2019)	Kutnjak et al. (2019)	Kutzner et al. (2018)	Lammers et al. (2018)
Adopt			x						x					x	
Business model		x			x	x	x		x		x	x	x	x	
Capabilities	x				x										
Change	x										x		x	x	x
Competitiveness						x									
Complex													x		
Customer												x			
Digital technologies	x		x	x	x		x	x	x				x	x	x
Digitalization									x		x		x		
Disruptive		x										x			
Improvement					x			x	x						x
Innovative					x	x				x					
Leadership				x	x									x	
Organization wide/holistic					x				x		x			x	
Processes	x	x		x	x	x				x			x	x	
Products/services		x			x	x			x		x	x		x	
Restructure/reconfigure					x				x						x
Sociotechnical			x												

(continued)

Table 7 (continued)

Concepts	Albino and Souza (2019)	Babar and Yu (2019)	Bockshecker et al. (2018)	Bordeleau et al. (2019)	Brown and Brown (2019)	Crowley et al. (2017)	Culot et al. (2020)	Drieschner et al. (2019)	Götz et al. (2018)	Hausberg et al. (2019)	Henriette et al. (2015)	Hilali and Manouar (2019)	Kutnjak et al. (2019)	Kutzner et al. (2018)	Lammers et al. (2018)
Strategy	x				x	x								x	
Structure	x	x												x	

Concepts	Loonam et al. (2018)	Lundgren et al. (2018)	Morakanyane et al. (2017)	Nazir et al. (2019)	Osmundsen et al. (2018)	Osterrieder et al. (2019)	Pihir et al. (2019)	Reis et al. (2018)	Savastano et al. (2019)	Teichert (2019)	Vial (2019)	Voß and Pawlowski (2019)
Adopt			x									
Business model	x		x		x			x			x	
Capabilities							x			x		
Change					x	x		x		x	x	x
Competitiveness		x									x	
Complex		x	x									
Customer	x		x		x		x	x		x		
Digital technologies	x	x	x	x	x		x	x	x	x	x	x
Digitalization												
Disruptive	x		x		x						x	
Improvement				x	x							
Innovative					x						x	
Leadership												
Organization wide/holistic										x		x

(continued)

Table 7 (continued)

Concepts	Loonam et al. (2018)	Lundgren et al. (2018)	Morakanyane et al. (2017)	Nazir et al. (2019)	Osmundsen et al. (2018)	Osterrieder et al. (2019)	Pihir et al. (2019)	Reis et al. (2018)	Savastano et al. (2019)	Teichert (2019)	Vial (2019)	Voß and Pawlowski (2019)
Processes	x		x				x	x		x	x	
Products/services	x											
Restructure/reconfigure	x									x		
Sociotechnical								x			x	
Strategy	x		x				x			x	x	
Structure										x	x	

(2019) explains the change organizations implement through digital technologies as "IT-enabled transformation" or IT-enabled organizational change, with the ultimate goal being achieving competitive performance. This is realized by changing organizational capabilities, strategies (e.g., digital business or transformation strategy), structures, processes, and cultures. Further, Vial (2019) proposes that digital transformation extends beyond IT-enabled organizational change in that its consequences are more profound, extends beyond organizational boundaries, and can cause societal change. The central tenet is the focus on the changes in society and industries (digital transformation) that subsequently force organizations to change (IT-enabled transformation). Viewing digital transformation in this way disrupts organizations' competitive environments and forces them to change. An important differentiation between Vial's (2019) definition and others is the expansion of digital transformation to not only being organization-centric but also viewing societies, industries, and cultures as entities that can be digitally transformed.

4 Adapting Digital Transformation to a Government Context

Our goal in this research was to answer the research questions:

(1) What is digital transformation?
(2) How is it different from digitization and digitalization?
(3) How is digital transformation in a public context different from digital transformation in a private context?

In addition to providing an overview of digitalization and the usage of associated terms over time, we confirmed our assumption that there is a lack of research on digital transformation in the public context. Most of the papers we examined were published in the research fields of information systems, business and management, information and communication systems, and industry. Very few papers focused on the public context; these examined technologies, eHealth, and education issues in digital transformation contexts. Considering this, we argue that, to understand digital transformation in government contexts, it is meaningful to draw on the knowledge produced in other contexts.

While examining the usage history of the different terms in the extant literature, it is interesting to note that "digitalization" is the oldest. As early as the 1920s, several papers in the medical field used the term "digitalization". In the 1960s, "digitizing", "digitization", and "digitalization" began gaining popularity. The terms "digitizing", "digitization", "digitalization", and "digital transformation" have made large gains in terms of use, in the last 10 years. While this is not an in-depth study on the history of these terms, these results provide strong indications that these terms have been a component of the research literature for quite some time—although their meanings have changed over the years.

In the next sub-sections, we summarize our findings from the literature review into a discussion responding to the research questions introduced above. We also provide examples of how these terms can be used, explore how the different terms conceptually intertwine, and label them according to their interconnections. Then, we briefly discuss the usage history of these terms. Finally, we discuss research question 3, specifically in terms of the unique characteristics that are associated with digital transformation in a public context.

4.1 Key Terms

4.1.1 Digitizing and Digitization

Our examination of the papers showed both the terms differed from each other and they were inconsistency among them. Regarding digitizing and digitization, the papers mostly limited the meaning of the terms to the process of converting physical information into a digital format, whereas others preferred a broader coverage and used the terms "digitizing", "digitization", "digitalization", and "digital transformation" interchangeably. Bockshecker et al. (2018) and Demlehner and Laumer (2019) were the only papers that did extensive work constructing definitions for these terms. For these reasons, and to avoid more confusion, we agree with Bockshecker et al. (2018), Demlehner and Laumer (2019), and Reis et al. (2019) and argue that "digitizing" and "digitization" should be defined as follows:

> Digitizing and digitization is the process of converting information from the analog to the digital.

To illustrate digitizing and digitization in the public context, we provide some typical examples of such. Paper-based documents, messages, and mail have been converted to digital files, and paper forms have been transformed into online digital versions. This allows employees and citizens much easier access to these products and services, and improves convenience, as they can now work with the converted versions using a range of electronic devices. Tax administrations around the world are digitizing tax return forms to make it easier for citizens to self-report their tax information (Maphumula & Njenga, 2019; The Norwegian Tax Administration, 2020). Public organizations are also digitizing their documents and archiving systems to make them easily accessible (Astle & Muir, 2002).

4.1.2 Digitalization

Digitalization was described as a sociotechnical process (Bockshecker et al., 2018; Osmundsen et al., 2018) with a focus on products, services, and processes (Bockshecker et al., 2018; Kutzner et al., 2018; Osmundsen et al., 2018; Savastano et al., 2019). Demlehner and Laumer (2019) argued that digitalization disrupts or improves business models, and Kutzner et al. (2018) noted that it also enables new business models and, thereby, organizational change. Hausberg et al. (2019) argued that digitalization affects business and society, but Reis et al. (2019) contradicted this by proposing that digitalization does not change the way organizations conduct business. Despite these disagreements, the authors also agreed upon several statements. For instance, the term “digitalization” extends beyond technical aspects (Osmundsen et al., 2018)—unlike “digitizing” and “digitization”. Digitalization is about implementing digital technologies in organizational processes (Demlehner & Laumer, 2019; Osmundsen et al., 2018; Savastano et al., 2019) and altering products and services (Kutzner et al., 2018; Osmundsen et al., 2018). Based on this, and considering digitalization’s interplay with digitizing, digitization, and digital transformation, we suggest the following definition for “digitalization”:

> Digitalization is a sociotechnical process aiming to convert and modify organizational processes into a digitally enhanced form.

We posit that digitalization is used to not only convert an archive of analogue documents into a digital format but also to change the way in which public organizations manage these archives. Digitization is the process of scanning documents and storing them digitally. Digitalization, on the other hand, involves digitizing documents and restructuring processes and systems associated with these digital documents (i.e., a sociotechnical process). In other words, digitalization occurs when public organizations modify and optimize their processes (Hammer, 1990) and, thus, fully digitalize them—instead of only replacing analog with digital elements. Another example of digitalizing public services involves service automation and self-service alternatives for citizens, which results in new roles and tasks for public officials. Citizens can then access these new digital public services from anywhere using digital tools (Lindgren et al., 2019). Based on the above, we argue that digitalization focuses predominantly on processes.

4.1.3 Digital Transformation

“Digital transformation” is often defined and described more broadly compared to the other three digital terms. Researchers generally agree that digital technologies and organizational processes are central to digital transformation. The difference between “digital transformation” and the other terms lies in the former’s organizational and societal focus (Demlehner & Laumer, 2019). The term is used when organizations significantly modify their business models (Vial, 2019) and strategies (Morakanyane et al., 2017), which often leads to their offering new customer experiences (Reis et al., 2018). In other words, digital transformation affects both the external and internal parties of an organization.

We noticed some inconsistencies in how digital transformation was described in the works analyzed, demonstrating a divide in understanding in terms of the level or areas the term represents. A few papers stated that digital transformation is about significant or radical change with potentially more widespread and profound transformational consequences, than the other terms, that go beyond organizational boundaries and affect us at the society level (Vial, 2019). This is an interesting perspective on digital transformation and contrasts with other established terms, such as “IT-enabled organizational change” or “IT-enabled transformation”, that have been described in the information systems literature over the last 25 years. This is similar to how most papers in our sample described digital transformation as affecting organizational levels with potential to affect industry, societal, or cultural levels as well (as consequences).

Based on the above arguments and considering our interpretations of “digitizing”, “digitization”, and “digitalization”, we suggest the following definition for “digital transformation”:

> Digital transformation is significant changes in organizational or societal, service logics, structures, and values enabled by digital technologies.

Two examples of organizations that have experienced digital transformations are the Norwegian Tax Administration and the Norwegian Labor and Welfare Administration. Both of these entities converted their analog forms, reports, messages, and documents into digital versions (digitizing), changed and improved their processes, supported new digital solutions (digitalization), and adapted the entire organization toward becoming digital, resulting in completely new customer experiences as well as organizational and societal change (digital transformation). As a result, the Norwegian Tax Administration has changed its business logic around tax returns, leading to new roles for the organization and its end users. Specifically, citizens now verify the tax information received from the tax administration is correct instead of providing the tax information and sending it to the tax administration, which again needs to confirm that the information is correct. A third example is the Norwegian Postal Service. This example slightly differs from the previous two, since it has not directly undergone digital transformation. Instead, the environment the Norwegian Postal Service operate in has been digitally transformed. Digital technologies enabled citizens to use alternative methods of communication, which results in reduced demand for postal services. The whole postal industry experienced radical transformations, changing society and how we communicate with each other. The Norwegian Postal Service needed to adjust themselves to citizens’ new demands. They were forced to digitize, digitalize, innovate, and create new services. One of the results from these processes was digital mail services (Posten, 2020). These examples support the argument that the process of becoming a digital government is called “digital transformation”, and it transforms through digitization and digitalization processes.

While we believe most of the reviewed papers are in line with our definition of digital transformation, some challenges remain regarding the definition of digital transformation as referring to organizational and societal change. One main question arises: Is digital transformation possible without societal change? For instance, an organization could go digital but still deliver the same services and products to citizens. If digital transformation is defined to include societal change, one might exclude cases that could be defined as digital transformation cases without affecting societal change. Therefore, we define this term as involving organizational or societal change.

4.1.4 Relations Between the Terms

The papers from our literature review establish that digitization (and digitizing), digitalization, and digital transformation are different terminologies. We examine their conceptual alignment with each other in Table 8.

The above table shows that digitizing and digitization are associated with converting analog information into a digital form. Digitalization is a wider concept: As it focuses on both technical and social (sociotechnical) elements, digitalization can consist of one or more digitizing (or digitization) processes. The footprint of digital transformation thus transcends those of the above three terms. While digitalization often focuses on processes, digital transformation concentrates broader, on totality. For instance, digital transformation can focus on how processes are connected, how an organization can be digitalized on the whole, and how these changes affect the organization or society in general. These terms thus coexist. Moreover, digital transformation can include one or more digitalization processes, which include digitization processes. In our model (Fig. 6), digital transformation is visually shown as a process tied to organizational or societal change, with its important

Table 8 Digital terms and associated concepts

Concepts	Digitizing	Digitization	Digitalization	Digital transformation
Analog to digital products	●	●	●	●
Analog to digital services			●	●
Business models			◒	●
Digital technologies	●	●	●	●
New digital technologies			●	●
Organization-oriented			◒	●
Organizational change			◒	●
Processes			●	●
Radical, significant change				●
Social aspects			●	●
Strategy			●	●
Technical aspects	●	●	●	●
World-oriented				●

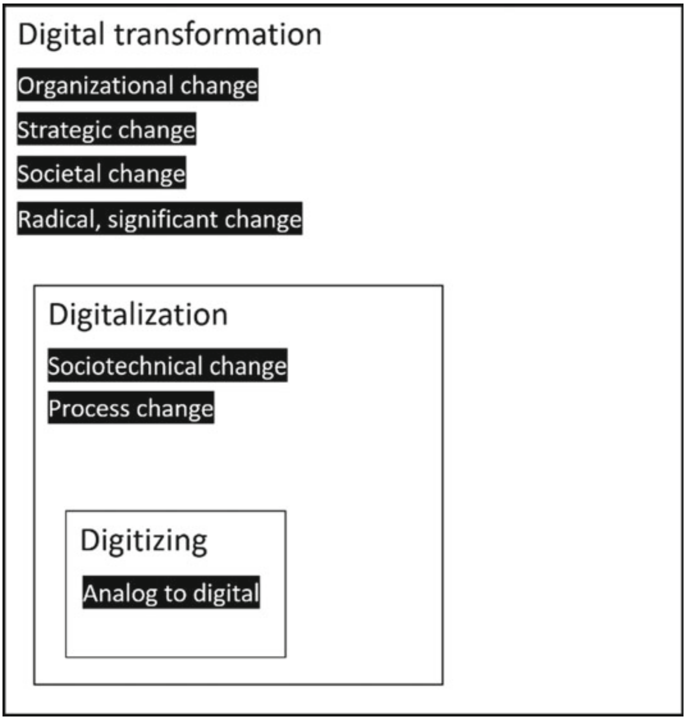

Fig. 6 Co-existing digital terms

components including business strategies and business models. Inside digital transformation, there exists one or more digitalization processes. These typically focus on processes as a whole and are sociotechnical in nature. Inside this again is digitizing (and digitization), showing that digitalization processes include one or more digitizing processes, which involve converting analog products or services into digital formats, as such conversions are seen as necessary preconditions for digitalization and digital transformation.

The literature we studied highlighted a variation in the understanding of the basic concepts, especially the terms "digitalization" and "digital transformation". In many cases, these terms were used interchangeably. We also found evidence of digital transformation being understood as something new, a new concept, that extends previous understanding of IT-enabled organizational change to involve deeper and more profound implications at the societal level. We consider this distinction as adding conceptual clarity that can help researchers distinguish between the different concepts and thus increase precision in future studies. To this end, we also suggest definitions of digitizing, digitalization, and digital transformation that can be discussed and further developed by the academic community.

4.1.5 Digital Transformation in the Public Context

We found a few literature reviews focusing specifically on digital transformation in governments and public organizations. Even though our definition of digital transformation covers organizations in both private and public contexts, the ramifications of digital transformation in government and public organizations can be different in several ways. First, these organizations consist of complex relationships, with different government branches, civil society representatives, citizens, and stakeholders. These contemporary societies are characterized by complex problems that require synergies across both multiple disciplines and stakeholders in order to be tackled (Pereira et al., 2018). Radical transformation could lead to powershifts in an already widely complex type of organization. Second, with government and public organizations' different goals, such as addressing severe, social challenges, (Pereira et al., 2018) or aiming to enhance society's quality of life and promoting sustainable growth (Charalabidis & Lachana, 2020a), best practices, and reasons for success and failures, the benefits and challenges associated with digital transformation initiatives might be different than findings identified from the private context.

We therefore argue that there are good reasons to bridge the knowledge from information systems and eGovernment and seek to align the use of concepts rather than developing them in parallel. Still, there is a lack of research on digital transformation in the public context, and this should be a target for future research as a way in which to strengthen the Digital Governance Science Base (Charalabidis & Lachana, 2020a, 2020b).

5 Conclusion and Future Research

In this study, we did a meta-review of the literature on digital transformation with the objective of understanding the term and the related terms “digitizing”, “digitization”, and “digitalization”. To add to the conceptual clarity for the terms of going digital, we suggest definitions of the concepts “digitizing”, “digitization”, “digitalization”, and “digital transformation”. Further, we propose that these concepts are distinct but related and that they can be nested in a structure, as shown in the discussion section. We propose that the mentioned concepts and definitions should be embraced by both information systems and eGovernment scholars to leverage the cumulative building of knowledge over the parallel development of competing concepts. Finally, we discussed digital transformation in the public context and how it differs from the private context. One suggestion for future research could be to aim to further develop the academic and practical understanding of the different digital terms by analyzing their usage history and how their meaning has evolved through the years. Another avenue could be to identify the drivers, benefits and challenges, success factors, and best practices for digital transformation initiatives in the public context.

Appendix

See Table 9.

Table 9 Overview of papers defining and describing the terms

	Digital transformation			Digitalization			Digitizing/digitization		
Author	Developed definition	Used existing definitions	Described term	Developed definition	Used existing definitions	Described term	Developed definition	Used existing definitions	Described term
Albino and Souza (2019)	x	x	x						
Babar and Yu (2019)			x						
Barbosa and Saisse (2019)		x							
Berghaus (2016)	x								
Bernhard-Skala (2019)				x	x				
Bockshecker et al. (2018)	x	x	x	x	x	x		x	x
Bogéa Gomes et al. (2019)		x							
Bordeleau and Felden (2019)			x						
Brown and Brown (2019)		x	x						
Cortellazzo et al. (2019)		x							
Crowley et al. (2017)	x		x						

(continued)

Table 9 (continued)

Author	Digital transformation			Digitalization			Digitizing/digitization		
	Developed definition	Used existing definitions	Described term	Developed definition	Used existing definitions	Described term	Developed definition	Used existing definitions	Described term
Culot et al. (2020)			x						
Demlehner and Laumer (2019)	x	x	x		x		x	x	x
Drieschner et al. (2019)			x						
Gebayew et al. (2018)		x							
Gölzer and Fritzsche (2017)									x
Götz et al. (2018)			x						
Hausberg et al. (2019)		x	x		x				
Henriette et al. (2015)		x	x						
Hilali and Manouar (2019)			x						
Kutnjak et al. (2019)			x						

(continued)

Table 9 (continued)

	Digital transformation			Digitalization			Digitizing/digitization		
Author	Developed definition	Used existing definitions	Described term	Developed definition	Used existing definitions	Described term	Developed definition	Used existing definitions	Described term
Kutzner et al. (2018)			x			x			
Lammers et al. (2018)		x	x						
Lammers et al. (2019)		x				x			
Loonam et al. (2018)			x						
Lundgren (2018)			x						
Morakanyane et al. (2017)	x	x	x						
Nazir et al. (2019)			x						
Osmundsen et al. (2018)	x	x	x			x			x
Osterrieder et al. (2019)			x						
Piccinini et al. (2016)					x				
Pihir et al. (2019)	x		x						

(continued)

Table 9 (continued)

	Digital transformation			Digitalization			Digitizing/digitization		
Author	Developed definition	Used existing definitions	Described term	Developed definition	Used existing definitions	Described term	Developed definition	Used existing definitions	Described term
Reis et al. (2018)	x	x	x						
Reis et al. (2019)		x			x	x		x	
Sanchez (2017)								x	x
Savastano et al. (2019)			x			x			
Teichert (2019)		x	x						
Vial (2019)	x	x	x						
Voß and Pawlowski (2019)		x	x						
Wiedenmann and Größler (2019)		x							
Wolf (2019)		x							

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A Public Value Impact Assessment Framework for Digital Governance

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Abstract Impact assessments have long been used for policy evaluation as well as for assessing (emerging) technologies. Within the field of Digital Governance, impact assessments are often used to analyze policy implications or to assess the impact of technologies such as big data and artificial intelligence on public services. Furthermore, within this research field, impact is expected to not only include economic impact, but also deliver public value and address societal challenges. Therefore, impact assessments performed need to take into account a broad, and sometimes conflicting, range of impacts, requiring tailored impact indicators and frameworks for measurement. This chapter presents an Impact Assessment Framework for Digital Governance aimed at measuring public value. Using three exemplary case studies we demonstrate its use for policy makers as well as for scholars aiming to understand the policy context of Digital Governance. The three cases were carried out using action research combining an analysis of policy, organization, and technology elements of government-to-business and government-to-citizens public services. Based on these cases we present six findings that need to be taken into account when performing public value impact assessments within Digital Governance.

Keywords Public value · Impact assessment · Public services · Digital governance · Government-to-business · Government-to-citizens · Public value management · Policy evaluation

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1 Introduction

Within the field of Digital Governance, policy makers aim to create public value by addressing societal challenges, delivering services to citizens and businesses, and increasing operational efficiency and effectiveness (Andersen et al., 2020). However, the question of what constitutes public value is not easily answered. An inventory of public values identified 72 different ones, thereby showing that there are many different public values (Jørgensen & Bozeman, 2007). Therefore, public value creation often refers to an attitude of governments meeting citizens' collective expectations of the public sector including its public services (Moore, 1995; Twizeyimana & Andersson, 2019). The public management paradigm Public Value Management captures this attitude. *Public Value Management* is defined as the continuous assessment of the actions that the public sector undertakes to ensure that public value is created (Stoker, 2006). It, thereby, represents a dynamic perspective rather than a static state of being. The number and wide variety of public values as well as the changing nature of what constitutes public value, thus, present significant challenges to governments aiming to measure or assess the public value they create. These challenges emerge across policy fields, including Digital Governance.

To evaluate the (expected) value that is created by their policies and public services, government organizations often seek to assess their impact, by means of performing an impact assessment (European Commission, n.d.; Podhora et al., 2013). *Impact assessments* are used to perform analyses both before (ex-ante) and after (ex-post) implementation (OECD Directorate for Science, Technology and Innovation, 2014). Next to evaluating the (expected) impact of a policy on a specific solution, governments as well as other stakeholders may seek to evaluate the (expected) impact of a new or emerging technology to assess its capacity to solve a particular problem. In the field of Digital Governance, both policy *and* technology impact assessments have been carried out, often focusing on public services (Sivarajah et al., 2015; Yannacopoulos et al., 2010). However, rather than evaluating the (expected) impact of these policies and technologies, governments increasingly aim to understand their impact on public value creation and transformation (Bannister & Connolly, 2014). Therefore, this chapter develops a Public Value Impact Assessment Framework for Digital Governance aimed at assessing the public value that is created. Subsequently, this framework is demonstrated by performing three exemplary case studies of different types of public services.

Although the impact assessment methodology has a long history in academic literature as well as in policy studies of Digital Governance, we found that its application to practice and associated advantages and risks have not yet been investigated in-depth. While in academic literature focus is often on conceptualization of public value, policy documents usually focus on the matter at hand rather than analyzing the methodology. The contribution of this chapter to methodologies for Digital Governance is, thus, threefold. Firstly, it develops a Public Value Impact Assessment Framework for Digital Governance, focusing on delivering public value by combining elements of policy and technology impact assessments. Secondly, it demonstrates the practical use of this framework by presenting three recent exemplary cases of impact assessments applied to different types of public services: a federated architecture for administrative burden reduction for businesses, disruptive technologies' impact on accessibility and inclusiveness of social services, and the impact of artificial intelligence on public services for citizens. And, thirdly, it lists six findings based on these exemplary cases to guide policy officers as well as scholars of Digital Governance aiming to perform such impact assessments. The exemplary case studies are carried out using action research, which allowed us to gain an in-depth understanding of the development and application of impact assessments as well as at the same time providing policy makers with information that they may use to further develop their policy.

This chapter is structured as follows. In the next section, we present background literature on measuring public value in the field of Digital Governance. Subsequently, we provide an overview of impact assessment methodologies, followed by the development of the Public Value Impact Assessment Framework. The following sections present the methodology used and the three exemplary cases respectively. The last sections present the findings from the case studies and the conclusions.

2 Measuring Public Value in Digital Governance

Creating public value is central to the role of government, which means to ensure that the collective expectations of citizens of government and public services are met (Moore, 1995). Accordingly, the Public Value Management paradigm of public management is concerned with the dynamic assessment of what constitutes public value and how this can be created in networks of stakeholders (Stoker, 2006). This is as much applicable to the field of Digital Governance as to other areas of government (e.g. Bannister & Connolly, 2014; Cordella & Bonina, 2012; Scott et al., 2016; Veenstra & Janssen, 2012). To illustrate, Andersen et al. (2020, p. 3) state: "Information and communication technology (ICT) in government has been part of these efforts in lowering administrative burdens and bettering citizen services, as well as making government more transparent, accessible, accountable, open, and inclusive, and preventing corruption". This statement shows that public value in Digital Government is not only a dynamic concept, but also one that may encompass a wide variety of values (Bannister & Connolly, 2014; Jørgensen & Bozeman, 2007). In the research field much attention is given to the role of public services (e.g. Scott et al., 2016). Public services can be divided into three categories: government-to-citizens (G2C; delivery of public services to citizens, which encompasses services provided to individuals and general services provided to society as a whole), government-to-business (G2B; delivery of public services to businesses), and government-to-government (G2G; public services used within and between public administrations at different levels and for their own operations).

A challenge for measuring public value is the changing nature of technology deployed in public services, ranging from information systems for operational processes to websites and social media, and from blockchain and cloud infrastructure to open data, big data and the use of algorithm and artificial intelligence (e.g. Bozeman & Bretschneider, 1986; Janssen et al., 2012; Klievink et al., 2017; Ølnes et al., 2017; Scott et al., 2016; Wirtz & Müller, 2019). Moreover, to create value with these technologies in processes of Digital Governance, the mere adoption of these technologies is not expected to be effective; the notion of transformational government holds that value delivery depends on transforming governments' organizational processes, thereby leveraging these technologies to realize an overhaul of the public sector aimed at public value creation (Barcevičius et al., 2019; Nograšek & Vintar, 2014; Veenstra et al., 2011). Such an overhaul is considered necessary to align policy and public services' objectives with the technologies that are used. Technologies are, in this view, themselves enablers of public values that enact with their organizational and institutional environment (Cordella & Iannacci, 2010). This means that to measure the public value in relation to the use of technology for public services, also organizational processes and structure need to be taken into account, via measuring organizational capabilities or organizational readiness (e.g. Klievink & Janssen, 2009).

Different ways to classify public values were found in the literature. Bannister and Connolly (2014), who build on the inventory of 72 public values (Jørgensen & Bozeman, 2007) but focus specifically on Digital Governance, classify public values based on the distinction between duty oriented, service oriented, and socially oriented. Twizeyimana and Andersson (2019), based on a literature review of 53 articles, take a similar approach and distinguish between values pertaining to improved public services, administration, and social value. They subsequently operationalize the three categories into six dimensions of public value, which are: improved public services; improved administrative efficiency, which includes open government capabilities and improved ethical behavior and professionalism; and improved social value, which comprises improved trust and confidence in government, and improved social value and well-being. These six dimensions are similar to Faulkner and Kaufman's categorization of public values that distinguishes four categories: outcome achievement, trust and legitimacy, service delivery quality, and efficiency (Faulkner & Kaufman, 2018). These different categorizations thus share similarities by distinguishing between different types of public value based on for whom they deliver value (e.g. government itself, citizens or society at large) or put differently between public values pertaining to the administrative role of government, public values pertaining to the duty of government: the delivery of public services, and public values aiming to create societal value.

3 A Public Value Based Impact Assessment Framework

Impact assessments are traditionally performed for two distinct types of analyses: firstly, they are often used in the process of policy making (e.g. European Commission, n.d.; OECD Directorate for Science, Technology and Innovation, 2014; Podhora et al., 2013), and secondly for the assessment of technology (e.g. Martinez-Plumed et al., 2020). The former type of impact assessment supports policy making in two ways: firstly, "it contributes to valuable and empirical data on policy decisions; and secondly, it builds a comprehensive and well-informed framework to foresee the consequences of potential regulatory policy options" (Amo et al., 2007, p. 3). Similarly, the latter is "aimed at providing decision makers with an objective analysis of effects of a technology" (Eijndhoven, 1997, p. 269). Impact assessments can be performed at different times, for example before ("*ex-ante*", which involves a prospective analysis of what the impact of an intervention might be, so as to inform policy making) or after ("*ex-post*", which aims to understand to what extent and how a policy intervention impacts the problem it intended to address) implementation (OECD Directorate for Science, Technology and Innovation, 2014). While an impact assessment mainly focuses on whether an initiative achieves its expected benefits, other aspects also need to be taken into account, since impacts can be *positive* or *negative*, and *intended* or *accidental* (Streatfield & Markless, 2009).

Impact assessments performed in the field of Digital Governance usually focus on public services delivery and draw on a combination of policy, organization, and technology elements (Sivarajah et al., 2015; Yannacopoulos et al., 2010). Firstly, they cannot be considered outside of the policy objectives of Digital Governance, such as addressing societal challenges, improving service delivery to citizens and businesses, and increase operational effectiveness and efficiency. Secondly, they assess the expected impact of (new or emerging) technologies in the field, such as websites, blockchain technology, big data or artificial intelligence. Thirdly, as outlined earlier, following the logic of transformational government, also an additional element needs to be taken into account: organizational capabilities and readiness (Cordella & Iannacci, 2010; Klievink & Janssen, 2009; Nograšek & Vintar, 2014). This means that impact assessments in this field cannot be considered as mere technology or policy oriented, but also need to take into account the organizational context when studying public services. For example, an impact assessment of Web 2.0 technologies in local government also uses a combination of these three layers of Digital Governance (Sivarajah et al., 2015). The impact assessment framework we develop will, therefore, also take all three layers into account.

Several impact assessment frameworks in the field of Digital Governance have been developed and applied, such as on e-Government and Web 2.0 use. The e-Government framework developed by Yannacopoulos, Manolitzas, and Spyridakos (Yannacopoulos et al., 2010) is an ex-ante impact assessment, and distinguishes between digital services provided to citizens (G2C) and to businesses (G2B). The former category includes twelve different services, such as income taxes, social security benefits, health related service, etc. The second category includes eight services for businesses, such as corporate tax, environment permits, and public procurement. Sivarajah et al. (2015) have developed an ex-ante impact assessment framework for Web 2.0 technologies and their use in—and impact on—local government. They have classified multiple impacts of Web 2.0 use in e-Government, categorizing them in organizational (culture and change, transparency and accountability, policy alignment and governance, knowledge management, collaboration and communication, organizational learning, human capital, and financial resources), technological (security and privacy, interoperability, scalability, data protection) and social impacts (participation and engagement, co-production, innovations and crowdsourcing solutions, and building and maintaining trust).

Based on the literature on public value in Digital Governance (drawing on Bannister & Connolly, 2014; Faulkner & Kaufman, 2018; Twizeyimana & Andersson, 2019) and on impact assessments (drawing on Yannacopoulos et al. (2010) for focus on public services and on Sivarajah et al. (2015) for the categorization), we propose a number of clusters of impact factors: effectiveness, efficiency, openness, outcomes and social value, ethical behavior and professionalism, and trust (see Table 1). For every category, an explorative indicator is provided as an example based on the above mentioned categorizations and indicators of public value. An overview of the main elements of the Public Value Impact Assessment framework for Digital Governance is presented in Fig. 1.

4 Case Study Methodology

To illustrate how impact assessments based on public value can be used in the field of Digital Governance, we present three exemplary cases using an action research approach (Argyris et al., 1985; Baskerville, 1999). "Action research is an interventionist approach to the acquisition of scientific knowledge" that takes place in two stages: a diagnostic stage in which the researcher and the subjects of the research collaboratively analyze the current situation and a therapeutics stage that involves collaboratively designing and implementing interventions (Baskerville & Wood-Harper, 1996, p. 237). It is often used to study information systems and digital technologies (e.g. Baskerville, 1999) and applied in the field of Digital Governance, such as in studies of public services (Axelsson & Melin, 2007). Since action research aims "at solving an immediate problem situation while carefully informing theory" (Baskerville, 1999, p. 3), the challenge of action research is to address a problem at hand through intervention and to contribute to research at the same time (Axelsson & Melin, 2007). Using an action research approach to the exemplary cases in this chapter means that the authors were actively involved in both the diagnostic stage as well as the therapeutic stage. Practically, this means that we were involved in developing the impact assessment frameworks used to explore the topic at hand and in formulating recommendations based on application of these frameworks. In some cases, we were also involved in performing the actual impact assessment.

The three cases were selected based on their combined scope of policy and technology assessment, and on their focus on creating public value by means of public service delivery:

1. The Once-Only Principle of sharing for cross-border businesses (G2B);
2. The impact of disruptive technologies on social services (G2C); and
3. Social and economic impact of AI on public services (G2C).

Table 1 A proposed impact assessment framework for measuring public value in Digital Governance, with explorative indicators

	Effectiveness	Efficiency	Openness	Outcomes and social value	Ethical behavior and professionalism	Trust
Policy	(Better) policy alignment for public value	Administrative burden reduction	Evidence-based, transparent policies	Increased government legitimacy, long-term goals	Increased public involvement, institutional accountability around digitization	Alignment of EU values and strategies
Organization	(Better) use of digital means to deliver services	More time for quality in services	Accountability, explanation of decisions	Increase in connection of goals and outcomes	Appointment of data protection officer, organization of external audits	Multi-stakeholder approaches
Technology	Increased understanding of impact of digitization	Increase technology assessment and better forecasting	Open data, open source software	Structural measurement of outcome and impact	Transparency procurement of novel service development	Public understanding of AI and legal protection

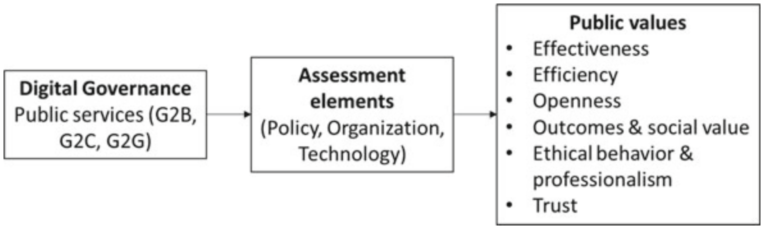

Fig. 1 A public value impact assessment framework for digital governance

All three cases combine elements of policy, organization, and technology assessments and focus on public value creation. More specifically, they do so via public services. Whereas the type of policy or technology under study differs, in all cases the technology is expected to have an impact on public values through enabling (novel forms of) public services. Sometimes service innovation may directly affect public values because the innovation is affecting the form and shape of the service delivered to citizens and sometimes it affects public value in a more indirect way through the internal organizational processes (Bannister & Connolly, 2014). Furthermore, all three cases have a presence in European and national digital strategies for public sector innovation. Whereas the cases vary in nature and scope, and are by no means meant to cover all aspects of the proposed framework, they present a complementary set of recent impact assessments that help to explore if and how impact assessments of Digital Governance address public value. The exemplary cases focus on three different policy-technology topics, see Table 2.

All cases are recently performed: they were carried out between 2017 and 2021. The impact assessments in these cases are typically undertaken in a relatively early stage of development, often focusing on pilots. In the next sections, we will first describe the case study, its scope and method, and the topic under study: its policy-technology focus. This is followed by a section in which we elaborate how public value was assessed including the indicators that were used to measure public value.

5 Case: The Once-Only Principle for Cross-Border Business

5.1 Case Description and Method

The Once-Only Principle (OOP) aims to ensure that businesses need only to provide their data once to a government organization, after which it will be shared with other government organizations to realize administrative burden reduction (Kalvet et al., 2018). To support the OOP, the European Commission initiated a Large Scale Pilot project that aims to develop a federated architecture to enable cross-border data sharing, and to prove the feasibility of the OOP by developing multiple pilots of

Table 2 Overview of the focus of the impact assessment in the case studies

Case name	Topic under study	Public value	Type of services	Development stage; IA approach
The once-only principle (OOP) for cross-border businesses	Federated architecture for the once-only principle for cross-border data sharing between governments	Administrative burden reduction	Government-to-business	Ex-ante and ex-post impact assessment of pilots for OOP services
Impact of disruptive technologies on social services	Disruptive technologies (e.g. blockchain, artificial intelligence, robotics) in public services	Accessibility and inclusion	Social services; government-to-citizens	Analysis of digitization strategies including ex-ante assessment of disruptive service delivery in-development
Social and economic impact of AI on public services	Artificial intelligence (AI) in public services	Social and economic value	Public services; government-to-citizens	Ex-ante assessment via European and national strategies, experts and case studies

digital services that make use of this architecture. The project thus aims to create impact on all three levels: on the policy, organization, and technology layer. The policy layer is concerned with preparing national governments for the OOP; the European Commission adopted the Single Digital Gateway Regulation (European Commission, 2021) that sets the goals of developing a one-stop-shop for digital services in Europe and the outcomes of the project on the OOP will directly feed into the development of the Single Digital Gateway. The organizational layer of the project deals with question of impact on information processes in different levels of government. The technology layer aims at offering a federated architecture, that builds on top of existing information infrastructures, allowing for data exchange between already existing registries in Member States.

In the diagnostic phase we developed an impact assessment framework specifically for the project and its purposes, and subsequently applied these to the pilot projects that were developed to demonstrate the working of the federated architecture. Via several rounds of surveys and workshops with pilot representatives we captured generic impacts of the OOP as well as pilot-specific impacts and discussed and gathered what relevant indicators for such impacts would be and where to find supporting data. Throughout the project, multiple impact assessments (ex-ante and ex-post) were performed using the same framework and indicators of public value to provide recommendations to the pilot development and for implementation of the federated architecture after the project is finished (the therapeutic phase). The project started in January 2017 and finished in March 2021.

5.2 Approach to Assessing Impact on Public Value

In terms of public value, this case is aimed at administrative burden reduction for businesses, at quality of services, and at government efficiency (Kalvet et al., 2018). Based on a literature review, administrative burden reduction was operationalized to cost and time savings by businesses. In this case, providing one's data only once clearly fits in the category of administrative burden reduction—making it easier to access business or citizen data cross-border would alleviate many cumbersome processes. Often, impact assessments of administrative burden reduction are aimed at government efficiency internally, looking mainly at the "supply" side. Yet, if public value would be a starting point, the impact assessment would also look more outwards to the demand-side, to better understand why end-users would need this system or innovation, or why they would refrain from using it. Providing data only once and making it sharable can invoke other impacts that affect public values, for example, the value of privacy and the level of trust in a government handling one's data carefully. Moreover, different regulatory, organizational and/or societal boundaries may exist in different countries, making harmonization of OOP one of the challenging topics.

For our impact assessment methodology, we not only develop indicators for the three main categories of public value (administrative burden reduction, quality of service, and government efficiency), but also for an additional category "secondary benefits and negative consequences", based on our data gathering and workshops with participants in the project. The impact categories mobilized were administrative burden reduction (looking at transformation of stakeholder's relations and legislation, data harmonization, improved data quality and reliability and cost and time savings), quality of service (looking among others at non-discrimination, reliability, trust, transparency, accessibility, and societal responsiveness), government efficiency (in which we address among others fraud reduction and prevention, avoidance of task duplication, interconnectivity and interoperability and user satisfaction), and finally secondary benefits and negative consequences such as start-up effects, platform dependency, but also increased performance and improved ICT infrastructure (Table 3).

Table 3 Public value impact assessment framework for the OOP for cross-border business

	Effectiveness	Efficiency	Openness	Outcomes and social value	Ethical behavior and professionalism	Trust
Policy	Improved collaboration between government organizations, fraud reduction and prevention	Transformation of stakeholders' relations and legislation	Ubiquity, access, and availability	Responsiveness to the needs of society and legitimation	Non-discrimination, transparency and accountability	Reliability and trust
Organization	Simplification of processes	Avoid duplication of tasks, re-use and interconnectivity of building blocks	Transparency and accountability	Harmonization of data, startup-effects	Platform dependency	Improved mobility
Technology	Performance and effectiveness	Improved organization and ICT architecture	Security breaches	Ubiquity, access, and availability	Responsiveness to the needs of society	User satisfaction, risk of identity theft

6 Case: Impact of Disruptive Technology on Accessibility and Inclusion of Social Services

6.1 Case Description and Method

This case study concerns a study of the impact of disruptive technologies on social services delivery. By analyzing national digital strategies and cases of social services using disruptive technologies, the study meant to find evidence of the use and impact of digital technologies on accessibility and inclusion of social services, in particular artificial intelligence, robotics, internet of things and domotics, virtual and augmented reality, online platforms, blockchain, and digital and biometric identification. While the focus was on these emerging technologies, we also considered more common technologies such as smartphone applications and web-based services. In order to validate to what extend disruptive technologies are being developed or already deployed in social service delivery, and to what extend such developments stem from particular governmental strategies or programs concerning digitization of government services, in a series of country case studies we explored both national strategies and including up to three examples of social service delivery innovations, with a specific focus on technologies that are expected to be disruptive, being artificial intelligence, blockchain and/or robotics. The study, thus, focused on the three layers of the impact assessment: policy, organization, and technology.

While the country case studies can be seen as the diagnostic phase, in the therapeutic phase we developed recommendations around indicators to take into account regarding accessibility and inclusion of such services. Regarding digital strategies, we researched drivers of the digitalization strategy and links with past initiatives and other policies, we described the strategy in terms of elements of accessibility and inclusion and we provided evidence of impacts of the strategy on service users, if available. Case-specifically, we provided a brief description of the digital social service in terms of geographic level, type of social service, technology used, whether the service is in kind or in cash, when the service or pilot was initiated and who in the long term provides the service (government, private actor, or combination). Based on desk research and interviews with policy makers, we then provided qualitative evidence of impact on both service provider (start-up costs, skills, adapting processes etc.) and end-user (understanding/use of service, quality of service, possibility to file complaints etc.). The study hints via case studies, although in early stages, at proof of impact of digital social service delivery innovations on these public values (accessibility and inclusion). The study was performed between January and December 2018.

6.2 Approach to Measuring Public Value

While the potential benefits of digitization to government agencies are clear (OECD, 2016) there are unintended consequences such as the widening of the digital divide. Though new digital technologies such as care robots or machine learning promise increased usability by offering more freedom and autonomy for a service provider or end-user, they also bring about new challenges, such as having less face-to-face contact and the increased dependency of social services on technology. We looked at national strategies and at cases of innovative digital service delivery through a set of impact indicators connected to accessibility and inclusion. We sought reference points and definitions to help connect public value improvement to digitization of welfare states which in turn could help frame digital accessibility and inclusion, and turned to a study of public services in the welfare areas (OECD, 2016), who refer to digital welfare when discussing the use of digital technologies in the modernization of education, healthcare, and social care and protection services. Accessibility of social services is defined in terms of its key dimensions: access, availability, affordability, and acceptability. In this study we defined inclusion narrowly as the inclusiveness of the digital technologies and application, for example, the availability and take-up of appropriate training when introducing a digitized service. Focus was on the social services as listed in the chapter about social protection and inclusion of the European Pillar of Social Rights (European Parliament, Council and Commission, 2017).

In order to translate policy frameworks on accessibility and inclusion into indicators to assess digital, disruptive services, we used intermediary terminology and concepts such as e-inclusion and drew from declarations that underpin these values (Riga Declaration on e-Inclusion, 2006). In untangling the term e-inclusion, we came across a multidimensional model of e-inclusion that created an overview of e-inclusion dimensions, being *access, usage, impact of ICT and the internet on quality of life,* and *empowerment* (Hrustec et al., 2016). These dimensions served as a basis for impact indicators. When it comes to defining accessibility and related indicators, there is no single definition of the concept of accessibility with regard to social services. It is a “quality concept that is interpreted differently depending on the design approach used for the development” (Persson et al., 2015, Introduction). Nevertheless, there is much communality on the *dimensions of accessibility* among the authors writing on the subject. In that respect, all the main aspects covered in academic literature on accessibility, geographical access, availability, affordability, and acceptability are relevant in considering the contribution and impact of digitization on social services delivery. Yet in gathering evidence, even via our use cases, there is a lack of measuring instruments that connect policy impact goals with either technology impacts and/or public value impacts. Furthermore, many indicators were hard to measure because of a lack of available data and mature enough cases to assess.

Connecting such outcomes to our impact assessment framework of public value, this study tells us that many indicators for categories related to public value stem from non-digital service delivery assessments, but they do not easily translate into digital services, and that data on digital social factors is often lacking. Moreover, impacts on public value are, both in positive and negative sense, estimated higher than the pace of digitization in the public sector can promise or deliver (Table 4).

7 Case: Social and Economic Impact of Artificial Intelligence on Public Services

7.1 Case Description and Method

The third case study evolves around the development of an impact assessment methodology for the social and economic impacts of artificial intelligence (AI) on public services for citizens. This methodology is developed within the AI Watch programme for the European Commission. This study addresses both G2C services on the individual level and G2C generic public services (such as the police, road maintenance, education etc.). In this case study, the technology element is, thus, AI, even though in this study it is mentioned that no widely accepted definition of this technology exists yet. The measurement of impact of AI should be seen in light of common European values to be upheld and protected. The High Level Expert Group on AI (AI HLEG) appointed by the European Commission mentions specifically human autonomy, prevention of harm, fairness and explicability in their AI ethics guidelines (High-Level Expert Group on Artificial Intelligence, 2019). These guidelines can be considered as leading public values for any European study on AI and algorithms in the public sector. They can be considered the policy element of this case study, since the European Commission aims to ensure that these European values will lead the development and application of AI. Furthermore, the organization element in this case study is in studying the application of AI to policy and decision making processes as well as in operational processes of public services.

In order to understand the effect of AI applications developed in and for public services, as well as their impact on citizens, we needed to draft a combined basic framework on which key indicators can be based. One of the most salient areas is that of applications of automated decision making and decision support, both from the perspective of public administrators using such systems, and that of the citizen who, directly or indirectly, interacts with public services through such applications. The study, therefore, is a combination of a policy impact assessment and a technology impact assessment, with the aim of informing on an organizational level how to measure public value impacts. In the diagnostic phase, we developed an overview of impact indicators based on desk research and expert workshops, and we compiled a long and a short list of case studies to "test" impact indicators and their measurability. The main emphasis in the therapeutic phase lies on the development of a methodology for making informed choices regarding public sector adoption of AI within governments. The study was conducted between December 2019 and May 2021.

Table 4 Public value impact assessment for the impact of disruptive technologies on social services

	Effectiveness	Efficiency	Openness	Outcomes and social value	Ethical behavior and professionalism	Trust
Policy	Improving social service delivery	Stimulation programs and innovation funds	Development/implementation of accessibility standards	Reaching more people in need of social services	Types/openness of procurement processes	Public consultations National ombudsmen investigations
Organization	Improve internal processes	Less administrative burden, more time for citizen/client	(Difficulties with) IP and maintenance of service in PPPs	Technology adoption by service delivery	Training of personnel	Use of standards and external auditing
Technology	Increase uptake of novel technologies for service delivery	Improved connection between policy and service	Open-source tools and platforms	Higher level of autonomy, self-reliance	Courses for service deliverers and administrators	User feedback sessions, co-development methods

7.2 Approach to Measuring Public Value

Taking a public value approach when developing an impact assessment for social impacts of AI introduces many different variables and starting points, from human rights and ethics through government strategies and core public sector functions to current AI indices and monitors (e.g. OECD AI Policy Observatory, n.d.) to case studies of current forms in which AI is being deployed. Where some impacts, for instance on fairness and bias in AI seem obvious, others, such as secondary effects of (de)skilling of public administration and accountability in relation to automated decision making are more difficult to capture. The analysis we performed was aimed in particular at identifying current and future requirements and opportunities for applications of AI in the public sector, foreseeing potential disruptions and risks (social and economic), understanding the opportunities and challenges of (not) acting at European level, and defining indicators to measure them.

In the development of relevant indicators, we tried to draw and combine indicators from four areas of sources that emerged from various disciplines around AI impact. From AI high-level principles as defined by the AI HLEG (High-Level Expert Group on Artificial Intelligence, 2019) and other frameworks key emphasis is put on inclusive growth, sustainability, and well-being, safeguards to ensure a fair and just society, diversity, accountability, and explicability. From public sector tasks and related policy advice on AI, we distilled: public and private investment in research and development to spur innovation, stimulation of accessible AI ecosystems, open policy environment for trustworthy AI, empowerment of people and workers with skills for AI transition. Finally, from literature on impact assessments and current AI service case studies and/or existing AI monitors we summarized the following impacts: AI for social inclusiveness, increase of self-reliance; reduction of dependency on state, enhancement of access to services, and increase of social cohesion via better social services. The latter positive impacts depend on how governments design and develop meaningful human control, explicability of AI and user-centric methods that aim to avoid negative impacts of AI. These may be the result of reproduction of existing inequalities and digital divides and less trust due to opaqueness of automated decision making.

Concerning the measurement of such indicators, the project addressed formal institutional places for indicators in which policy and technology connect with service users (e.g. European Ombudsman, 2012) and acknowledged (yet did not delve into) informal ones (e.g. of appraisals or complains via social media). Combining several sources of indicators, we proposed a first framework to inform case study research, which was validated in a workshop with Member States representatives. They added important additions to our indicators: better use of public resources, potential new avenues for the development of public services, uptake of new technologies by citizens, reducing poverty, creating more inclusive public services, increasing the efficiency of public administrations and improving public administration ability to predict and prevent societal issues. On the topic of how to measure these impacts, very little was in place at that moment. We used the literature and the expert workshop input to create a preliminary case study template that served as a basis for further case study collection and analysis into if and how such questions, which relate to impact indicators, are actually capturable and classifiable in a constructive manner (Table 5).

8 Findings and Discussion

8.1 Findings from the Exemplary Cases

Applying our proposed impact assessment framework for public values in digital government in three case studies has provided a first exploration of its potential value and points for improvement. Where more in-depth findings will be provided below, we start with a brief summary of our findings per case. In the OOP for cross-border business case, we found that the framework was useful in breaking up the aimed impact of administrative burden reduction into more fine-grained steps along the different categories (impact on policy, organization, and technology, respectively). Yet, the lack of outside validation of impact assessment indicators in the different use cases testing the OOP, revealed a strong focus on which external impact (of making it less burdensome to register cross-border businesses) was related to impacts on internal processes, more than on outside conflicting values such as privacy and its impacts on the OOP itself.

In the case of analyzing the impact of disruptive technologies on social services, the public value of accessibility and inclusion were at the same time both obvious for public service delivery and very challenging to measure. The framework helped in mapping what potentially to look for in terms of classification of impacts and measurements. However, the early stages of development and the wide variety of novel disruptive technologies made it hard to make the framework specific enough while at the same time remaining helpful to draw more generic lessons. We did not find many applicable indicators in government programs or strategies for developers or impact assessors to make accessibility and inclusion more tangible and thus measurable in the case of particular novel technologies used in public service delivery. What our framework did do is help mapping out where and how to find fruitful avenues for data collection on indicators, and potentially where to create new ones, for instance regarding trust and reliability. It also helped showing connections between policy, organization and, technology (or showing the gaps in between these three categories, especially when one of the categories is taken as the dominant force, such as technology in this case).

In the third case, the framework was used to map the complexity of artificial intelligence (AI), and the emphasis on ethics and societal expectations of what the public sector is doing or is planning to do with AI. The framework helped to explicate the variety of sources of AI ethics and the widely varying views on potential benefits and risks of AI, for both the public sector internally and for society at large. The main

Table 5 Impact assessment for social and economic impact of AI on public services

	Effectiveness	Efficiency	Openness	Outcomes and social value	Ethical behavior and professionalism	Trust
Policy	Increase of citizen-government connections	Cost/benefit of services	Accessibility of AI strategies and services	Protection/enforcement of EU values	Clarity of purpose of AI use	Perception of legitimacy
Organization	Value for money (of third party AI)—procurement	Increase in quality of gov services through AI	Transparent and open processes	Added value create	Professionalism of AI service	Citizen engagement in AI-based service development
Technology	Best-practices and mutual learning	Increase AI skills and education	Use of explainable AI	More uptake of AI, increased understanding	Avoid AI-function creep, long-term assessment	Platform-and vendor-independent

challenge for the public sector is the transformational nature of AI and algorithmic decision making, which poses novel challenges for safeguarding public value; current institutional checks and balances and organizational skills and infrastructures seem inadequate in capturing the changes AI potentially will instigate. Nor are there many approaches in place to capture the views and expectations the wider society has of public sector uptake of AI. Based on the three cases of applying the Public Value Impact Assessment Framework, we now present six findings for performing impact assessments in the field of Digital Governance aimed at gaining insight into public value creation of public service delivery.

8.2 Conflicting Views Exist on What Constitutes Public Value and How to Weigh Them

In the three cases we see different foci and diverging points of departure when it comes to public values. Often, public services are intended to be geared toward specific outcomes that are defined in policy documents, but during development and implementation, also other public values come into play. Furthermore, there is an inherent interplay between the technology, organization, and policy (or institutional) layer and these layers shape each other; technology is a carrier and enabler for public value and public values held by the organization or the institutional environment, in turn, shape technology (Cordella & Iannacci, 2010). This suggests that the use of impact assessments during the design and development and the implementation phases may be useful to gain insight into the different views on what constitutes public value.

In the three cases, we often observed a discrepancy between policy documents and the starting point of the public services. For example, in the case of the Once-Only Principle, administrative burden reduction for businesses was the starting point, but during the Large Scale Pilot project the federated architecture became the main focus of the development. And in the case of the impact of disruptive technologies on social services, accessibility and inclusiveness were central to many policy documents in the field, but they were often not used as a starting point by developers of public services. In the case of the impact of artificial intelligence on public services, much attention is given to the opportunities of these new technologies for public services, for example on efficiency gains in realizing automated decision making. Yet, in the policy realm, the AI HLEG point at a number of other public values that should be taken into account such as inclusiveness, sustainability and well-being, and diversity, accountability and explicability as safeguards to ensure a fair and just society.

8.3 It Is Necessary to Take Unexpected (and Negative) Outcomes into Account

Impact assessments aim to assess the outcomes of a specific policy or technology, thereby identifying benefits or possible impacts of an information system or disruptive technology on both the public sector itself (often efficiency or administrative burden reduction) as well as on society at large (by being able to offer faster or more inclusive services for example). However, in all three cases analyzed in this paper, we found that negative consequences and second-order effects as impacts are crucial to take into account, be it only to manage expectations better within governments and toward society. These second-order and potentially negative effects are often hard to foresee, yet being sensitive to expert experiences, "weak signals" (Saritas & Smith, 2011) as well as plain-sight but overlooked public values that are most likely to be scrutinized, can help in building stronger impact assessment frameworks.

To exemplify, in the first case, we learnt via in-depth focus groups with representatives of national governments that one of the main barriers for the update of the OOP by citizens was fear of privacy breaches and identity theft. Moreover, from a business perspective, the start-up costs of redesigning processes and installing yet another top-layer of software or application was mentioned as a negative impact, as was vendor or software lock-in, both on the side of the service provider as well as the end-user. None of these impact factors were found in the original impact assessment framework developed for this project. From the case on disruptive technologies of social service delivery, some of the service developers experienced pushback from early user tests, because either the service did not add sufficiently novel value or were deemed too complicated to explain or comprehend for citizens or public servants. In many cases regarding elderly care or social care services, the assumption of technological eloquence and readiness of the end-users was over-estimated and under-researched, impacting the level of trust in the offered system.

8.4 Public Value Is Often Not Captured in Easy to Measure Indicators

Impact assessments that have been applied to the field of Digital Governance (e.g. Yannacopoulos et al., 2010; Sivarajah et al. 2015), assess policy, organizational and technological measures that somehow alter and affect governing processes. In these existing frameworks, the approach for gathering and evaluating indicators for impact varies widely, ranging from structural quantitative methods to qualitative approaches and accompanied indicators. However, in the context of novel, experimental and disruptive technologies or policy principles, impacts on public values are often hard to measure in a quantitative way. Although some forms of public value measurement occur in existing literature on impact assessment (e.g. Twizeyimana & Andersson, 2019), the measurement indicators often evolve around citizen satisfaction with a public service. When discussing a broader perspective on public values and impact assessment, we experienced in the three case studies that the lack of quantitative indicators for societal impacts and public value made them seen as “anecdotal” evidence, leading also to developing measuring tools to gather data for such indicators.

In our cases, this was especially observed in the case of the impact of disruptive technologies on social services and in the case of the impact of AI on public services. In both cases, there is not much evidence yet of how these technologies impact services, as the use and application of these technologies in the field of public services can still be considered to be in an early stage. In both cases, part of the exercise to perform an impact assessment was to gather data and evidence that can be used to formulate recommendations. In the case of disruptive technologies in social services, this was especially the case for gathering data on inclusiveness and accessibility and in the case of AI in public services, this was focused on the gathering of sufficient instances and applications of public sector AI. The application of impact assessments, thereby also spurs the development of unified indicators and data gathered for measuring.

8.5 Impact on Public Value Is Assessed in the Pilot Phase but Achieved in the Long Term

The focus on public values also reveals a gap between offering a service via for instance a novel AI-based interface and the potential cost saving that would entail on a large scale. Impact on public values is often achieved in the long term instead of in the short term. More often than not, novel technologies in public services hinge on an idea or archetype of a way of offering, meaning that not only start-up costs on both the side of the service deliverer, the governmental agency and the end-user are high, it also means that perhaps the idea or archetype of service is fitting, yet multiple service developers need to invest and develop (and perhaps fail) before a solution manifests itself.

For example, in the case of the OOP there is a lot of emphasis on sustainability. However, this is defined as how to bring the results of a pilot and scale it up to a government-level implanted solution (see Larsson & Grönlund, 2014), rather than at the impact that may be achieved once this policy principle and its technical solution is implemented in practice. In practice this meant that the impact assessments aimed at capturing the potential impacts and formulate recommendations for scaling up in practice. In a similar vein, the impact assessment of AI in public services is performed based on examining a large number of pilot projects. While it is useful to gather information early on to explore potential impacts, it would also be useful to perform impact assessments when the public services are implemented to capture actual impacts.

8.6 *Measuring Impact Is Often Carried Out from the Perspective of Government*

As mentioned before, it is not always clear what constitutes public value and to what extend societal, political, and commercial stakes can be weighed when governments are tendering or developing programs for digital service innovation. Yet we see in practice that the influence of policy makers and government organizations often take the upper hand vis a vis public services and societal concerns. In all three cases, (rounds of) validation workshops were carried out with policy makers or representatives of Member States, while few other stakeholders were consulted. This may result in an implicit bias toward the advantages and public values propagated by government organizations, while public values propagated by societal stakeholders may be overlooked.

In our exemplary cases, we have witnessed how during the assessment of public value, often attention shifts toward public sector internal values, thereby moving away from a focus on citizens, business, or society toward more measurable outcomes for government. We often managed to gather information of government officials, public servants, technology developers, and policy makers. Yet it was usually out of scope to find adequate approaches to include representative slices of society at large in the impact assessments. From other disciplines, this challenge (of citizen engagement) is very well known, yet often still also not very-well addressed methodologically (Oudshoorn & Pinch, 2003). In the social services case and in the AI in public services case, we gathered insights in official and unofficial ways of measuring and monitoring impact on public value, for instance via representative groups, national ombudsmen, NGO's and so on.

8.7 *The Transformation of Public Services May Bring Different Public Values into Play*

The uptake of disruptive technologies such as data analytics and AI in public services is growing. The literature on digital technologies and society highlights that digital technologies never come value-free and rarely deliver on all the promises made upon their introduction (e.g. regarding time or cost savings, Pelizza & Hoppe, 2018). While some technological innovations might currently look promising and appear like a "solution for all", they are often still in a start-up or pilot phase: the innovation has not yet been confronted with the complex reality of technology uptake and application in the public sector (Savoldelli et al., 2014). To ensure that the benefits are achieved, organizations and business processes often need to adapt as well and a transformation of public services needs to take place (e.g. Barcevičius et al., 2019; Veenstra et al., 2011). These transformations entail a massive transfer of governmental responsibility to uphold and safeguard public values from public servants to technologies.

We have experienced this in the two cases of performing impact assessments in studies of public services that focus specifically on disruptive technologies such as data analytics and AI. In the disruptive technologies in social services case, the emphasis was put on increasing digital or digitally enabled forms of connecting citizens to government services, thus decreasing human-to-human interactions. The AI in public services case showed increased proliferation of application of algorithmic decision making and data-driven policy making, which are likely to have a similar effect by decreasing not only the contact between public officials with citizens, but by decreasing the involvement of public officials in decision making altogether. The impact of this may be truly transformational but not at all clear yet.

8.8 Discussion

Based on our findings, our Public Value Impact Assessments Framework was found to be useful to break down the concept of public value from different perspectives and to assess the impact on public value at several times during the conceptualization, development and implementation of public services. However, also challenges remain, including weighing different public values, including negative or unexpected impacts, developing the right indicators, capturing impact on the longer term, including the perspectives of citizens, businesses and society at large, and assessing transformational aspects. While many of these elements and challenges have been described perhaps separately, the contribution of our impact assessment framework, which was built upon several other frameworks, is to present a comprehensive overview of (potential) public value in Digital Governance by including both expected and unexpected, desired and undesired effects, different viewpoints and stakeholders' perspectives, both short-term and long-term effects. Our framework also allows for capturing the impacts of potentially disruptive technologies such as artificial intelligence that may not only transform governments but also the public value they aim to deliver. In these ways, our impact assessment framework contributes to the development of a science base for Digital Governance, helping to unlock transformational value (Charalabidis & Lachana, 2020a, 2020b).

Subsequently, we demonstrate the practical use of our Public Value Impact Assessment Framework by applying it to three exemplary cases of policy-technology topics. In such applications, the impacts are often framed as benefits, for both, or either government or citizens, thereby often missing the potential secondary or negative impacts of such innovations (for instance on accessibility and inclusion, startups costs, legal uncertainty around data, wrongful data coupling etc.). Therefore, it is essential to actively investigate these categories of impact factors. Furthermore, we found that indicators of public value as well as data that may be used to assess them are often lacking. To perform impact assessments of public value it is, therefore, often necessary to develop these indicators as well as to build up a data collection, for example by identifying use cases for measurement. We also found that for an assessment of public value it is necessary to look beyond the policy perspective.

Although this may be a time-consuming exercise, the views of citizens, businesses and society at large need to be included to obtain a balanced perspective on the impact on public value. Finally, digital technologies may have a transformational effect on public services, for example impacting the involvement of public officials in decision making. This should also be taken into account too when performing an impact assessment.

In the wider field of digital technologies, the use of impact assessments appears to become more common. A recent innovative approach to counter the lack of equilibrium from a policy or government level vis a vis citizens or society at large are impact assessment methodologies specifically aimed at data and artificial intelligence. These impact assessments are based on earlier work performed in this area (e.g. Kemp & Vanclay, 2013; Gellert, 2018). However, more empirical work and methodological insights in the area of public value impact assessment are necessary to fully understand how this will work out in practice. Potential reputational damage and decrease in trust when technologies are implemented carelessly in public services may lead to scandals (think of privacy breaches or discrimination). Further research should thus look into methodologies for the inclusion of different perspectives into the assessment of public value, investigating unforeseen outcomes and including citizens' views or the impact of society at large. It should also look into ways of building up a knowledge base allowing for assessment of impact, including more qualitative indicators related to public value and their validity in the process of (ex-ante) impact assessments. Finally, it should look into new ways to capture the transformational effects beyond the technical infrastructure of public services and their economic impacts.

9 Conclusion

In this chapter we develop a Public Value Impact Assessment Framework for Digital Governance and subsequently demonstrate how it can be applied to assess public value in practice. Based on literature we propose three layers of policy, organization, and technology for assessment and identify six categories of value: effectiveness, efficiency, social outcomes, openness, ethical behavior and professionalism, and trust, and demonstrate its use by performing three exemplary case studies of public services. Analyzing if and how our framework helps to put public value on the methodological agenda for impact assessment, we draw up six findings for future work in this area. These six findings include the conflicting views on public value, the use of including unexpected or negative outcomes, difficulties of measuring public value, the longer-term outlook on public value, taking a citizens' and societal perspective, and the potential transformative impact of evolving technology. Considering its long history in the research field, impact assessment methodology is lacking a structured analysis of its application to assess public value in practice, including drawing findings on its methodological and practical use. This chapter fills this gap in the literature. Further research should look into the development of methodologies to include these indicators, perspectives, and measurements into impact assessments. Based on exemplary case studies, our aim was to contribute to the assessment of public value in Digital Governance, the more so in light of recent developments toward forms of automated decision making and data driven policy. In such developments, retaining a connection to values and impact on citizen is key in ensuring trust and good governance.

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Fostering a Data-Centric Public Administration: Strategies, Policy Models and Technologies

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Abstract The aim of this research is to understand what strategies, models and technologies can be deployed to transform the public administration into being more efficient, effective, fair and data-centric. To do that, the research team has carried out a set of 14 case studies in three analytical domains: the first is data strategies, policies and governance, which includes initiatives in the public sector both at the strategic level, such as data strategies, data governance and data management plans; and at organisational level, aimed to create units or departments, and to elaborate new processes and role; the second is policy modelling and simulation, considering initiatives to improve policy analysis through new data sources, robust and reliable models to perform 'what-if' scenarios, predictive analytics and hypothesis testing, and tools allowing policymakers to carry out scenario analysis through intuitive interfaces; the third and final domain concerns data technologies: new architectures, frameworks, tools and technologies to be used by public administrations to gather, store, manage, process, get insights and share data. Each set of cases has been subject to a cross-analysis in order to develop a number of policy take outs and recommendations.

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1 Introduction[1]

Data are a fundamental resource for carrying out all government activities, from regulation to service provision. In that regard, the communication on 'data, information and knowledge management' calls for a more strategic use of data, information and knowledge. In this context, a data strategy and a related action plan have been set up in 2018, with the objective of transforming the EC in a data-driven organisation. The eight actions of the action plan are centred around 5 different dimensions: data, people, technology, organisation, policy. The data strategy highlights indeed that these dimensions need to mature and evolve harmonically to deliver a real transformation on how data are used in the decision-making processes. In 2019, an operational governance framework has been set up to closely follow-up the implementation and the evolution of the action plan. The 2016–2020 ISA^2 (interoperability solutions for public administrations, citizens and businesses) programme funded with a budget of 131 million euro aims to support the development of digital solutions that enable public administrations, businesses and citizens in Europe to benefit from interoperable cross-border and cross-sector public services. But where do we stand? What kind of data strategies, models and technologies are implemented by the public administrations around the world? To answer these questions, the authors study in-depth three domains in relation to data analytics in government. The first section is **data strategies, policies and governance**, which include initiatives in the public sector both at the strategic level, such as data strategies, data strategies, data governances and data, management plans; and at organisational level, aimed to create units or departments and to elaborate new processes and role. The second section is **policy modelling and simulation**, considering initiatives to improve policy analysis through new data sources, robust and reliable models to perform 'what-if' scenarios, predictive analytics and hypothesis testing, and tools allowing policymakers to carry out scenario analysis through intuitive interfaces. The third and final section concerns **data technologies**: new architectures, frameworks, tools and technologies to be used by public administrations to gather, store, manage, process, get insights and share data. This domain includes the study of how data are governed as well as data collaboratives, and in particular, stresses the joint analysis of governance and technologies. In order to implement the analysis, the research team has carried out 14 case studies: five for the domain data strategies, policies and governance, five for the domain policy modelling and simulation and four for the domain data technologies. The choice of the case studies has been carried out based on literature review, as well as based on the opinion of key informants. The case studies have been based on collection of documental evidence, as well as on a set of interviews (1–3 per case) to case representatives. Each set of cases has

[1] The research presented in this chapter has been carried out within the scope of the study Data Analytics for Member States and Citizens (Framework Contract DI/07624—ABC IV Lot 3) commissioned by the European Commission, Directorate-General for Informatics, to Deloitte and the Lisbon Council for Economic Competitiveness and Social Renewal. The project has been carried out within the scope of the ISA^2 Action 2016.03—Big Data for Public Administrations.

been subject to a cross-analysis in order to develop a number of policy take outs and recommendations on how to push the implementation of a data-centric public administration. In that regards, fostering a data-centric public administration is a core element of digital governance (Charalabidis & Lachana, 2020a, 2020b; Viale Pereira et al., 2018), meant as the set of methods and frameworks aimed at enhancing public service quality, openness and transparency, through the use of ICT. Therefore, this present chapter can give an important contribution to the field as the use of data strategies, models and infrastructure is crucial for evidence-based decision-making.

2 Data Strategies, Policies and Governance

This section presents the result for data strategies building on five case studies selected for the in-depth analysis, based on the level of ambition and maturity: Barcelona Data Commons, Data Agenda Government in the Netherlands, New Zealand Data Strategy and Roadmap, Secondary use of health and social data (Finland), and Udbetaling Denmark. The case studies have been carried out on the basis of documental evidence and interviews to key informants (1–3 per case), focussing on the policy context, building blocks of the agenda, governance of the implementation process, data quality and sharing, public values, human capital and skills, monitoring and evaluation, success factors and lessons learnt. A cross-case analysis was then focussed on the main points, such as building blocks, governance, key enablers, success factors and lessons learnt and policy take outs. The cases can be considered pioneers in ensuring a strategic approach to data governance in public administration. These are not economy-wide data strategies—like the digital agendas or data economy strategies, but initiatives focussing on greater adoption of data-driven solutions in the public sector. The strategies generally pursue the combined goals of fostering data analytics for public value creation and ensuring trust, accountability and citizen's agency over how data are used. Both dimensions are important, although arguably with different emphasis. The Danish, Dutch, New Zealand and Finnish cases are driven by the primary goal to increase data analytics and reuse and balance this with a strong emphasis on safeguards, ethical aspects and consent as pre-conditions or enablers of data reuse. For instance, in the case of New Zealand, the rationale for the data strategy is to address the disconnect between the rhetoric (which focusses on opportunities) and the reality of data-driven policies (which focus on minimising risks of data misuse). The data strategy is part of the overarching government goal to get more value from data. In Finland, the data reuse strategy is based on the 'National health-sector growth strategy', which aims to make Finland an internationally renowned pioneer in health business and in well-being. In the Danish case, the strategy addresses a clear concrete needs to fight fraud and detect errors at an early stage. On the other hand, the Barcelona strategy is the only one originally driven by a strong 'political' dimension related to data and technological sovereignty—for instance with data provision requirements in the context of public private partnerships. This difference is related to the specific policy context. In Barcelona, the data strategy is part of the wider city strategy ‘Transition towards digital sovereignty’, whilst in the other cases, it fits under the narrower strategic priorities related to digital government, social affairs or data reuse. The role of the private sector is also different. In the Finnish case, the private sector is clearly identified as a data reuser, whilst in the Barcelona and Danish case, it is identified mainly as a data provider. In the Dutch case, companies are considered as both data providers and reusers. What is clear across all strategies is that the private sector and citizens are part of the stakeholders that need to be involved in building a data ecosystem for public value creation. The very existence of a strategy reveals the long-term importance of the topic. In all cases, governments sought via the strategy to ensure a structural commitment to the data priority (at least three years).

2.1 Building Blocks

Table 1 presents the building blocks of each data strategy.

When looking at the actual implementation of the strategies, other aspects emerge. First, there is limited technological investment. The two larger scale, more ambitious whole of government strategies of the Netherlands and New Zealand do not include the creation of any horizontal ‘**infrastructural platform**’ for data analytics, but focus on enabling services. The Dutch strategy instead includes projects on five specific challenges: energy transition, manure issue, infrastructure and spatial bottlenecks, poverty and the issue of debt and subversive crime. Barcelona, which does have a centralised data and analytics infrastructure also advances its data analytics activities in an incremental way, based on priority policy challenges. Second, all strategies

Table 1 Building blocks of each data strategy

BCN	1. Understanding data as an urban infrastructure, just as the provision of water and energy are. Data are seen as a meta-utility that will enable the city of Barcelona to support more effective delivery of public services to Barcelona citizens for greater equity, safety and quality of life 2. Integrating the use of big data and data analytics to improve public decision-making (data-driven projects) 3. Treating data as a common asset, and making it available for social and economic innovation processes focussed on citizens’ needs. This also means that the immense economic value that citizen-produced data represents should be returned back to those that generate that value in the first place: the citizens 4. Enforcing data and algorithmic transparency (data ethics). This not only requires opening up data, but also encouraging the reuse, providing citizens with the tools and knowledge to be able to verify these and to be informed about automated decisions and their underlying algorithms 5. Protecting people’s privacy and data sovereignty. This is also about shifting agency and control to citizens themselves that have the right to decide what data they want to share, with whom and on what terms

(continued)

Table 1 (continued)

NL	1. Problem-solving with a data-driven approach: five social challenges have been selected: energy transition, manure issue, infrastructure and spatial bottlenecks, poverty and the issue of debt and subversive crime 2. Focussing on legislation and public values to develop new general principles on a responsible way of dealing with data taking into account legal and ethical frameworks 3. Improving the quality of government data and using it more efficiently to ensure government has the right data and is able to share (open) data at the right time and in the right way in order to foster a service-oriented and transparent public sector 4. Collecting and sharing knowledge about a data-driven approach (sharing of best practices) 5. Investing in people, organisations and changes in corporate culture (to address skills needs and cultural change)
NZ	1. Invest in making the right data available at the right time a. To provide visibility of key datasets and proactively address gaps b. To improve accessibility of government held data c. To open up more non-sensitive, non-confidential data to the public 2. Grow data capability and supporting good practice a. To take a strategic and coordinated approach to uplifting capability across the public sector b. To make better use of existing data capability 3. Build partnerships within and outside government a. To co-design the future data system and work together to maximise use and impact of data b. To co-design with Māori across the data system 4. Implement open and transparent practices a. To establish appropriate accountabilities and protection mechanisms b. To build public knowledge and understanding of how they can benefit from data use
FI	1. To enable efficient and secure processing of personal data collected during the provision of social and health care as well as personal data collected for the purpose of steering, supervision, researching and collecting statistics on the social and health care sector 2. To allow the collected personal data to be combined with the personal data held by Social Insurance Institution of Finland, Population Register Centre, Statistics Finland and Finnish Centre for Pensions 3. To secure the legitimate expectations, rights and freedoms of individuals when processing personal data
DK	1. High quality data analysis across registry 2. Trusted collaboration with sectoral department (national and local) 3. Collaboration with foreign authority 4. Special initiatives

include **data mapping**. In the case of Barcelona, it is the data office itself which carries out the mapping exercise, whilst in the others, it is part of the distributed data stewardship and process tasks.

2.2 The Governance of Data Strategies

Governments adopt very different approaches to the governance of data strategies. The political positioning of the data strategy and related implementation agencies is varied. First and foremost, the strategies do not entail the promulgation of new legal provisions, but remain at the level of strategic document. Only in the case of Finland, because of the sensitive nature of the data, a dedicated law has been approved to clarify the scope of reuse of health data. Only in the case of Barcelona, the strategy sits firmly at the executive level under the mayor's office, which is a fundamental factor in ensuring stability and compliance. In the other cases, the data strategy sits under specific ministries: in NL and NZ, under the department in charge of digital government, whilst in Finland, it is the ministry of social affairs, in Denmark, it is the social payments agency (Udbetaling Danmark) under the ministry of employment. On the same line, Barcelona is the only case which presents the figure of a Chief Data Officer, and a central 'Municipal Data Office'. They have a major role as responsible for the management, quality, governance and use of data controlled and/or stored by Barcelona City Council and all of its associated bodies (both public and private). And the data office is not only the coordinator but also the implementer of the data commons strategy. In the other cases, the roles are softer. There is no chief data officer, but the effort is conceived as decentralised and collective: in the New Zealand Case, the role is named 'chief data steward' and his role is to foster a culture of data stewardship across government. Data stewardship is intended as 'the careful and responsible collection, management and use of data'. In particular, the goal is to spread the role of data stewardship across each agency. The case of Findata is also different, as its role is not to ensure data quality or sharing but to manage the data and consent flows. As such, it is a dedicated agency with strong enforcement roles but limited to the data and consent flows. This different degree of centralisation is related with the broadness of the strategy: the broader the scope, the more decentralised the approach. The Dutch and New Zealand initiatives have a very broad mandate cutting across all departments and levels of government, whilst the Barcelona and Finland are more focussed (respectively on one institutional level and on a specific data type). In any case, whether more or less centralised, all initiatives have an extensive set of **boards and steering groups** including a wider variety of participants. Consistently with this 'inclusive' approach, all initiatives share a strong emphasis on **co-creation** with all relevant agencies. The extensive range of consultation and collaboration activities in place is repeatedly mentioned as leading edge and unique with respect to traditional processes. As mentioned in the Findata case, 'the unique cooperation between public authorities, companies and associations was key to success'. It appears that data collaboration not only aims to break data silos as an outcome, but in doing so it requires the adoption of a systematic silos breaking approach as part of its process. For instance, statistics New Zealand 'led multiple workshops and interviews, gaining independent technical guidance and expertise on what was important to stakeholders and where help is needed'. In the

Danish case, the extensive collaboration with municipalities takes place also online through a SharePoint platform.

This co-creation activity can also extend beyond public administration, towards external stakeholders such as business and civil society. New Zealand and Finland extensively involved these players in the shaping of the strategy, in order to make sure that it includes the perspective of external users. This activity went beyond traditional consultation, as made clear in the case of Findata: 'experts from ministries, authorities, companies and associations from across the private and public sectors worked together to prepare the implementation simultaneously with the legislation process. It was a unique way of working and something carried out for the first time at the national level'. However, this co-creation aspect often is too focussed on the process, rather than on the final output: interviewee mention the lack of user orientation of some services as a clear challenge. In data-driven innovation just like in digital government, the motto 'build it and they will come' is a path for failure.

The **budget** assignment for the strategies is typically moderate. In the Dutch case, it includes 10 million euros for three years in addition to agencies' contribution. In Barcelona, the overall budget is nearly four millions euros for 2018/19. In Denmark, 3.4 million euros per year, and in New Zealand, there is no dedicated funding for cross agency work. The budget for Barcelona, in this case, stands out taking into account that it refers to a single city, and it reflects the strong role of the municipal data office in implementing the strategy. The Danish case actually generates revenues far in excess of its costs (62 million euros in 2019). Data sharing and improved data quality are a general priority across all strategies. Greater sharing of high quality of data can be considered one of the main goals across the board: for Denmark, New Zealand and the Netherlands, across ministries and levels of government; for Barcelona, across different municipal agencies; and for all the different player in the value chain. Data sharing has different levels of compliance. In the Netherlands, it is compulsory for public administration to share and reuse data from the base registries, and some of the base registries are open to the public. Therefore, one of the key policy levers in both the Dutch and Barcelona cases to encourage public organisations to share data is communication on two aspects: why and how. Why data sharing should happen focusses on demonstrating data-driven value creation in best practices. How data sharing can happen focusses on knowledge exchange between organisations on topics such as quality and standards. Similar soft arrangements with regards to data standards are in place in other strategies, as it remains a challenge to ensure compliance.

2.3 Key Enablers

All strategies have strong emphasis on safeguards, not just in terms of mere compliance, but to create a shared data culture that maximises analytical power with ethical values. Typically, the data protection competence is separated from the data stewardship or responsibility competence. The notion of safeguards, accordingly, spans well beyond compliance with GDPR, to encompass a full ethical framework. Notably, the concept includes not only data processing, but the ultimate purpose of what is done with the data, with the goal of keeping the interests of citizens first, rather than those of government. This is why in Barcelona the ultimate goal is to empower citizens with data, citizens are involved through experimentation and consultation and the activities of the strategy include algorithmic accountability and how public decisions are influenced by data. Wherever possible, data-driven projects will be able to check the algorithms using simulations based on city data. Likewise, using open-source code or other means, third-party technology suppliers must reveal the underlying logic behind any IT process for (automated) decisions pertaining to any of their systems used by the City Council. By the same token, the Dutch strategy has developed general principles for the responsible use of data, after several municipalities had indicated running into difficulties regarding data sharing with companies. The Dutch case also shows the importance of the purpose of analysis, namely to avoid that data analytics is carried out with punitive purposes. Similarly, in Denmark, the strong data protection provisions go hand in hand with strong citizens' rights when it comes to the investigation, including the need for notification and the impossibility to access sensitive data in other registries (e.g. criminal records).

Citizen's control over their data is also an important issue. It is one of the leading principles of the Barcelona data sovereignty scheme, defined as 'the need for an individual to have control, at all times and in all relevant systems, over the collection, storage, use, transfer and publication of their data, whether it be of a technical, scientific, economic, social or personal nature'. The Dutch government has launched the policy initiative *control over data* (Regie op gegevens), which aims to give citizens and businesses more control on what is happening with their data.[2] At the moment, various appointment systems and solutions are being developed to support citizens and businesses in managing their data. Ultimately, this should result in a generic cross-sectoral framework that enables secure, reliable and user-friendly digital exchange of data between governments, private and social organisations. The lack of adequate skill is a major issue across all strategies, and all strategies include actions to address it. These actions are basically: training of civil servants (e.g. National academy for digitisation (RADIO) in the Netherlands), creation of new job profiles and/or data and statistical capability framework to support training and recruitment, trainee programmes for recruitment in the public sector (e.g. in the Netherlands), creation of communities of practice and centres of competence (e.g. LED experts centre in the Netherlands). Finally, for what concerns monitoring, with the exception of the Danish case, it remains very lightweight across all strategies. There are no KPI in place and no systematic monitoring. In the Netherlands, there is a reporting system in place for projects launched under the strategies, which ultimately is presented to parliament. In Denmark, there is strong accountability mechanisms due to market-like relation between the national agency Udbetaling Danmark and the municipalities, with clear Key Performance Indicator, Service Level Agreements and financial accountability.

[2] More information available at https://www.digitaleoverheid.nl/overzicht-van-alle-onderwerpen/gegevens/regie-op-gegevens/.

3 Policy Modelling and Simulations

The cases analysed regard 5 simulation models: one focusses on monetary policy and central banking (NAWM II), two on energy (WEM and PRIMES) and two on environment (GAINS and MESSAGE):

- NAWM II—The European Central Bank New Area-Wide Model II. The model was first developed in 2008 at the European Central Bank. NAWM, a micro-founded open-economy model of the euro area, was designed for use in the (Broad) macroeconomic projection exercises regularly undertaken by ECB/Eurosystem staff and for policy analysis. A new version of the model has been developed in 2018, called New Area-Wide Model II, in the view to incorporate a financial sector with the following objectives: (i) accounting for the role of financial frictions in the propagation of economic shocks and policies and for the presence of shocks originating in the financial sector itself, (ii) capturing the prominent role of bank lending rates and the gradual interest-rate pass-through in the transmission of monetary policy in the euro area and (iii) providing a structural framework that can be used for assessing the macroeconomic impact of the ECB's large-scale asset purchases conducted in recent years.
- WEM—World Energy Model. Since 1993, the International Energy Agency (IEA) has provided medium- to long-term energy projections using the World Energy Model. The model is a large-scale simulation model designed to replicate how energy markets function and is the principal tool used to generate detailed sector-by-sector and region-by-region projections for the World Energy Outlook (WEO) scenarios. Updated every year and developed over many years, the model consists of three main modules: final energy consumption (covering residential, services, agriculture, industry, transport and non-energy use); energy transformation including power generation and heat, refinery and other transformation and energy supply. Outputs from the model include energy flows by fuel, investment needs and costs, CO_2 emissions and end-user pricing.
- PRIMES—Price-Induced Market Equilibrium System. The model has been developed by the Energy-Economy Environment Modelling Laboratory at National Technical University of Athens in the context of a series of research programmes co-financed by the European Commission. The model has been designed as a modular system aiming at representing agent behaviours and their interactions in multiple markets. The model has combined microeconomic foundation with engineering representations aiming at simulating structural changes and long-term transitions. From mid-90s until today, PRIMES has been continuously extended and updated. PRIMES has been widely used and established in studies of medium and long-term restructuring of the EU energy system, in view of climate change, renewable energy development, energy efficiency and impact assessments of numerous community energy and environmental policies. The PRIMES model has served to quantify energy outlook scenarios for DG TREN and DG ENER (Trends publications since 1990), impact assessment studies for DG ENV, DG TREN, DG CLIMA and DG ENER and others, including energy roadmap to

2050 (2011–2012) and policies to 2030 (2013). PRIMES has been also used at national level for governments, companies and other institutions including for EURELECTRIC in the power choices strategic study.

- GAINS—Greenhouse gas—Air pollution Interactions and Synergies. GAINS was launched in 2006 as an extension to the RAINS model which is used to assess cost-effective response strategies for combating air pollution, such as fine particles and ground-level ozone. GAINS provides an authoritative framework for assessing strategies that reduce emissions of multiple air pollutants and greenhouse gases at least costs, and minimise their negative effects on human health, ecosystems and climate change. GAINS is used for policy analyses under the convention on long-range transboundary air pollution (CLRTAP), e.g. for the revision of the Gothenburg protocol and by the European Commission for the EU thematic strategy on air pollution and the air policy review. Scientists in many nations use GAINS as a tool to assess emission reduction potentials in their regions. For the negotiations under the United Nations Framework Convention on Climate Change (UNFCCC), a special version of GAINS has been developed to compare greenhouse gas mitigation efforts.
- MESSAGE—Model for Energy Supply Strategy Alternatives and their General Environmental Impact. MESSAGE stands at the core of ENE's modelling framework. It provides a flexible framework for the comprehensive assessment of major energy challenges and has been applied extensively for the development of energy scenarios and the identification of socioeconomic and technological response strategies to these challenges. The modelling framework and the results provide core inputs for major international assessments and scenarios studies, such as the Intergovernmental Panel on Climate Change (IPCC), the World Energy Council (WEC), the German Advisory Council on Global Change (WBGU), the European Commission, and most recently the Global Energy Assessment (GEA).

The case studies have been carried out on the basis of documental evidence and interviews to key informants (1–3 per case), focussing on rationale, main actors and stakeholders, historical development of the model, data sources, models, tools, degree of maturity, drivers and challenges, social and economic outcomes, scalability and transferability. A cross-case analysis was then focussed on the main points, such as rationale and type of models, data sources, collaborative development and validation, success factors and challenges, use in policy making, scalability and sustainability, success factors and lessons learnt and policy take outs.

3.1 Use in Policy Making

All the models studied have extensive use in policy making. As for **NAWM II**, it is regularly used for policy making by the European Central Bank, and its results are adopted by members of the euro area as well as from member states. Specifically, the

NAWM II model allows to carry out economic projections contributing to the elaboration of the projection baseline for the largest euro area countries and to forecasting with judgement and model-based projection narratives. Further, the model allows for risk analysis and policy analysis, the latter related to the impact study of monetary policy options as well of strategic issues related to monetary-fiscal-financial policy mix in the euro area. More practically, in the last decade, the ECB's standard monetary policy operations have been complemented by several non-standard measures (NSMs) which have responded to the challenges posed by the different phases of the financial crisis that had begun in 2007. These measures have included lowering the deposit facility rate, longer-term refinancing operations and an expanded asset purchase programme targeting a variety of investment-grade private and public sector securities. Asset price reactions suggest that these NSMs had expansionary effects but the quantitative impact on other macroeconomic variables remains uncertain. The only way to assess the quantitative effects of NSMs was to develop a coherent structural macroeconomic modelling framework, going beyond the standard DSGE models which cannot be used to study the transmission channels of NSMs. Therefore, the creation of NAWM II has improved the comprehension of the effects of the monetary policies and operations carried out by the ECB.

Concerning **WEM**, The IEA's WEM-based WEO has become one of the most important inputs into government decision-making about energy and has a significant effect on the political and economic decisions of administrations and stakeholders regarding both conventional and renewable energy. Specifically, the WEM is used by all OECD member nations as well as many non-member countries to inform energy and climate policies, and it has a broad role in promoting alternate energy sources, including renewable energy, rational energy policies and multinational cooperation in energy technology. In fact, WEM helps policymakers in assess the cost of each policy option related to energy, both in terms of necessary capital investments and the impact on economic growth, as well as of the overall environmental impact and climate-change adaptation costs. A core application of the WEM is also on the Paris climate agreement, as well as to the sustainable development goals. Other policy areas where it has been used include implement energy strategies for sustainable development, including diversified energy sources using cleaner technologies, increasing the share of renewable sources to meet climate objectives, diversifying energy supplies, strengthening the EU emissions trading scheme, reducing energy consumption through improved energy efficiency, promoting carbon capture and storage and improving integration of energy efficiency and environment into energy policies.

The **MESSAGE** model is part of the energy programme that IIASA has created to improve the understanding of the key characteristics and determinants of energy system changes. In addition, the modelling framework provides core inputs for major international assessments and scenarios studies (amongst others the Intergovernmental Panel on Climate Change (IPCC), the World Energy Council (WEC), the German Advisory Council on Global Change (WBGU), the Global Energy Assessment (GEA), the European Commission). Scenarios developed with MESSAGE have been used in, for example, the assessments and special reports of the IPCC and the

GEA, MESSAGE was also used to generate one of the four representative concentration pathways (RCPs) currently being used to estimate future climate change in the context of the IPCC 5th Assessment Report (2014), and a special agreement between IIASA and the International Atomic Energy Agency (IAEA) allows MESSAGE to be used for country studies within the IAEA and its member states.

The **GAINS** model is used successfully as a policy support tool in Europe and Asia and aims to support informed decision-making that maximises synergy between different measures. Then, the implementation of the GAINS model would assist South Africa in the development of GHG and air quality polices and would be in line with the overall national development goals. GAINS is used for policy analyses under the convention on long-range transboundary air pollution (CLRTAP). For instance, it has been used for the revision of the Gothenburg protocol, and by the European Commission for the EU thematic strategy on air Pollution and the air policy review. Scientists in many nations use GAINS as a tool to assess emission reduction potentials in their regions. GAINS can be also used to identify measures to mitigate local air pollution and thus global climate change. For instance, worldwide implementation of 17 emission reduction measures targeting black carbon and ozone precursors could reduce future global warming by 0.5 °C and could avoid the loss of 1–4% of the global production of maize, rice, soybean and wheat each year. According to estimations made in the course of the GAINS-Asia assessment, application of advanced emission control technologies could reduce health impacts in China by 43% in 2030. GAINS in optimisation mode was also able to identify the most cost-effective portfolio of measures to achieve these health improvements, but at 20% of the costs. In addition, GAINS has assisted South Africa, that reports approximately 20,000 premature deaths due to air pollution annually, in the development of GHG and air quality polices.

PRIMES includes a rich representation of policy instruments and measures. The model can support policy analysis in the fields: such as security of supply, environmental issues, pricing policy and taxation, energy efficiency, alternative fuels, conversion to decentralisation and electricity-market liberalisation, as well as policy issues regarding electricity generation, gas distribution and new energy forms. ETS market simulation is explicit in PRIMES. However, the projections based on PRIMES are compatible with the five-year time resolution of the model and the model algorithm only approximates the arbitration of allowances holders over time. Nonetheless, PRIMES can handle multi-target analysis, for example, simultaneously for ETS, non-ETS, RES and energy efficiency, where the aim is to determine optimal distribution of achievements (targets) by sector and by country. PRIMES has successfully provided results for that purpose in the preparation of the 2020 Energy and Climate Policy Package (2007–2008) and recently for the 2030 Policy Analysis (2013). Further, to support impact assessment studies, PRIMES provides detailed reports of scenario projections. The reports calculate cost indicators (with various levels of detail distinguishing between cost components and sectors), as well as for numerous other policy-relevant indicators. Topics covered include environment, security of supply and externalities (e.g. noise and accidents in transport). Thus, the model provides elements and projections to support cost–benefit analysis studies, which are the essential components of impact assessments. When PRIMES links with the macroeconomic model GEM-E3, the coverage of projection data for the purposes of cost–benefit evaluations is completer and more comprehensive. Similarly, linkages with GAINS (from IIASA) provide wider coverage of cost–benefit projections regarding atmospheric pollution, health effects, etc.

3.2 Success Factors and Challenges

Concerning **NAWM II**, as reported by Dou et al. (2020), there are several drivers and success factors for the adoption of DSGE models. First, DSGE models are less subject to the Lucas critique due to their explicit account for the role of expectations and their identification of deep structural parameters, making them more suitable for policy analysis and counterfactual experiments. Further, DSGE models are able to identify and decompose economic and policy structural shocks on the quantitative level by the mean of an impulse-response analysis. In this regard, the identification of structural shocks greatly improves the reliability of policy analysis and counterfactual experiments, and mitigates the Sims critique. And finally, DSGE models are able to discover deep structural parameters thanks to their capability to link model implications to time-series and cross-sectional data. On the other hand, the financial crisis of 2007–2009 has given new urgency in extending the power and reach of DSGE models. In the same way as the great depression inspired Tinbergen and Klein, and the recession and stagnation of the 1970s inspired Lucas, Kydland and Prescott, the current macroeconomic situation has prepared the way for a major shift in macroeconomic modelling for policy. Specifically, DSGE models need to take to take risk into account by incorporating individual, institutional and regulatory responses to changing risks. Further, DSGE models need to incorporate the financial sector and its intricacies. Finally, DSGE models should departure from the assumption of optimising agents following rational expectations and allow for certain predictable irrationalities in their behaviour. As for **WEM**, it is a common argument (inter al. Mohn, 2017) against the methodology and models of the WEM is that the flexibility of economic behaviour is effectively contained and that the relations of the modelling system are not sufficiently responsive to shifts and shocks in technology, preferences, policies and prices. Critics also argue that the IEA's World Energy Outlook, which uses the WEM, is largely a product of historical trends and developments, which lead to a status quo bias in favour of fossil fuels. Mohn also says that 'any sort of feedback effects from energy policies, technological change and energy back on economic activity (growth) is neglected in the main scenarios. This is clearly a shortcoming of the modelling approach', he says. There is also an underestimation of the power of new technologies. Hoekstra et al. (2017) argue that the WEM and other models 'underestimate the potential of technologies that diverge from the status quo'. The paper focusses on WEM's photovoltaic predictions in the World Energy Outlook, saying 'stagnation of the solar industry is predicted over and over again'. 'This disconnection from reality could be due to, for example, sponsor requirements or mental biases like confirmation bias, status quo bias or system justification bias, but the way the model works could also be a factor', the authors conclude. They argue that 'most of the energy transition management model requirements that we deduce from the literature are implemented partially or not at all. The result is a model that is unable to envision and leverage the exponential developments in solar energy'. By the same token, Mohn sees 'general suspicion that IEA's methodology and modelling strategy puts too little emphasis on the flexibility in economic behaviour'. Finally, some researchers argue for a lack of transparency. Newell et al. (2018) also urge greater transparency, but with a broader argument—to improve the comparability of the projections produced by different organisations. 'Outlooks vary in a number of important methodological aspects, and comparing between outlooks is not straightforward', they say in a 2018 paper. 'Without a way to clearly compare one outlook to the next, decision-makers may not understand the range of possibilities envisioned by different short-, medium- and long-term projections, or the assumptions that underpin those projections'. On the other hand, the IEA defends itself with the argument that the WEO does not make forecasts but provides policy-dependent projections. As declared by the IEA Executive Director Birol, 'some colleagues and friends in the renewables industry have at times criticised the projections of future renewables energy supply in our main scenario as too conservative. But they rest squarely on the foundation of officially declared policy intentions'. Further, the WEO in 2017 introduced the sustainable development scenario, which is focussed on climate issues. In this regard, consultancy Menlo Energy Economics praised the 2018 edition of the WEO for expanding the focus beyond oil and other fossil fuels and including the growing role of electricity as the fuel of choice amongst end-users. Finally, there has also been an improvement in terms of transparency. In fact, in the latest edition of the WEO, the IEA says: 'we have made all the key policy assumptions available for all scenarios, along with all the underlying assumptions on population, economic growth and energy resources (which are held constant across the scenarios) and information on prices and technology costs (which vary by scenario depending on the market and policy context)'.

The main driver for the use of the **PRIMES** model is the need for medium- and long-term energy system projections, in both demand and supply sides, in particular projecting prices influencing the evolution of energy supply and demand, as well as technological progress that cover the entire energy system including emissions. Duwe and Vallejo (2018) argue that 'the PRIMES model currently used by the commission is frequently criticised for its lack of transparency on modelling inputs and assumptions, which reduces confidence in its results'. But they went on to say that 'this criticism is potentially an expression of a larger concern over the lack of transparency in decision-making on long-term policy. A shared disaggregated structure describing the key indicators of the transition and an engagement process spanning more than a few months are needed to elaborate meaningful dialogue and narratives. This need to also include additional dimensions (e.g. social and cultural) that are of key interest for stakeholders but often go beyond the capacities of modelling tools', according to this paper. The European Federation for Transport and Environment, in an August 2018 report included a lack of transparency amongst 'technical limitations' of the

PRIMES model in the transport sector (see Earl et al., 2018). Amongst other things, the environmental campaign group urged the European Commission to improve the transparency of the process and include more active stakeholder involvement, give a stronger focus on the potential of zero-emissions technologies to achieve full decarbonization in the transport sector, include all transport emissions, particularly in the aviation and maritime sectors, better account for the societal cost of greenhouse gas emissions, including an analysis of the impact of non-action. Finally, EURELECTRIC said in a 2012 report on the energy roadmap 2050 that stakeholders needed better access to elements of PRIMES (EURELECTRIC, 2012): 'stakeholders are not able to access the country-specific output from the PRIMES model used to develop the different scenarios. Without this national breakdown of information (to allow comparison, for example, with national studies on 2050 pathways), it is difficult to provide detailed comments on the validity of the assumptions and output from the PRIMES 2050 pathway analysis. This national breakdown should be made available to all stakeholders', EURELECTRIC said. On infrastructure, EURELECTRIC said 'further clarity would be needed to understand how cross-country transmission capacities, as well as national distribution capacities, are considered in the PRIMES approach', according to this paper. For what concerns **GAINS**, we rest on the fact that in the atmosphere, many air pollutants contribute to climate warming or cooling. As these substances are generally shorter-lived in the atmosphere than greenhouse gases, reducing air pollution will yield climate change benefits much earlier than greenhouse gas reductions alone. Current and future economic growth will cause serious air quality problems, negatively impacting human health and crop production, unless further air pollution control policies are implemented. Increased economic activity will also lead to more greenhouse gas emissions and subsequent climate change. Yet, air pollutants and greenhouse gases can be reduced simultaneously at far lower costs because they often originate from the same sources. GAINS provides an authoritative framework for assessing strategies that reduce emissions of multiple air pollutants and greenhouse gases at least costs and minimise their negative effects on human health, ecosystems and climate change. Specifically, GAINS provides an efficient framework for assessing strategies, which reduce emissions of multiple air pollutants and greenhouse gases at the minimum cost, and as much as possible, their negative effects on human health, ecosystems and climate change. Further, GAINS helps identify measures to mitigate local air pollution and thus global climate change. Finally, GAINS provides a framework to cover all sectors and can be used in conjunction with the energy model MESSAGE, the land-use model GLOBIOM, the air pollution and GHG model GAINS, the aggregated macroeconomic model MACRO and the simple climate model MAGICC, creating a framework that covers all major sectors, including agriculture, forestry, energy and industrial sources, permitting a concurrent assessment of how to address major sustainability challenges. As in the case of MESSAGE below, transparency and interaction with stakeholders remains a challenge.

Concerning challenges, **MESSAGE** was developed for the application to geographical regions the size of continents. It may also be applied to smaller regions or countries, provided that some care is taken in supplying the input data and in interpreting the model results. A particular problem that may arise comes from the continuity of the model variables that, for small countries, may very likely result in sizes of energy conversion facilities that are unrealistically small. In addition, in some regions or countries, the energy system may have some peculiarities, which have not been considered in the general model formulation. Concerning success factors, MESSAGE can be used in conjunction with other models. For instance, 'MESSAGE-Access' describes a residential energy and technology choice model, which interacts with the global energy system model MESSAGE. MESSAGE-MACRO results from the linking of a detailed energy supply model (MESSAGE) with a macroeconomic model (MACRO). MESSAGE-MAGIC results from the linking of the energy model MESSAGE with the climate model MAGICC allows the integrated analysis of (probabilistic) climate. MESSAGE-GLOBIOM results from the linking of the energy model MESSAGE and the IIASA's global biosphere management model (GLOBIOM).

4 Data Technologies

The research team studied four in-depth cases:

- Reproducible analytical pipelines (RAP) is a methodology for the production of statistical publications that was developed during a collaboration between the Government Digital Service (GDS) and the Department for Digital, Culture, Media and Sport (DCMS) in 2016. The project aimed to improve the production of a statistical bulletin by introducing techniques from software engineering, data science, and academia. The use of open-source software was critical to the success of the project which reduced production time of the statistical bulletin by an estimated 75%.
- New Zealand's the integrated data infrastructure, the social investment analytical layer and the social investment data foundation. The integrated data infrastructure (IDI) is a large research database holding anonymised data from across the public sector about citizens, linked to data about life events such as education, income, migration, justice and health. The IDI is longitudinal, meaning that it tracks anonymised individuals and households throughout their lives and as such is exceptionally useful for answering questions about groups of people or businesses with similar characteristics over time. SIAL helps agencies understand the potential ROI before investing in a new service. SIDF builds on the IDI and the SIAL and allows public servants and researchers to answer more in-depth questions about individuals and to generate service metrics that summarise an individual's interactions with government over a time period.
- Findata, a Finnish agency to enable the secondary use of social and healthcare data in the research, public and private sectors. It guarantees a flourishing ecosystem (both organisational and technological) around the secondary use of social and health data streamlining the processes for the issuing of research permits and data

collection and ensuring that data are being used in secure environments, thereby maintaining the trust that the general public have in authorities and the public sector.

- KOKE, an analytics solution for fraud detection in use by the Estonian Tax and Customs Board. Through data analytics, they redefined their strategy towards the identification of cases to verify. They moved from an 'unstructured approach' to this 'case selection towards data-driven methods' based on an algorithm identified risk coefficient for each case, with the overall objective of increasing tax compliance and preventing fraud. For this purpose, EMTA analyses a large amount of structured data coming from government sources, mainly such as business registers and tax declarations.

The case studies have been carried out on the basis of documental evidence and interviews to key informants (1–3 per case), focussing on rationale, development of the work, user needs, value for society, outcomes and results, technology, lessons learnt. A cross-case analysis was then focussed on the main points, such as choice of the cases, methodology of analysis, recommendation, critical success factor, policy take outs.

4.1 Meeting User Needs

In all of the case studies that are considered in this analysis, a common user need is that of consumers of public sector data to have access to timely and accurate information to inform decision-making. These users may be individual citizens, businesses, researchers, public bodies, or decision makers. Clearly, this is a key group of users, and many initiatives in the public sector data space will target the outcomes experienced by these users. One element of this that the IDI and Findata both address is the provision to users of a single point of contact and process for requesting and accessing data. Findata aims to provide a 'one stop shop' where those who want access to Finnish social and healthcare data can go, whilst the IDI is wider ranging and stores many datasets from across NZ Government departments. Both projects simplify the situation for would-be users by reducing duplication in the application process for data access, ensuring consistent standards and levels of data protection and security. Further, data analysts should be recognised as a user group in their own right. In the RAP and IDI case studies, we have also identified the needs of the individual public sector analysts or researchers who need to interact with the data on a daily basis (hereafter, 'analyst users'). Often, legacy processes for working with public sector data can be repetitive, time consuming and may not best utilise the skills of the analyst. Part of the success of these two case studies is that they both addressed this user need: the IDI with the creation of the SIAL and SIDF and RAP with its aim of automating repetitive and labour intensive tasks. Meeting this analyst user need is consistent with the primary need of meeting consumer's expectations—if repetitive tasks are automated, there may be more room to conduct more valuable analysis, and the resulting data products may be more timely and of better quality. Moreover, analyst users should be able to exercise sufficient autonomy over the tools that they use. Not all analyst users are alike, and whilst some will be comfortable using modern analytical tools like R and Python, many (probably most) analyst users will be more comfortable working with spreadsheets like Microsoft Excel or Google sheets. Best practice accommodates all types of analytical users and allows them to access data in the way they find most comfortable. The precursor data lakes which form the basis of Findata's data storage were designed to cater for the needs of in-house business intelligence (BI) staff, doctors and medical thesis workers, and computational researchers (Darst et al., 2017)—use cases that span from the ubiquitous spreadsheet, to artificial intelligence research using cutting edge open-source tools. Concluding, failing to provide analysts with sufficient autonomy can be costly. Research from the UK Government Digital Service (GDS) suggests that spreadsheets are so prevalent that it would be fair to say they are the default model for government data.[3] Whilst it is recognised that spreadsheets lead to many errors when relied on for business processes (inter al, Panko, 2016), attempts to replace them frequently fail when they are supplanted by tools that the analysts cannot adapt so easily.[4] Indeed, whilst successful, the future of the current implementation of Estonia's KOKE system is under review for this very reason: lack of autonomy, and the need to outsource work to further adapt the system. By contrast the success of RAP and the SIAL and SIDF tools is that given enough autonomy, skilled analyst users in NZ and the UK were able to develop their own tools internally to solve problems they encounter, obviating the need to outsource. When this autonomy is coupled with open-source software allowing analysts to share their work with other teams, departments, or even governments, the benefits are multiplied enormously.

4.2 Reusability and Open Source

This category starts with the principle that using and writing open-source software fosters reusability. There are two ways in which open-source software helps with reusability. Firstly, if analysts use open-source tools for their analysis, or the technical infrastructure on which analytical environments are built is based on open-source tools, it allows analysts and data engineers to make use of innumerable online resources. GitHub, for instance, the platform, where many RAPs and the SIAL and SIDF are published openly, is used by more than 40 million users, from around 2.9 million organisations worldwide. Another platform stack overflow allows users of open-source software to ask questions that can be answered by other users. In 2018, the platform had over 100 million users, with 2 million out of 2.5 million questions

[3] See for instance https://gds.blog.gov.uk/2017/01/31/what-you-can-learn-from-making-data-user-centred/.

[4] Improving how we manage spreadsheet data—Data in government. Available at https://datainggovernment.blog.gov.uk/2019/06/10/improving-how-we-manage-spreadsheet-data/.

answered successfully. When faced with a new problem for which a solution does not exist, a public sector data analyst working with an open-source language can look on GitHub or stack overflow to reuse or adapt a solution that others have developed for the same or a similar problem. Given the amount of material that now exists on these sites and others, it is a challenging problem indeed that cannot be at least partly solved within ten minutes and access to a search engine. The second way in which open-source software can assist with reuse, is if analysts across the public sector are able to publish their work openly for others to reuse. This is precisely the situation with RAP and the SIAL and SIDF layers for the IDI. One reason why RAP has been so successful is that the prototype was published openly on GitHub under a permissible licence that allowed anyone with an Internet connection to scrutinise, adapt and reuse the tool for their own use case. Clearly, not all public sector code can be shared openly, but often it is not the logic enshrined in the code that is sensitive, it is the data on which the logic operates, and these two can easily be decoupled. Another way in which using open-source tools can aid with reuse is by preventing vendor lock-in. Findata provides a good example of this. The data lake infrastructure uses an open-source technology called Apache Hadoop. If the decision is made to change the hosting option, it would be a relatively straightforward undertaking to reuse everything that has been built by deploying it to a new host. Not only does this give public sector organisations great flexibility in where their data are stored and processed, but it can help to keep the cost of the infrastructure competitive by ensuring that it is possible to switch suppliers. Finally, it is clear that working with open-source software facilitates the reuse of code to solve analytical problems, but there are other ways in which the examples in the case studies have built on prior work. Both the IDI and Findata were built on a number of projects that had been completed over the preceding years. The IDI prototype, for instance, was created from data integration efforts completed for various projects prior to Cabinet approval for a cross-government data integration service in 2013. The infrastructure underlying Findata was trialled in precursor projects orchestrated by health administrations across Finland, and evaluated openly by a third party. These were valuable projects in their own right, and the lessons learnt were able to inform the implementation of Findata.

4.3 Architecture and Hosting

There is no ‘one size fits all’ solution for data infrastructure, and organisations need to make well informed choices about which infrastructure to use and where to deploy it. Whilst ‘big data’ solutions can seem appealing, many public sector organisations do not have big data and will likely never have big data by today’s standards. This is because administrative data often conforms to a fairly homogenous format that can be stored easily and managed using tried and tested technologies. Furthermore, cloud suppliers are able to scale these traditional technologies in ways that were not previously possible, making it even easier for organisations to store ever larger quantities of data, with ever decreasing effort. Of the three case studies which involve a data storage solution, the IDI and KOKE projects use traditional proprietary database solutions, whilst Findata is built upon an open-source ‘big data’ solution. Health data stored by Findata in particular can fall into the realm of big data because it can include images and video from medical imaging devices. Such data are difficult to store and analyse with traditional solutions. Furthermore, Findata followed three precursor projects which tested the technology and was subject to independent and public scrutiny. Such systems are, however, significantly more complex than simpler more traditional technologies; recognition of this complexity and the related skills gap was an outcome of the precursor projects. Further, interoperability is key to breaking down silos. The IDI is a good example of a concerted effort to bring together datasets from various government departments and to store them on one common integrated data infrastructure. Despite the IDI gathering around 550 public sector datasets together in one place, it does not automatically solve the issue of interoperability. This problem arises because organisations tend to have different processes for managing, collecting and using data. The SIAL was built to address this problem: ironing out the idiosyncrasies of data from 14 different agencies, all of which likely have subtly different ways of representing reality in their data. This is in part why the SIAL is successful: anyone who uses the IDI immediately faces this interoperability problem, and it usually only needs to be solved once. One way to help solve these issues is to encourage organisations to conform to the same standards in their own business processes, so that when data from two organisations are brought together, they already have similar characteristics. The UK Government registers initiative[5] is a good example of this. Key pieces of data infrastructure from lists of countries to lists of government organisations are curated by a custodian and made publicly available via an easy to consume service with an API. RAP also deals with the interoperability problem. The UK government does not yet have an integrated data infrastructure like the IDI, but agencies do share data between each other. The prototype RAP for instance was built on data collected by the Department for Digital, Culture, Media, and Sport (DCMS) and the Office for National Statistics (ONS). These data arrive to the analytical team replete with the idiosyncrasies of each agency and in multiple formats. RAP deals with the interoperability problem by developing a software layer—like the SIAL—in which various data sources are manipulated into a common format before they are used in analysis. Public trust is paramount but also very important is capacity building. In that regard, developing data capability can reduce the need to outsource technical work. The SIAL and SIDF tools were developed by highly skilled data scientists who were able to build the tools to meet their own and others’ needs internally. These resources were then shared openly allowing others to benefit from the work. Building this kind of capability can allow organisations to solve more of their analytical and infrastructural problems internally without the need to outsource. Conversely, the future implementation of the Estonian KOKE system is being reviewed due to the expense and time taken to make changes to the system (which must be outsourced), although this may have more to do with

[5] More information available at https://www.gov.uk/government/publications/registers/registers.

the system being based on proprietary tools rather than a lack of in-house capability. Analysis of the precursor projects to Findata noted that the capability to deal with the highly technical data infrastructure was an early constraint. In the event, the management of at least part of this infrastructure was outsourced to a private sector consultancy, but for this highly complex system to be utilised to the fullest extent, it will likely require upskilling of operators in the day to day use of the technology. In this regard, recruitment and retention of highly skilled analysts can be hard. In fact, highly skilled data analysts, scientists and engineers are in demand across all sectors, and the public sector may find it difficult to compete with the salaries and benefits that are available to the most skilled. Providing good opportunities for development can help fill these skill gaps by upskilling existing public servants, and by attracting more junior data professionals who aspire to develop these skills. One reason for the popularity of RAP is that it has allowed analysts to develop skills that are highly sought after, and use tools that are in demand across all sectors.

5 Policy Take Outs

After the case studies and the cross-analysis of the cases by domain, the research team has extrapolated a set of recommendations for transferability and scalability based on the success factors and lessons learned of the practices applied in each domain.

5.1 Data Strategies

The in-depth analysis suggests a set of recommendations for policymakers at EU and national level:

1. **Start with the problem, not with the technology**. Building a data strategy does not necessarily entail an investment in a technological data analytics platform, and certainly it does not start with it. Very few strategies include such investment, and those who do are typically vertically focussed on specific sectors or organisations. On the other hand, there are not many examples of successful government data analytics platforms, but there is room for focussed centralised technological components, as shown by the reproducible analytical pipeline case analysed. A common trait of most advanced horizontal and vertical strategies is a demand driven approach: providing a variety of support mechanisms, from governance to skills to support services, to address real problems, such as health, poverty and urban issues. Focus on the key questions to be answered and the policy problems to be solved. This is important in order to deliver tangible results.
2. **Analyse permanently user needs**. Users include both data holders and data reusers, both internal and external. Too often user needs remain assumed or

based on anecdotical evidence. Not only it is necessary to formally analyse them in the first place, but perhaps more importantly to constantly monitor them over time to adapt to how solutions are used. The constant collaboration between the Danish data mining unit and the municipalities frontline case workers is a clear example of this. Iteration of delivery is, therefore, crucial—no service is designed perfectly the first time.

3. **Co-creation is a fundamental component** of the strategy. Bringing internal and external stakeholders onboard is a necessary (not sufficient) condition of success. But it is equally important to keep stakeholders onboard after the strategy is launched, during the implementation. Other government agencies need to see the benefit to share data and to conform to the required standard and processes, because there are costs in doing so. Of course, there is a shared perception amongst decision-makers that data are a strategic resource and that investment is needed, but this is only sufficient for kickstarting the process: the difficult part lies ahead.
4. **It is not sufficient to consult and co-create with stakeholders: what matters is delivering results**. There is a lack of business case for data innovation. Existing strategies should focus, as in the case of the Netherlands and New Zealand, on delivering short-term results via small scale pilots on topical issues. But pilots should be the beginning of service delivery, as shown by the Findata case, and their results should be well documented and shared. The problem is not only the difficulty in demonstrating impact—the ultimate benefits in terms of quality of public service. It is the actual difficulty to demonstrate deployment and adoption—simple projects that work and deliver. Data strategies should balance long-term perspectives to data stewardship with short term delivery of pilots.
5. **In order to ensure delivery, it is crucial to take a practitioner led approach**. The most successful strategies are those were data experts in public administrations are brought together and given a visible role in the process, as in the Netherlands with the creation of a cross department sounding board with data analysts and policy experts. There is a permanent gap between data experts and decision makers, and for data strategies to work, data experts should be empowered. And communities of practices are the fundamental tool to enable mutual learning and empowerment of practitioners.
6. **Create a data culture across departments and institutional levels**. Data-driven innovation requires cultural change, training and bringing in new resources from the outside. New centre of competences (such as the Dutch labs) has to be created. Data training should be provided to all civil servants, and in particular to decision makers. But it also requires the reinforcement of internal capacity and the creation of effective communities of practice that cut across government silos, and the creation of knowledge and expertise centres to facilitate knowledge exchange between data champions and novices.
7. **Because it is a long-term process, expectations need to be managed correctly and hype should be avoided**. Delivering data-driven innovation is not easy, it is not a low hanging fruit. Data are not a commodity. It requires extensive work for

access, preparation and cleaning but also for processing and reprocessing. There is a constant risk of disappointment that backfires. It is important for data leaders to raise realistic expectations from other stakeholders and to start by focussing on data availability. Pilots should be selected based on two criteria: a genuine need and access to available data. Luckily, the evolution towards a data culture is visible across society and the economy, and it is here to stay—particularly so following the ongoing pandemic crisis. There is no need to overhype the opportunities.

8. **A robust ethical framework is crucial and can be instrumental to innovation**. The results are long term, and it is important to avoid crisis in the short term that would 'put back the clock'. The safeguards can work hand in hand with more data reuse, by creating a shared data stewardship culture. Actions for data protection compliance should be integrated with those on increased data literacy: in fact, the lack of a data culture is damaging for both data protection and data innovation. But an ethical approach goes beyond compliance with data protection and includes also what is done with the data, for instance to avoid any punitive spirit in the services being put in place to fight poverty based on the data gathered.
9. **Monitoring should be present and structured but not drive the process**. Milestones and KPI should be core part of any strategy—and it is currently very rarely the case. KPIs should not concern only outputs, but also the inputs and the process, such as the percentage of datasets in line with the required standards, the access to base registries, and the number of departments taking part in the different activities. In fact, the main compliance mechanism in the case of such soft strategies is monitoring and reporting, as shown by the Dutch case where the most important control mechanism is reporting to Parliament. And they become fundamental in ensuring the long-term collaboration of different stakeholders, as in the Danish case.

5.2 Policy Modelling and Simulations

The following are policy take outs extracted by the cross-analysis of simulation models:

1. **Timely collection and transparency of data**. It is crucial to ensure that the data collected are updated and that are collected at regular and timely intervals. In fact, in order to ensure the relevance of the policies, they should build on timely analysis and results. Further, it is important to provide specific and complete information about the methodology and procedures for the data collection, in order to inform the users of the models of the caveats and shortcomings. Also, it is important to provide stakeholders with access to results and outputs used to develop the different scenarios, in order to ensure comparability.
2. **Transparency and openness of assumptions and models**. Trust in the results stemming from the model is increased if all the assumptions made by the

modellers are transparent and available for the other experts to criticise and scrutiny. In fact, openness of assumptions and modelling structure improves the comparability of the analysis and projections produced by different organisations using different models. There are cases in which results of the analysis vary in a number of important methodological aspects, and without a way to clearly compare one analysis and set of results to one another, decision-makers may not understand the range of possibilities envisioned by different short-, medium- and long-term projections, or the assumptions that underpin those projections.

3. **Use and reuse of data and software modules**. Apart from transparency of data, it is also important to make databases as open as possible in order to allow other researchers to replicate the results of the analysis carried, as well as to use the data for other research purposes. In fact, such modelling endeavours produce a wealth of data that should not be wasted. This is also clearly linked to the issue of transparency, as the availability of metadata helps the researchers in understanding the weaknesses of the data produced and therefore the suitable methodologies of analysis. By the same token, the models should be built in modules, to be made available to researchers for reuse and recombination (see point 4). This allows researchers and practitioners to download, re-adapt and reuse the modules for their analysis, therefore conceiving new applications.
4. **Perform validation and sensitivity analysis exercises**. As we have seen, the results of many modelling exercises have been deeply influenced by the modelling and estimation techniques used. In this respect, a core activity ensuring the robustness of the modelling exercises performed consists in applied different modelling and estimation techniques to the same set of data, as well as changing the values of the input and internal parameters of a model to determine the effect upon the model output. Related to this issue is the necessity to validate the models by employing them on comparable but different data sources to see how the model results change and to keep them open in order to scrutiny and criticisms by other researchers. Last but not least, also keeping data open allows to carry out different modelling and estimation techniques by different researchers.
5. **Generate collaborative model simulations and scenarios**. Clearly, the collaboration of several individuals in the simulation and scenario generation allows for policies and impact thereof to be better understood by non-specialists and even by citizens, ensuring a higher acceptance and take up. On the other hand, modelling co-creation has also other advantages: no person typically understands all requirements and understanding tends to be distributed across a number of individuals; a group is better capable of pointing out shortcomings than an individual; individuals who participate during analysis and design are more likely to cooperate during implementation. In the case at hand, the joint elaboration of simulations and scenarios by policymakers and scientists helps in producing models that are refined to tackle the containment policies adopted. Collaboration entails also the development of data aggregators that visualise the data coming from the field every day and that improve the situational awareness of the policymakers.

6. **Use models properly**. Models are not a commodity that provide a number which the policymakers use to take decisions. There needs to be a full understanding of the subtleties involved, the levels of uncertainty and the risk factors. In other words, you need in-house data and model literacy embedded in the policy making process, in-house. Indeed, a recent report for the US highlighted the limitations of a process that involved experts on an ad hoc, on demand basis, leaving much arbitrariness to the process: ‘expert surge capacity exists in academia but leveraging those resources during times of crisis relies primarily on personal relationships rather than a formal mechanism’. By the same token, in the US, ‘there is currently limited formal capacity within the federal government’, whilst in the UK, ‘the criticism levelled at the prime minister may be that, rather than ignoring the advice of his scientific advisers, he failed to question their assumptions’.
7. **Models integration**. Finally, there is the need for a flexible modelling framework for the comprehensive assessment of major challenges in the analysed domain and to be used in conjunction with other models in order to address major global challenges in a holistic way. In this respect, integration of sectoral models is a key issue to assess important interrelations and feedbacks. More generally, models should be developed in modules and in a flexible way in order to allow integration with other models.

5.3 Data Technologies

The recommendations concerning data technologies are as follows:

1. **Put user needs before organisational needs**. The European Commission should aim to meet the needs of both consumers of public sector data products, and the needs of the analyst users that produce it. Clearly, the needs of consumers (be they individual citizens, businesses, public bodies, or decision makers) to have access to timely and accurate information is critical to any data infrastructure and analysis strategy. However, it is also important to recognise analysts as a user group with distinct and often varying needs and often the capability to meet their own needs if given sufficient flexibility. The case studies examined in this analysis demonstrate the ability of analysts to build the tools they need to do their work better, and by working openly, to share those tools with the wider community and enable their reuse.
2. **Work in the open and foster reusability**. The European Commission should embrace open ways of working and embed the same approach to member states. In two of the case studies that we examine in this analysis, working in the open has been a major contributor to success. The decision in NZ to work openly on the SIAL and SIDF has led to significant cost savings amongst other public sector bodies who do not, as a result, need to repeat the same work. Similarly, working openly in the production of RAPs has fostered the creation of a community that spans all the devolved administrations in the UK, and some regional public

sector bodies: a grassroots movement for modernisation of tooling and practices that originates from the analysts themselves.

3. **Adapt to data readiness**. The European Commission should recognise that different public sector bodies have different needs and capabilities and a 'one size fits all' approach to data analysis tools and infrastructure is unlikely to be appropriate. It is also important that tools and infrastructure are interoperable, support common standards (for example data formats) and should be able to scale to support future needs. The implementation of RAP, for instance, varies significantly between organisations depending on requirements and capability. NHS Scotland defines seven levels of maturity that an agency can adopt, all based on the principles of RAP and all built using open-source technologies that can be easily adapted and developed as required.
4. **Use open source**. The organisation and the member states should start prioritising the use of open-source technologies in the future developments. Advances in statistical techniques, the availability of large amounts of data and the availability of cheap computing power have led to rapid changes in the field of data analysis. Software companies and researchers routinely publish their research and tools freely under open-source licences. These tools are almost uniformly written in open-source languages. Allowing analysts to use the same open-source tools ensure that they can keep up to date with developments in the field. This is critically important as public sector bodies increasingly adopt machine learning and artificial intelligence: the field moves so quickly that what was once considered to be cutting edge can be obsolete in a matter of months. Furthermore, open-source languages act as a 'programmatic glue' that can combine disparate data sources, varied analysis and multiple outputs with minimal effort. Moreover, public sector bodies often differ in their choices of proprietary software for all manner of budgetary and political reasons. Adopting common open-source tools like Python and R removes these barriers to sharing, enabling reuse.
5. **Invest in data capability at all levels**. The data landscape is changing rapidly, and the pace of that change is increasing. Member states should recognise the need to invest in the capabilities of their personnel in order to keep pace with these changes. The RAP project provides a good example of this. Because the project relied predominantly on open-source software, it did not imply a big new capital investment, but did require capability building both amongst the analysts who would use and develop the tools, and amongst the managers responsible for them. As public sector organisations become increasingly sophisticated in their exploitation of data, these organisations must ensure that the whole organisation develops data literacy as a core skill and that the benefits that data can bring are not siloed amongst small groups of highly data literate specialists.
6. **Break down silos**. The commission should work to break down the siloing of data within public sector organisations and encourage member states to do the same, whilst prioritising proportionate measures for data security and protection that ensure that the public trust that their data are being well managed. One of the biggest data problems that the public sector faces is that data are often siloed in different organisations, in different formats and on different infrastructure.

Both the IDI and Findata develop legislative and infrastructural solutions to these problems, whilst some of the issues that are solved by RAP exist only because of inconsistencies in the way data are stored and managed by UK Government departments. However, member states should be aware that citizens may be concerned about the collation of datasets within government servers, and the release of this data to organisations outside of the public sector. Both the IDI and Findata have strong approval processes in place to ensure that this is done appropriately and technical solutions in place to safeguard citizens' privacy.

6 Conclusions

The objective of this chapter is to understand what strategies, models and technologies can be deployed to transform the public administration into being more data-centric, and therefore more efficient, effective, fair and transparent. To this end, the study team has performed a set of case studies, from which analysis a set of three policy take outs has been produced, one per each domain. Clearly, there are some common points across the policy recommendations for the three domains. One is the need for **co-creation** of the strategy/models/infrastructures with relevant stakeholders. This would ensure that the needs of users are met and that the models and infrastructures produced respond to actual needs. Another element is the **transparency** in data, modelling structures and assumptions and working procedures. This element will entail the creation of real communities of interest aimed at supporting the policy making activities. Further, the topic of data and software **reuse** is of utmost importance. In this respect, data and software modules should be accompanied by appropriate metadata in order to be easily reusable and therefore boost economy and research. A final element is the need to invest in **capability** of civil servants and policymakers, ensuring that they are able to use relevant technologies and to understand what is the message conveyed from data and simulation results, and therefore how models and simulations can be used to improve policy making. Concerning the limitation of the analysis, clearly the number of cases and the choice of them have been limited by the COVID-19 pandemic outbreak, which has also somewhat limited the interactions with informants. As for further research in the domain, the study team is going to carry out an analysis of the main simulation models developed to tackle the COVID-19 pandemics, highlighting the data sources available and the limitations and drawbacks of models and data.

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A Methodology for Evaluating and Improving Digital Governance Systems Based on Information Systems Success Models and Public Value Theory

Euripidis N. Loukis

Abstract The evolution of digital governance gives rise to the development of many different kinds of public sector specific information systems (IS), which aim to serve many different goals and objectives, such as efficiency improvement of government agencies, provision of quality services, transparency, public participation, collaboration with citizens and value co-creation, economic development, etc. Given the large amounts of public financial resources spent for their development, operation and support, it is necessary to conduct comprehensive evaluation of them from various perspectives, identify their strength and weaknesses, and prioritize and perform the required improvements of them. So, a critical element of the science base of the digital governance domain should be public sector specific methodologies for evaluating and improving the various kinds of digital governance IS, which address the specificities of the public sector, especially the wider range of objectives it has to pursuit and achieve, in comparison with the narrower set of objectives of the private sector. In this direction this chapter describes a public sector specific methodology for the evaluation, and also the improvement, of the different kinds of digital governance IS, based on a sound theoretical foundation from private sector management research, the information systems success models, and also a sound theoretical foundation from public sector management research, the public value theory. Furthermore, two applications of this methodology are presented.

Keywords Digital governance (government) · Electronic governance (government) · Evaluation · Information systems success · Public value · Value flow model

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1 Introduction

The concept of digital governance has undergone an extensive evolution in the last twenty years with respect to the functions of government agencies. It aims to support, enhance and transform through the use of information and communication technologies (ICT). So, we can distinguish some distinct ‘generations’ of it (Janowski, 2015; Lachana et al., 2018), which aim at the development of quite different kinds of information systems (IS), with quite different goals and objectives. In particular, we can distinguish a first generation of digital governance aiming at the support, enhancement as well as transformation initially of the internal works and processes of government agencies, and later of the transactions of citizens and firms with them using electronic channels, such as the Internet. Subsequently a second generation of digital governance appeared, influenced by the public participation ideas (Rowe & Frewer, 2000, 2004) as well as the open government ideas (Hilgers & Ihl, 2010; Mergel & Desouza, 2013; Nam, 2015), aiming at the support, enhancement and transformation of government agencies’ communication, interaction and collaboration with citizens, firms and the society in general, taking advantage at the quite high adoption and penetration of the Internet, and later the social media (Chun & Luna Reyes, 2012; Loukis et al., 2017; Margo, 2012). Recently, a third generation of digital governance emerges, aiming to support, enhance and transform the highest level functions of government agencies, which are dealing with the formulation and design of public policies for addressing the bog challenges that modern societies face, leading to the development of ‘policy informatics/analytics’ (Gil-Garcia et al., 2018; Janssen & Wimmer, 2015; Loukis et al., 2019).

Furthermore, in all these three generations of digital governance initially the main focus is the development of simpler IS that provide digital support of existing processes and practices of the corresponding functions (aimed by each of these generations) of government agencies; however, later they advanced toward more ambitious and innovative directions: development of more complex and sophisticated IS that change and transform significantly some processes and practices of the corresponding functions of government agencies, leading to ‘digital transformation’ of them (Janowski, 2015; Mergel et al., 2019; Pedersen, 2018). Also, all these three generations of digital government continuously evolve technologically as well, by exploiting beyond the ‘traditional’ ICT also various emerging ‘disruptive’ ICT, such as artificial intelligence, internet of things, big data, etc. (Ronzhyn et al., 2019).

This evolution of digital governance has given rise to the development of many different kinds of IS, which support, enhance and transform various different functions of government agencies, and aim to serve various different goals and objectives, concerning efficiency improvement of government agencies, quality services provision, transparency, public participation, collaboration with citizens and value co-creation, economic development, etc. Given the large amounts of public financial resources spent for their development, operation and support, it is necessary to conduct comprehensive evaluation of them from various perspectives, in order to assess the value they generate, identify their strength and weaknesses, as well as define, prioritize and perform the required improvements of them. This becomes even more important, due to the increasing innovativeness and transformative nature of these IS, aiming at significant ‘digital transformations’ (Mergel et al., 2019; Pedersen, 2018), as well as the increasing exploitation of emerging ‘disruptive’ ICT, such as artificial intelligence, internet of things, big data, etc. (Ronzhyn et al., 2019), which make the comprehensive evaluation, and also the gradual improvement, of these highly sophisticated, novel and innovative-transformative digital governance IS imperative. These novelties (both functional and technological) necessitate extensive evaluation, in order to assess to what extent they really ‘work’ and are successful and beneficial, and also gradual improvements, order to reach higher maturity. Therefore, a critical element of the science base that the digital governance domain should develop (Viale Pereira et al., 2018; Charalabidis and Lachana, 2020a, 2020b) must be public sector specific methodologies for evaluating and improving the various kinds of digital governance IS, which can address the specificities of the public sector, and especially the wider range of objectives it has to pursuit and achieve, in comparison with the private sector IS (which have a more narrow range of objectives, concerning mainly operating cost reduction, and increase of sales revenue and profits) (Pang et al., 2014; Rose et al., 2015). In order to develop such multi-perspective evaluation methodologies, it is necessary to use sound theoretical foundations, on the one hand from private sector management research, and on the other hand from public sector management research.

In this direction this chapter describes a methodology for the evaluation, and also the improvement, of different kinds of digital governance IS, based on a sound theoretical foundation from private sector management research, the information systems success models (DeLone & McLean, 1992, 2003, 2016; Jeyaraj, 2020), and also from public sector management research, the public value theory (Alford & Hughes, 2008; Alford & Yates, 2014; Bennington & Moore, 2011; Moore, 1994, 1995, 2013). We believe that this approach is of wider usefulness and applicability for digital governance research and practice in general: it has to be based on a sound science base, which exploits and combines the wealth of theoretical foundations that have been developed on the one hand in private sector management research, and on the other hand in public sector management research.

In particular, the proposed methodology includes the specification and estimation of a ‘value flow model’ of the digital governance IS under evaluation, which consists of the magnitudes of the various types of value it generates, as well as the associations among them, based on evaluation data collected from users of the IS; these magnitudes as well as associations enable the identification and prioritization of necessary improvements of the IS. In particular, the proposed methodology offers the following advantages:

(i) It enables a comprehensive and highly multi-dimensional evaluation of different kinds of digital governance IS, allowing the evaluation of wide range of aspects of them, as well as the assessment of the various different types of value generated by them, both at the efficiency and the effectiveness level.

(ii) It enables evaluation at a first level of the specific capabilities that a digital governance IS offers (efficiency-oriented evaluation), and at a second higher level of the support it provides for the accomplishment of users' objectives, which concern the promotion of specific public values (effectiveness-oriented evaluation), as well as the extent of its use.

(iii) It exploits not only the average ratings of users concerning the above multiple types of generated value, but also the existing associations among them, in order to gain more insight and draws more extensive and rich conclusions; the analysis of the associations among the value measures of the above two evaluation levels (efficiency and effectiveness related ones) enables a deeper understanding of how different types of value of one level are transformed to different types of value of a higher level, providing a clear picture of the value generation and flow mechanisms of the specific digital governance IS.

(iv) It can also identify and prioritize the necessary improvements of the characteristics, capabilities and services of this IS, which constitute the first (efficiency oriented) level of the value generated by it, taking into account their impact on the various types of higher level value the IS generates, which concern the support it provides for the accomplishment of specific users' objectives, corresponding to the promotion of various public values (such as efficiency, quality of services, transparency, public participation and collaboration, fairness, equal treatment of all citizens, trust, legitimacy, social cohesion, cultural development, etc.).

(v) The proposed methodology can be used at various stages of the development and use of a digital governance IS, such as the initial design, the detailed design, the first pilot applications, the 'real-life' use, as well as subsequent evolutions of it (performed in order to fulfill new needs or/and incorporate and exploit emerging 'disruptive' ICT), for conducting both formative and summative evaluation.

Also, in this chapter two applications of the proposed methodology are presented: the first one concerns the evaluation and improvement of an IS supporting the operations of the 'Local School Committees' of Greece; the second application concerns the evaluation and improvement of an advanced 'second-generation' open government data infrastructure developed as part of a European project.

This chapter is structured in five sections. The following Sect. 2 includes the background of the proposed methodology. The methodology is described in Sect. 3, followed by the above mentioned applications of it in Sect. 4, and the conclusions in the final Sect. 5.

2 Background

2.1 Information Systems Success Models

The methodology of the evaluation of IS has been extensively researched in the last 30 years, due to the continuous increase of the importance of IS for organizations, as well as the corresponding investments; this research aimed at the development of approaches and methodologies for identifying and quantifying the full range of positive as well as negative impacts of an IS (Farbey et al., 1999; Gunasekaran et al., 2006; Hirschheim & Smithson, 1988; Irani, 2002; Irani et al., 2006; Prat et al., 2015; Smithson & Hirscheim, 1998). This has turned out to be highly complex, because the benefits and in general the value created by most categories of IS are complex and multi-dimensional, both tangible and intangible. This makes it difficult to decide 'what to measure' for the evaluation of IS, and also 'how'. Furthermore, this extensive research on IS evaluation has revealed that there are many different kinds of IS, which differ significantly as to their objectives as well as the benefits and value they generate, so they require quite different kinds of evaluation methodologies and measures. Farbey et al. (1995) identify eight categories of IS with respect to the approach that have to be adopted for evaluating them: mandatory IS, automation IS, direct value added IS, management information and decision support systems (MIS—DSS), infrastructure IS, inter-organizational IS, strategic IS and business transformation IS; for each of them a different evaluation approach is proposed. Smithson and Hirschheim (1998) analyze the existing IS evaluation methods with respect to 'what' they assess and evaluate, and identify three basic categories: (i) 'efficiency-oriented' IS evaluation methods, which have been influenced mainly by engineering sciences, and evaluate an IS with respect to some predefined technical and functional specifications, focusing on answering the question 'is it doing things right?'; (ii) 'effectiveness-oriented' IS evaluation methods, which have been influenced mainly by management sciences, and evaluate how much an IS supports the execution of business-level tasks or the achievement of business-level objectives, focusing on answering the question 'is it doing the right things?'; (iii) 'understanding-oriented' IS approaches, which aim at obtaining a deeper understanding of the mechanisms of value generation by an IS and their association with the organizational context.

Prat et al. (2015) conduct a review of previous literature on the evaluation of IS artefacts, based on theoretical foundations from design science; with respect to the 'what' of IS evaluation (i.e. what has to be evaluated) they examine the IS evaluation criteria used by pre-existing methodologies with respect to the following five main aspects of a system: goal, environment, structure, activity and evolution. They conclude that IS evaluation methodologies focus mainly on the 'goal', 'environment' and 'activity' aspects of the evaluated IS, regarded as the most important aspects of it: they evaluate mainly to what extent the IS contributes to attaining business goals, is useful to employees (who constitute that most important part of its environment) (which correspond to 'effectiveness'), and also has high levels of performance and accuracy (which correspond to 'efficiency') respectively.

Another research stream has dealt with the measurement of IS success, which can be viewed as a form of IS evaluation; it has focused on the identification and measurement of the main aspects/dimensions of IS success, as well as the relationships among them, and this has led to the development of several 'IS success models (a review of the most important of them is provided by Jeyaraj (2020). The most widely recognized and used among them has been definitely the DeLone and McLean's IS success model (DeLone & McLean, 1992, 2003, 2016; Jeyaraj, 2020). The initial DeLone and McLean's IS success model (DeLone & McLean, 1992) defines six main dimensions of the success of an IS: 'system quality' and 'information quality' (at a first level), which affect 'user satisfaction' from the IS and the actual 'use' of it (at a second level); these affect its 'individual impact', which affects finally its 'organizational impact' (at a third and fourth level respectively). Subsequently an updated version of it was developed (DeLone & McLean, 2003), based on the experience from the extensive use of it, which defines the following dimensions of the success of an IS: 'system quality', 'information quality' and 'service quality' (at a first level), which affect 'user satisfaction' and the actual 'use' (at a second level), and these affect the 'net benefits' that the IS generates. Furthermore, the research that has been conducted based on the DeLone and McLean's IS success model has developed for each of these dimensions of IS success a number of individual items/measures (which can be viewed as evaluation criteria/measures) for assessing it; based on reviews of this research, the most important and widely used of them are (DeLone & McLean, 2016; Jeyaraj, 2020; Petter et al., 2008; Urbach & Mueller, 2012):

- for system quality: ease of use, ease of learning, flexibility, reliability, features, capabilities, sophistication, interactivity, navigation, availability, response time, portability, maintainability (so this system quality dimension of IS success is quite wide, as it covers aspects of the ease of use and usability of the system, the capabilities and functionalities it provides, and its technical quality);
- for information quality: relevance, understandability, accuracy, conciseness, completeness, relevance, understandability, currency, timeliness, format and usability;
- for service quality: characteristics of the quality of the support that the users of the IS receive from its support unit and personnel (internal or external), such as responsiveness, accuracy, reliability, technical competence and skills, flexibility, training and empathy;
- for user satisfaction: overall measures of user's satisfaction from the system, as well as of the degree of fulfillment of their needs and expectations;
- for use: amount of use, frequency of use, nature of use, appropriateness of use, extent of use, purpose of use, breadth of use, depth of use (this dimension is less important if the use of the system is mandatory);
- for net benefits: the extent to which the IS contributes to the success of individuals, groups and organizations, e.g. to improved decision-making, improved productivity, increased sales, cost reductions, improved profits, improved customer service and consumer welfare.

The DeLone and McLean's IS success model has been used extensively in IS research, mainly in studies aiming to test various hypotheses concerning the relationships between the abovementioned aspects/dimensions of IS success, as well as the effects of various factors (such as various organizational or project management characteristics) on them, for different kinds of IS, mainly for private sector IS (Iivari, 2005; Kulkarni et al., 2007; Lin et al., 2006; Mudzana & Maharaj, 2015; Trkman & Trkman, 2009) and to a smaller extent for public sector IS (Chatterjee et al., 2018; Floropoulos et al., 2010; Stefanovic et al., 2016; Wang & Liao, 2008); comprehensive reviews of these studies are provided by Urbach and Mueller (2012), Al-Kofahi et al. (2020) and Jeyaraj (2020). However, DeLone and McLean's IS success model has not been used/exploited for the evaluation of individual IS. So, the proposed methodology uses/exploits this widely recognized and validated DeLone and McLean's IS success model for the evaluation of individual IS, focusing on digital governance ones, as well as for their improvement. Also, while the abovementioned items/measures' sets developed for the assessments of the system quality, information quality, service quality and use dimensions can be used both in the private and the public sector, this does not hold for the net benefits dimension. Since as mentioned above the DeLone and McLean's IS success model has been used much more for private sector IS than for public sector IS, the items/measures set developed for its assessment reflects mainly the narrow range of objectives of the private sector (focusing on operating cost reduction, and increase of sales revenue and finally of profits); however, they do not reflect the wider set of objectives of the public sector (which include not only efficiency and quality of services, but also transparency, public participation and collaboration, fairness, equal treatment of all citizens, trust, legitimacy, social cohesion, cultural development, etc.). In order to develop an appropriate items/measures' set for the assessment of the net benefits dimension for public sector—digital government IS quite useful can be the public value theory, which is outlined in the following section.

2.2 Public Value Theory

The 'public value' theory initially articulated in Moore (1994, 1995), and subsequently elaborated by him and several other scholars as well (Alford & Hughes, 2008; Alford & O'Flynn, 2009; Alford & Yates, 2014; Bennington & Moore, 2011; Hartley et al., 2017; Moore, 2013; Williams & Shearer, 2011), emerged as a new public management paradigm, which was developed in order to address the weaknesses of the two previous dominant public management paradigms: the 'bureaucratic' (Weberian) and the 'new public management' (market/competition-based) paradigms (O'Flynn, 2007). According to the public value theory the objectives of government are not only the efficiency and outcomes related ones, which were the main focus of the previous post-bureaucratic new public management paradigm, but are much wider: the aim of government is to address a wide range of collective needs, desires, aspirations and preferences of the citizens, which concern various values regarded by them as important: efficiency in the use of public sector resources, quality of services, fairness, equal treatment of all citizens, trust, legitimacy, social cohesion, cultural development, transparency, public participation and collaboration, etc. Therefore, government activities (such as services, laws/regulations, public works, etc.), policy making, resources allocation and management should aim at promoting such a wide range of public values and achieving a multitude of relevant objectives. According to Moore (1994, 1995, 2013) public resources should be used by government agencies in order to generate public value (of various types mentioned above), in a way which is analogous to the generation of private value within private firms; for this purpose, it is necessary the strategy of government agencies to be based on the strategic triangle', which constitutes the central symbol of the public value approach, and includes three main necessary elements (that have to be equally developed, coordinated and aligned):

(a) public value proposition, meant as definition of specific types of public value to be created, which are regarded important by citizens and the society in general;
(b) development of legitimacy and trust for this, by attracting political support and necessary resources from the 'authorizing environment', including various political stakeholders, possibly with different concerns and interests;
(c) and at the same value development of operational and administrative feasibility for creating the above public value, based on the available resources.

Therefore, the public value theory constitutes a central scientific base and theoretical foundation for government research and practice, both descriptive (providing guidance for describing and analyzing government activities, i.e. answering the question 'what is government doing?'), and prescriptive (providing guidance for defining/planning future government activities, i.e. answering the question 'what government should do in the future?').

Considerable research has been conducted in the area of public administration on public value, which can be divided into two main streams differing in their perspective: (i) the institutional stream/perspective, which aims to find out what public value is, how it is defined, and what constitutes public value; (ii) the generative stream/perspective, which aims to develop normative frameworks for the required behaviors and actions of public managers in order to generate more public value (Davis & West, 2009; Pang et al., 2014). As part of the former research stream considerable research has been conducted in order to identify the specific public values that government has to pursuit and promote, which has identified a multitude of such values: Beck Jørgensen and Bozeman (2007) identified 72 values, while Rutgers (2008) identified 100 values, which indicates the wide and heterogeneous range of values and objectives that government has to address; a good review of this research is provided in Bannister and Connolly (2014) and Rose et al. (2015). Kernaghan (2003), based on a synthesis of relevant literature, developed a useful list of the most important of these public values, and grouped them into four categories:

(i) Ethical Values: Integrity, Fairness, Accountability, Loyalty, Excellence, Respect, Honesty and Probity.

(ii) Democratic Values: Rule of law, Neutrality, Accountability, Loyalty, Openness, Responsiveness, Representativeness and Legality.
(iii) Professional Values: Effectiveness, Efficiency, Service, Leadership, Excellence, Quality, Innovation and Creativity.
(iv) People-related Values: Caring, Fairness, Tolerance, Decency, Compassion, Courage, Benevolence and Humanity.

Rose et al. (2015), based on a review of existing public administration 'traditions', provided another useful categorization of the public values that government has to pursuit and promote, which includes four main values' categories:

(a) Efficiency-related values: efficient use of public resources, productivity, performance, cost reduction and value for money.
(b) Service-related values: services quality, accessibility and utility and citizen centricity.
(c) Professionalism-related: independent, robust and consistent administration, governed by a rule system based on law (legality), public record, which is the basis for accountability, equal treatment of citizens (equity) (Weberian principles).
(d) Engagement-related: engagement with the civil society to articulate the public good and facilitate policy development in accordance with liberal democratic principles, deliberation, participation and 'deeper' democracy.

Quite interesting research has been conducted concerning the relationship between digital governance and public values (Bannister & Connolly, 2014; Cordella & Bonina, 2012; Flak et al., 2009; Klievink et al., 2016; Panagiotopoulos et al., 2019; Pang et al., 2014; Rose et al., 2015; Twizeyimana & Andersson, 2019). This research has concluded that the directions and objectives of digital governance should not be limited to efficiency improvement and cost reduction, but should be expanded toward promoting the wider range of political and social public values identified by the abovementioned previous public administration research in this area; so, public value theory constitutes a sound and comprehensive framework for the design, analysis, deeper understanding as well as evaluation of government ICT projects, initiatives and programs, with respect to the types of public values they generate (or are expected to generate), as well as their enablers (e.g. government agencies' capabilities). Bannister and Connolly (2014), based on a review of previous literature on public values, attempt to identify a subset of them that can be substantially promoted through the use of ICT in government, as well as some public values on which negative impacts might appear (unintended negative side-effects). They conclude that ICT can have transformational-level impacts on many public values, and identified the ones most likely to be impacted: efficiency, effectiveness and economy in the public funds, equality of citizen treatment and access, citizen service, integrity/honesty, fairness, social inclusion, justice, respect for the citizen, impartiality, transparency, consultation, due process, self-governance, accountability, privacy protection, security protection, prevention of unfair exploitation of citizens and facilitation of democratic will. They argue that the impact of the use of ICT in government on most of these public values is expected to be positive, but there can be negative impacts on some of them as well (e.g. with respect to the public value of ‘equality of treatment and access’ the use of ICT might have positive impact for many citizens, but it can have negative impact on some citizens, who cannot afford the required ICT equipment and network connection for accessing electronic information and services provided by government through their websites). Rose et al. (2015) define four ‘ideals’ of digital government, which correspond to and aim at the abovementioned four categories of public values identified in this study; they focus on the improvement of government efficiency, services, professionalism and engagement with citizens respectively. Furthermore, for each of them they propose specific kinds of digital governance IS that can promote it. Twizeyimana and Andersson (2019), based on a review of previous relevant literature, identified six main types of public value generated by digital governance, which concern the improvement of administrative efficiency, public services quality, openness of government, ethical behavior and professionalism of public servants, social value generation and citizens’ wellbeing, as well as trust and confidence in government; furthermore, for each of them a set of more specific metrics have been defined. Panagiotopoulos et al. (2019), in an Editorial of a Special Issue on ‘Public value creation in digital government’ present an interesting conceptual framework of public value creation in digital government, which emphasizes the important role of relevant capabilities (especially dynamic ones) of government agencies for developing digital services that generate (individually or in aggregate through the combined use of them by citizens) public value in terms of efficiency, accessibility, ease of use, transparency, accountability, privacy, etc.; also, they provide an outline of six interesting papers that this Special Issue includes, which concern the different types of public value generated by the use of various digital technologies in government.

Therefore, public value theory can be an important element of the scientific base of the digital governance domain, and quite important for the evaluation of the many different kinds of digital governance IS that have been developed, or are under development, aiming to serve many different goals and objectives. The public value theory can be particularly useful for the multi-perspective evaluation of transformative digital government IS (that bring significant digital transformations of important functions of government agencies), as well of digital government IS that incorporate and exploit various emerging ‘disruptive’ ICT, such as artificial intelligence, internet of things, big data, etc. It enables extending the use of the IS success models (Sect. 2.1) for a wide range of digital government IS, by adapting the net benefits dimension of them to the wider range of objectives of government (in comparison with the private sector), through the development of appropriate items/measures’ sets for the assessment of net benefits that correspond to different types of generated public value.

3 Description of Methodology

3.1 Basic Principles

The proposed methodology of evaluation and improvement of digital governance IS includes two stages:

I Specification of a two layers' 'value flow model' of the specific digital governance IS under evaluation, which has the structure shown in Fig. 1, based on the IS success model of DeLone and McLean (see Sect. 2.1).
II Estimation of the value flow model using evaluation data collected from users of this IS (e.g. through a questionnaire).

We can see that the structure of the value flow model includes in the first layer five 'value dimensions': the first three of them correspond to the 'System Quality' of DeLone and McLean IS success model, which as mentioned in Sect. 2.1 covers aspects of the ease of use and usability of the system, the capabilities it provides and its technical quality, so we have the corresponding 'Ease of Use/Usability', 'Capabilities' and 'Technical Quality' value dimensions; however, we can have several capabilities-related value dimensions corresponding to different groups of capabilities provided by the system. The other two value dimensions of the first layer are 'Information Quality' and 'Service Quality'. The second layer includes two value dimensions: 'Objectives Accomplishment/Impacts', though we can have several

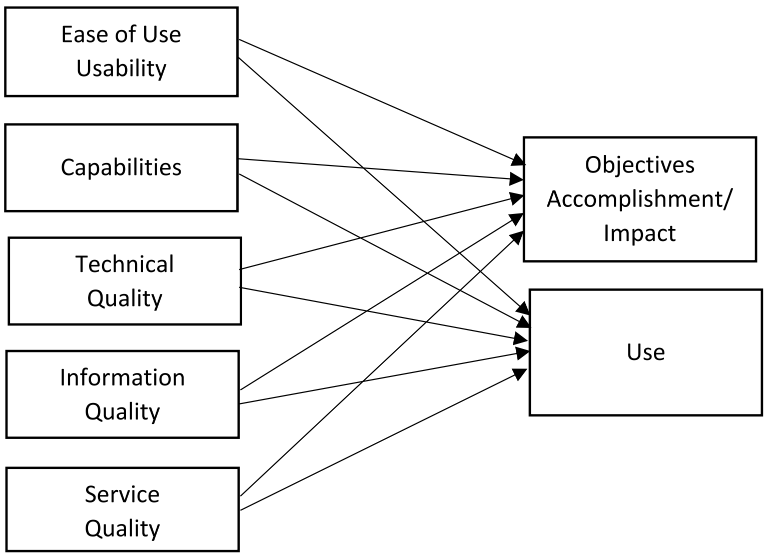

Fig. 1 Structure of the value flow model of a digital governance IS

value dimensions of this type corresponding to different objectives and impacts of the system, and 'Use'.

So, the second layer includes value measures concerning the effectiveness of the IS under evaluation, while the first layer includes value measures concerning its efficiency.

Each of these seven value dimensions is elaborated into a number of more detailed items/value measures, which will be used for the assessment of it. For this purpose, for the four value dimensions of the first layer, and the 'Use' value dimension of the second layer, we can use the items/measures (evaluation criteria) developed for these dimensions in the previous research that has been conducted based on the DeLone and McLean's IS success model (see reviews of this research in DeLone & McLean, 2016; Jeyaraj, 2020; Petter et al., 2008; Urbach & Mueller, 2012), which have been mentioned in Sect. 2.1, as well as adaptations of them to the specific digital governance IS under evaluation. The elaboration of the 'Objectives Accomplishment/Impacts' value dimension into a number of more detailed items/value measures, which will be used for its assessment, will be based on the public value theory (outlined in Sect. 2.2). In particular, for this purpose we can be based: on the one hand on the specific objectives of the IS under evaluation, which correspond to some public values it is intended to promote; and on the other hand on other possible impacts (positive or negative ones, not initially intended) that this IS might have on some other public values (e.g. a digital governance IS based on artificial intelligence may have been developed aiming at efficiency-related objectives, but at the same time might have negative impact on decisions' transparency). For this we can use the existing lists and typologies of public values (such as the ones discussed in Sect. 2.2—see Kernaghan, 2003; Rose et al., 2015), or even of the specific public values that can be impacted/generated by digital technologies and digital governance IS according to relevant previous research (such as the ones discussed in Sect. 2.2—see Bannister & Connolly, 2014; Rose et al., 2015; Twizeyimana & Andersson, 2019). These lists and typologies of public values can be used in order to identify public values that might be impacted/generated by the specific digital governance IS under evaluation, and based on them define corresponding items/value measures for elaborating/assessing the 'Objectives Accomplishment/Impacts' value dimension(s).

For the above value dimensions and measures of these two layers we are interested not only in their average ratings by the users, but also in the associations among them, and especially in the associations of the value dimensions and measures of the first layer with the ones of the second layer, shown by the arrows of the structure of the value flow model in Fig. 1, since they quantify the effects of the former on the latter. These associations are quite useful as they enable:

(a) A deeper understanding of the value generation and flow mechanisms of the specific digital governance IS: how different types of value of one layer (efficiency-oriented) is transformed to different types of value of a higher layer (effectiveness-oriented).
(b) The identification and prioritization of required improvements in system capabilities, characteristics and services of the first layer, based on their average

ratings by the users, as well as their effect on the accomplishment of objectives of the IS, and its impacts on various public values in general, of the second layer (that constitute a higher level of value generation), as well as on the extent of use of the IS (if it not mandatory). High priority should be assigned to the improvement of system capabilities, characteristics and services receiving low ratings by the users and at the same time having large effects on higher level value generation.

3.2 Detailed Steps

In particular, the proposed methodology for the evaluation and improvement of digital governance IS consists of the following steps:

Step 1: Initially, the basic structure of the value flow model shown in Fig. 1 is specified and elaborated for the specific IS under evaluation: for each of the seven (or more) value dimensions detailed items/value measures are defined, as described above; it should be noted that if there are different groups of users of the IS, having different objectives as well as access to different capabilities/functionalities of it, it is necessary to specify a different value flow model for each users' group.
Step 2: An evaluation questionnaire is developed based on the above value dimensions and items/value measures of each of them defined in step 1; it includes one section for each value dimension with questions corresponding to its individual items/value measures. This questionnaire is filled by users of the IS.
Step 3: The first step of processing of these evaluation data collected from users aims to investigate the internal consistency of the individual items/value measures of each value dimension, through the calculation of the Cronbach alpha internal integrity index of the value dimension, based on its items/value measures. If Cronbach alpha > 0.7 we can conclude that there is acceptable level of internal consistency of the items/value measures of the value dimension; if this does not happen, we might have to remove some of the items/value measures, or even to break this value dimension into two or more value dimensions.
Step 4: Average user ratings are calculated for each individual item/value measure, then for each of the above value dimensions, and finally for each of the two layers of the value model. This allows the identification of strengths and weaknesses of the IS at different levels of detail: at the level of individual item/value measure, value dimension and value layer.
Step 5: Then regression models are estimated in order to determine the extent to which the second layer value dimensions are affected by the first layer ones. In particular, a regression model for each value dimension variable of the second layer (=average of corresponding items/value measure) a regression model is estimated, having as independent variables the value dimension variables of the first levels. For each of these regressions the coefficient R^2 is examined: if these $R^2 > 0.5$, then we can conclude that the value flow model is characterized by satisfactory coherence among its layers (i.e. the second layer value dimensions

are explained to a satisfactory extent by the ones of the first layer), and therefore we can move on to the next steps. On the contrary, if the second layer value dimensions are only to a limited extent affected by the ones of the first layer, this indicates that probably some significant value dimensions may have been omitted from the first layer, and we should return to step 1 to re-specify the value flow model of the IS under evaluation.

Step 6: For each value dimension of the first layer, we estimate its effect on the value dimensions of the second layer. We can use for this purpose the bi coefficients of the above regressions, but due to possible multi-collinearity (i.e. high level of correlation between independent variables—see Greene (2018) for more details) these bi coefficients might not be reliable estimates of the effects of the independent variables (first layer value dimensions) on the dependent ones (second layer value dimensions); so it is better to calculate the correlations (e.g. the Pearson's correlation coefficients) of each of the value dimensions of the first layer with all the second layer ones. In this way, a second set of results is calculated that quantify the importance of the value dimensions of first layer for second layer ones, as mentioned above correspond to higher levels' value generation.

Step 7: By combining the results of step 4 and 6 a basic value flow model of the IS under evaluation is constructed, having the structure shown in Fig. 1, which includes for the 'nodes' (value dimensions) the calculated (in step 4) average ratings of them by the users, which quantify the magnitudes of the various types of value generated by the IS; and for the 'arrows' (relationships—effects) the above calculated (in step 6) correlations.

Step 8: The first layer value dimensions (corresponding to system capabilities, characteristics and services, which are independent variables (i.e. on which we can directly intervene and make improvements), are classified into four groups, based on the one hand on their average ratings by the users (from step 4), and on the other hand on the effect they have on the value dimensions of the second layer (i.e. on higher level value generation) (quantified through the correlations of step 6): higher rating—higher effect, higher rating—lower effect, lower rating—higher impact, lower effect—lower effect. The highest priority should be assigned to the improvement of the value dimensions (characteristics, capabilities, services) of the third group, which received low ratings by the users and had a high effect on the generation of higher-level value generation. On the other hand, the lowest priority should be assigned to the improvement of the value dimensions of the second group, which received high ratings by the users and yet had a low effect on the generation of higher-level value. Medium priority should be given to improving the value dimensions of the first and fourth groups.

Step 9: Finally, the steps 6, 7 and 8 are repeated at the level of the individual items/value measures of our value dimensions. This allows the creation of a more detailed value flow model than the basic one created in step 7, and also a similar classification of the individual items/value measures of the first layer, which correspond to more specific system capabilities, characteristics and services, leading to a more detailed identification and prioritization of specific improvements to be made. In particular, these first layer value items/measures are classified on the basis of their average ratings by the users and their average effects on the second layer items/value measures. This allows us to identify individual first layer items/value measures (corresponding to more specific system capabilities and services) that receive low ratings from users and at the same time have high effect on the second layer items/value measures, which should be given the highest priority for improvement.

4 Applications

In this section are briefly presented two examples of application of the methodology described in the previous section: the first one concerns an IS supporting the operations of the Greek 'Local School Committees', which aims to increase their efficiency; the second one concerns an advanced 'second-generation' open government data infrastructure, developed as part of a European project, which aims to promote and generate a wider range of public values.

4.1 Local School Committees Information System

The Local School Committees (LSC), according to Greek legislation, are responsible for the management of all government funding for the operation of all the primary and secondary schools of a specific geo-graphical area, as well as for the management of all other income of them (e.g. from school canteens, farms owned by schools, etc.). These financial resources are used for covering all kinds of schools' operating expenses (e.g. for lighting, heating, water supply, sewer, telephone services, consumables, cleaning, buildings and equipment repair and maintenance, etc.), as well as required purchases (e.g. equipment, materials, books, etc.). For the above purposes LSC have to make numerous procurements, contracts, payments, as well as book-keeping and reporting, following the relevant complex public sector financial management and procurement regulations. In order to support all these activities of LSC an IS has been developed, which is offered to all LSC of Greece as cloud SaaS; the main objective of this IS is the improvement of the efficiency of the LSC.

In order to evaluate this IS, and also identify and prioritize improvements of it, we initially specified the structure of a value flow model of it, which is shown in Fig. 2. We can see that it includes three value dimensions in its first layer, and two value dimensions in its second layer (i.e. a subset of the ones of the general value flow model structure shown in Fig. 1). Furthermore, it has an additional third layer, which includes one value dimension, users' future behavior with respect to the use of the system [based on the 'intention to use' of the Technology Acceptance Model (TAM) (Davis, 1989; Turner et al., 2010)]. Each of these six value measures has been elaborated into a number of items/value measures to be used for its assessment, based on the capabilities and the information provided by the IS, the services provided to

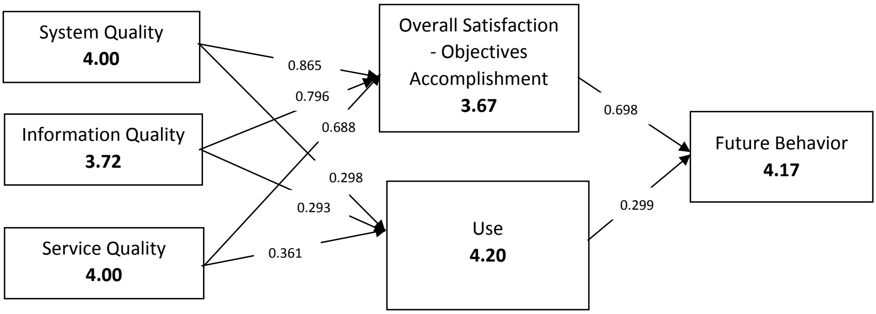

Fig. 2 Value flow model of the local school committees IS

its users, as well as its main objectives, which are shown in Appendix 1. These items were used for the development of a questionnaire, which was sent to all 122 LSC of Greece, and 100 completed questionnaires were received (response rate 82%). Each of the abovementioned items of Appendix 1 is a statement about this LSC IS, so the respondents were asked to answer to what extent he/she agrees to each of them in a five levels Likert-type scale (where 1 = not at all, 2 = to a small extent, 3 = to a moderate extent, 4 = to a large extent, 5 = to a very large extent). Based on these collected evaluation data the value flow model of the LSC IS was estimated and the results are shown in Fig. 2 (for each value dimension we can see its average rating, and on each arrow we can see the Pearson's correlation coefficient between the value dimensions it connects—all of them are statistically significant at the 5% level).

We remark that users find the system quality and the service quality good (average rating 4.0), while lower is their perception for information quality (moderate to good—average rating 3.72). The overall satisfaction of the users from the LSC IS and the support they receive for accomplishing the main objectives of the LSC are moderate to good (average rating 3.67), though the extent of using it is high (average rating 4.2). Finally, their future behavior intentions with respect to this LSC IS seem to be good (average rating 4.17). Also, we remark that the overall satisfaction—objectives accomplishment have quite high correlations with the three first level value dimensions (stronger with system quality, indicating that they are affected most by the functionality provided by the LSC IS); on the contrary, the use of it has much smaller correlations with the three first level value dimensions (stronger with service quality). In Table 1 we can see the 40 first layer items/value measures divided into two groups based on their average user ratings (in the right cell we can see the top 20 items/value measures in terms of average user ratings, and in the left cell the bottom

Table 1 Classification of first layer value measures based on average rating

1.21	**3.83**	**4.46**
1.4, 1.8, 1.9, 1.10, 1.14, 1.15, 1.16, 1.17, 1.19, 1.22, 1.23, 1.24, 1.25, 1.26, 1.27, 2.2, 2.3, 2.4, 3.1, 3.2		1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 1.11, 1.12, 1.13, 1.18, 1.20, 1.21, 1.28, 1.29, 2.1, 2.5, 3.3, 3.4, 3.5, 3.6

Table 2 Classification of first layer value measures based on average correlation with higher layers' value measures

0.000 **0.340**	**0.501**
1.3, 1.4, 1.8, 1.10, 1.11, 1.13, 1.16, 1.17, 1.19, 1.20, 1.21, 1.23, 1.24, 1.25, 1.26, 1.27, 1.28, 1.29, 3.4, 3.6	1.1, 1.2, 1.5, 1.6, 1.7, 1.9, 1.12, 1.14, 1.15, 1.18, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 3.1, 3.2, 3.3, 3.5

Table 3 First layer value measures with the highest priority for improvement

1.14	It offers full support for procurement—vendor management
1.15	It offers full support for school canteens management
1.22	It can produce automatically the required formal annual financial reports according to relevant legislation
2.2	It can create all the necessary reports—statements that have to be submitted to other government organizations in an appropriate form
2.3	It enables customization of the reports in order to meet specialized needs of the users
2.4	The reports provided by LSC SaaS allow having a complete picture of all activities of the School Committee
3.1	Satisfactory training is provided to the users
3.2	The content of this training was appropriate and complete

20 ones); in Table 2 we can see the same 40 first layer items/value measures divided into two groups based on their average correlations with higher layers' items/value measures (in the right cell we can see the top 20 items/value measures in terms of average correlations with higher layers' items/value measures, and in the left cell the bottom 20 ones). Finally, in Table 3 we can see the first layer items/value measures (corresponding to specific system capabilities, characteristics, services) that have lower user ratings and at the same time higher correlations with (and therefore effects) on higher layers' items/value measures, so they have to be assigned the highest priority for improvement. More information about this application of the methodology is provided in Loukis and Leou (2019).

4.2 Second-Generation Open Government Data Infrastructure

The second generation of Open Government Data (OGD) infrastructures aims to eliminate the distinction between the 'passive' data users/consumers and the 'active' data producers, and provide support for highly active data users, who assess the quality of the data they use/consume, identify weaknesses of them as well as new needs for data they have, and also often become data 'pro-sumers' (both users/consumers and providers of data). In this direction, this second generation of OGD infrastructures increasingly offers to data users capabilities for commenting and rating datasets, and also for processing them in order to improve them, adapt them to their specialized needs, or link them to other datasets (public or private), and then uploading-publishing new versions of them, or even their own new datasets. Such a second-generation OGD infrastructure, which was developed as part of a European project, described in more detail in Zuiderwick et al. (2013), was evaluated using the methodology described in the previous section. The objective of this OGD infrastructure was to promote/generate a wider range of public values: transparency of government activity, economic development (facilitate new economic activity in the area of value-added e-services), scientific development (facilitate scientific research). For this purpose, we initially specified the structure of a value flow model of it, which is shown in Fig. 3.

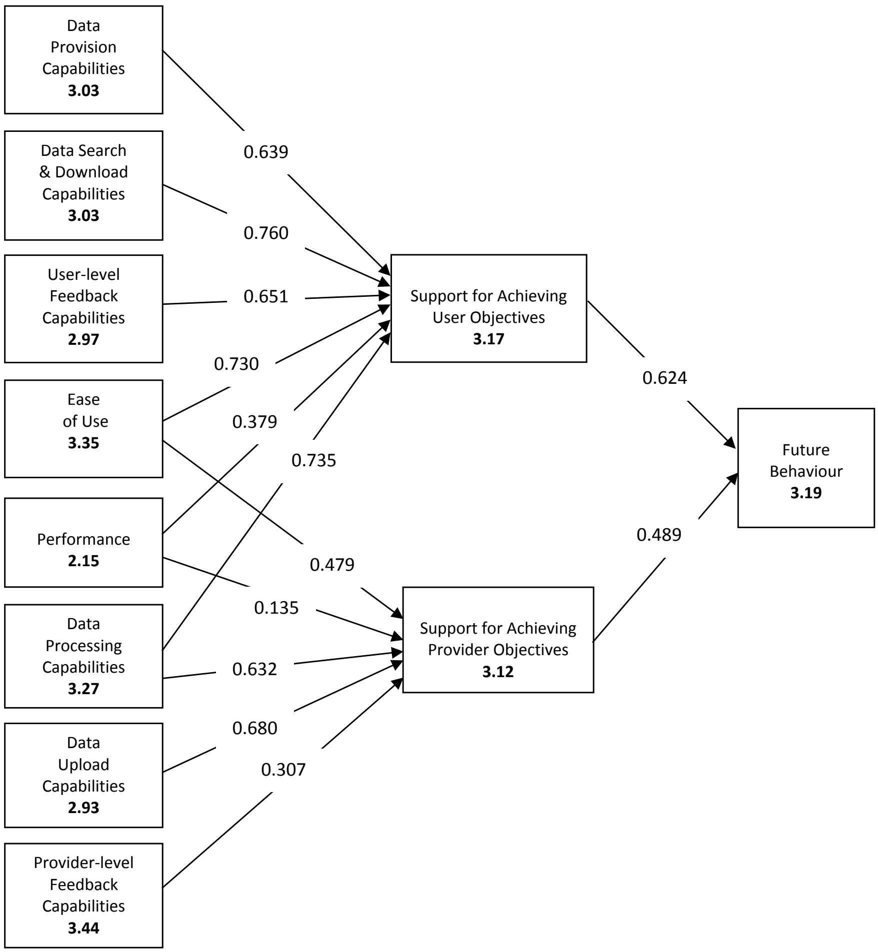

Fig. 3 Value flow model of OGD infrastructure

We can see that it includes eight value dimensions in its first layer. One of them concerns ‘information quality’ (i.e. the quality of the open data provided—‘Data Provision Capabilities’). The other seven value dimensions concern ‘system quality’: two of them concern data user capabilities (‘Data Search & Download Capabilities’ and ‘User-level Feedback Capabilities’), two concern data provider capabilities (‘Data Upload Capabilities’ and ‘Provider-level Feedback Capabilities’) and one concerns a set of capabilities for both data users and providers (‘Data Processing Capabilities’). Also, there is one value measure concerning technical quality (‘Performance’) and another one concerning ease of use. In the second layer there are two value dimensions concerning the support that the OGD infrastructure provides to data users and providers respectively for accomplishing their objectives. Finally, similarly with the previous application example, there is an additional third layer, which includes one value dimension, concerning the future behavior of the users with respect to the use of the OGD infrastructure. Each of the above 11 value measures has been elaborated into a number of items/value measures to be used for its assessment, based on the capabilities and the information provided by the IS, as well as its main objectives, which are shown in Appendix 2. A questionnaire was developed based on the above items/value measures (asking the respondents to answer to what extent he/she agrees to each of them in a five levels Likert-type scale, similarly with the previous application example). It was filled by 42 postgraduate students of the University of the Aegean (Greece) and the Delft University of Technology (The Netherlands) in the area of IS, who were trained in the capabilities offered by this OGD infrastructure, and then used it for implementing a representative scenario, which included both data user and data provider tasks. Based on the collected evaluation data the value flow model was estimated and the results are shown in Fig. 3 (for each value dimension we can see its average rating, and on each arrow we can see the Pearson’s correlation coefficient between the value dimensions it connects).

We remark that the users find the provider-level feedback capabilities (for collecting ratings and comments on the datasets they publish from their users), its ease-of use, and its data processing capabilities, between moderate and good (average ratings 3.44, 3.35 and 3.27 respectively). On the contrary, the users perceive the performance of the system (with respect to its availability, response time and bugs) as problematic (average rating 2.15). The remaining four first layer value dimensions (i.e. data provision, data search and download, capabilities for user-level feedback, and data upload) are regarded as moderate (average ratings 3.03, 3.03, 2.97 and 2.93 respectively). We remark that with respect to the support of user-level objectives by the OGD infrastructure, the data search and download capabilities, the data processing capabilities, the ease of use and the user-level feedback capabilities have high correlations on it (0.760, 0.735, 0.730 and 0.651 respectively), while the performance has lower correlation with it (0.379). With respect to the support of provider-level objectives by the OGD infrastructure, we can see that the data upload and the data processing capabilities have high correlations on it (0.680 and 0.632), while the performance has low correlation with it (0.135). Based on the above results the value model of this OGD infrastructure has been constructed and is shown in Fig. 3 (for each value dimension we can see its average rating, and on each arrow we can see

Table 4 Classification of first layer value dimensions based on average rating

Lower ratings group	Higher ratings group
Data provision capabilities, data search-download capabilities, data upload capabilities, performance	Provider-level feedback capabilities, ease of use, data processing capabilities user-level feedback capabilities

Table 5 Classification of first layer value dimensions based on average correlation with higher layers' value dimensions

Lower correlations group	Higher correlations group
Data provision capabilities, user-level feedback capabilities, performance, provider-level feedback capabilities	Data processing capabilities, ease of use, data search-download capabilities, data upload capabilities

the Pearson's correlation coefficient between the value dimensions it connects—all of them are statistically significant at the 5% level).

In Table 4 we can see the classification of the first layer value dimensions based on their average user ratings into two groups (in the right cell we can see the top four ones in terms of average user rating, and in the left cell the bottom four ones); in Table 5 we can see their classification based on their average correlation with higher layers' value dimensions (in the right cell we can see the top four ones in terms of average correlations with higher layers' value dimensions, and in the left cell the bottom four ones). From these two classifications we can conclude that our highest priority should be given to the improvement of the data upload as well as the data search and download capabilities, which received low ratings from the users, and have high impact on higher layers' value generation. The same can be repeated at the more detailed level of the first layer value measures (in order to identify more detailed improvement priorities concerning specific capabilities/characteristics of this second generation OGD infrastructure). More information about this application of the methodology is provided in Charalabidis et al. (2014).

5 Conclusions

Due to the rapid evolution of the digital governance domain, which gives rise to the development of many different kinds of IS, aiming to support, enhance and transform various different functions of government agencies, having a wide variety of goals and objectives, and using both the established ICT, as well as various emerging disruptive ones, it is necessary to conduct comprehensive multi-dimensional evaluation of them; this evaluation should allow also proceeding to continuous improvement of them, in order to reach higher levels of maturity. Therefore, it is absolutely necessary the science base of the digital governance domain to include powerful public sector specific methodologies for the evaluation and improvement of the various kinds of digital governance IS; these methodologies should take into account and address the specificities of the public sector, and especially the wider range of objectives it has to pursuit and achieve, aiming to promote a wide range of public value. For this purpose, they should have sound theoretical foundations from private sector management research, as well as from public sector management research.

In this chapter has been presented a public sector specific methodology for the evaluation, and also the improvement, of different kinds of digital governance IS, based on a sound theoretical foundation from private sector management research, the information systems success models, and also a sound theoretical foundation from public sector management research, the public value theory. It enables a comprehensive assessment of the magnitudes of different types of value generated by a digital governance IS, as well as identifying and prioritizing the required improvements in specific characteristics and capabilities of them, as well as relevant services provided by their supporting personnel. Also, two first examples of application of this methodology have been presented, concerning an IS that supports the operations of the 'Local School Committees' of Greece, and also an advanced 'second-generation' OGD infrastructure developed as part of a European project.

Further research is required, initially for the application of this methodology for the evaluation and improvement of other kinds of digital governance IS, especially highly transformative IS (leading to big transformations of internal works and processes of government agencies, as well as their transactions, consultations and in general interactions with citizens), as well as technically advanced IS, which incorporate and exploit emerging 'disruptive' ICT (such as artificial intelligence, internet of things, big data, etc.). This will enable also improving the methodology itself, with respect to the structures of the value flow models it uses, as well as the processing steps it includes. Also, it would be interesting to investigate the combination of it with the use of qualitative techniques (e.g. interviews, focus groups) in order to identify different types of public values generated and in general impacted (positively or negatively), especially by novel and highly transformative types of digital governance IS, beyond their initially intended objectives (and possibly incorporate these additional public values impacted in the value flow model of the system, mainly in its second layer).

Appendix 1

Items/value measures of the value dimensions of the Local School Committees IS model

1. *System Quality*
   - 1.1 The LSC SaaS functions smoothly without interruptions or other problems.
   - 1.2 The LSC SaaS is fully reliable.

1.3 It can be accessed from any computer connected to the Internet, without need for installation of some software or other interventions.
1.4 It can be accessed through a variety of devices (desktop/laptop, mobile phone, PDA, etc.).
1.5 It offers a simple and user-friendly work environment.
1.6 It was to learn the use of its main capabilities.
1.7 The steps of the procedures of using it are easy.
1.8 It provides capabilities for storing, managing and searching all the documents required for the operation of a LSC.
1.9 It provides a complete set of template documents for facilitating the activities of the LSC (e.g. for procurement, contracts, payments, etc.).
1.10 It offers complete support for electronic protocol keeping.
1.11 It offers complete support for recording, monitoring and managing fixed assets and materials.
1.12 It offers complete support for the whole cycle of invoices' management.
1.13 It offers full support of human resources management.
1.14 It offers full support for procurement—vendor management.
1.15 It offers full support for school canteens management.
1.16 It offers complete support for the management of farms owned by the school units.
1.17 It provides capabilities for entry of requests by the school units and then management of them by the LSC.
1.18 It provides capabilities for entry and management of income and expenses for each school unit separately.
1.19 It enables batch entry, update and delete of data.
1.20 It provides capabilities for detailed monitoring of treasury in real time.
1.21 It can perform automated calculation of all possible taxes and deductions.
1.22 It can produce automatically the required formal annual financial reports according to relevant legislation.
1.23 It enables making electronic payments.
1.24 It provides sufficient capabilities for interaction—communication among the school units of a LSC in order to exchange information and knowledge (e.g. through forum, bulletin board, etc.).
1.25 It provides satisfactory capabilities for communication between the LSC and the school units under its supervision.
1.26 The LSC SaaS has interoperability with other relevant government information systems (e.g. payment systems, systems of insurance funds).
1.27 It has interconnection with the information system of the 'Youth and Lifelong Learning Foundation'.
1.28 It provides satisfactory security.
1.29 It is adapted rapidly to changes of relevant legislation concerning the operation of LSC.

2. *Information Quality*

2.1 The LSC SaaS provides useful, reliable and comprehensible reports.

2.2 It can create all the necessary reports—statements that have to be submitted to other government organizations in an appropriate form.
2.3 It enables customization of the reports in order to meet specialized needs of the users.
2.4 The reports provided by LSC SaaS allow having a complete picture of all activities of the School Committee.
2.5 The LSC SaaS provides complete and reliable information about the legislation concerning LSC operation as well as changes and evolution of it.

3. *Services Quality*

3.1 Satisfactory training is provided to the users.
3.2 The content of this training was appropriate and complete.
3.3 There are complete and understandable instructions about the use of this LSC SaaS.
3.4 Good and efficient support is provided concerning the use of the LSC SaaS (e.g. through e-mail, telephone, etc.).
3.5 Good and efficient support is provided concerning the use of the LSC SaaS (e.g. through call center, e-mail, etc.) about the relevant legislation concerning LSC operation.
3.6 There is quick response to users' requests for support.

4. *Use*

4.1 I use the LSC SaaS frequently for the LSC works.
4.2 I rely on it for performing LSC works.
4.3 I use all the capabilities provided by this LSC SaaS.

5. *Overall Satisfaction—Objectives Accomplishment*

5.1 Based on my whole experience with the LSC SaaS I am fully satisfied with it.
5.2 It completely fulfills my expectations.
5.3 All the electronic support requirements are covered by the capabilities provided by the LSC SaaS.
5.4 The use of it improves the efficiency and effectiveness of performing LSC works and activities.
5.5 The use of it saves time and money.
5.6 It is useful for performing the works and activities of the LSC.
5.7 The use of it eliminates the need for manual work.
5.8 For performing the works and activities of the SC in addition to the use of this LSC SaaS we also have external support (e.g. by an accounting).

6. *Future Behavior*

6.1 We intend to continue using the LSC SaaS in the future.
6.2 I would recommend it to other SC.

Appendix 2

Items/value measures of the value dimensions of the Open Government Data infrastructure model

1. *Data Provision Capabilities*

   1.1 The platform provides a large number of datasets.
   1.2 The platform provides datasets useful to me.
   1.3 The platform provides to me complete data with all required fields and detail.
   1.4 The platform provides accurate and reliable data on which I can rely for my studies.
   1.5 There are datasets from many different thematic areas (economy, health, education, etc.).
   1.6 There are datasets from many different countries.
   1.7 The platform provides sufficiently recent data.

2. *Data Search and Download Capabilities*

   2.1 The platform provides strong dataset search capabilities using different criteria.
   2.2 The platform provides several different categorizations of the available datasets, which assist significantly in finding the datasets I need.
   2.3 The platform enabled me to download datasets easily and efficiently.
   2.4 The datasets are in appropriate file/data formats that I can easily use.
   2.5 The datasets have also appropriate and sufficient metadata, which allowed me to understand these data and also how and for what purpose they were collected.
   2.6 The platform provides strong API for searching and downloading datasets (data and metadata).

3. *User-Level Feedback Capabilities*

   3.1 The platform provides good capabilities for giving feedback on the datasets I download, e.g. for rating datasets, for entering textual comments on them.
   3.2 The platform provides good capabilities for reading available feedback of other users of datasets I am interested in, e.g. ratings, comments.

4. *Ease of Use*

   4.1 The platform provides a user friendly and easy to use environment.
   4.2 It was easy to learn how to use the platform.
   4.3 The web pages look attractive.
   4.4 It is easy to perform the tasks I want in a small number of steps.
   4.5 The platform allows me to work in my own language.

4.6 The platform supports user account creation in order to personalize views and information shown.
4.7 The platform provides high quality of documentation and online help.

5. *Performance*

5.1 The platform is always up and available without any interruptions.
5.2 Services and pages are loaded quickly.
5.3 I did not realize any bugs while using the platform.

6. *Data Processing Capabilities*

6.1 The platform provides good capabilities for data enrichment (i.e. adding new elements—fields).
6.2 The platform provides good capabilities for data cleansing (i.e. detecting and correcting ubiquities in a dataset).
6.3 The platform provides good capabilities for linking datasets.
6.4 The platform provides good capabilities for visualization of datasets.

7. *Data Upload Capabilities*

7.1 The platform enabled me to upload datasets easily and efficiently.
7.2 The platform enabled me to prepare and add the metadata for the datasets I uploaded easily and efficiently.
7.3 The platform provides good capabilities for the automated creation of metadata.
7.4 The platform provides good capabilities for converting datasets' initial metadata in the metadata model of the platform easily and efficiently.
7.5 The platform provides strong API for uploading datasets (data and metadata).

8. *Provider-Level Feedback Capabilities*

8.1 The platform allows me to collect user ratings and comments on the datasets I publish.

9. *Support for Achieving User-Level Objectives*

9.1 I think that using this platform enables me to do better research/inquiry and accomplish it more quickly.
9.2 This platform allows drawing interesting conclusions on past government activity.
9.3 This platform allows creating successful added-value electronic services.

10. *Support for Achieving Provider-Level Objectives*

10.1 The platform enables opening and widely publishing datasets with low effort and cost.

11. *Future Behavior*

11.1 I would like to use this platform again.
11.2 I will recommend this platform to colleagues.

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Understanding the Impact of Public Policy Context on the Implementation Orientation for the Digital Transformation of Interoperable Public Services

Raul M. Abril and Joep Crompvoets

Abstract The orientation of how to implement digital public services is a relevant subject. Anecdotal evidence indicates that a wrong orientation for the implementation is a root cause for failing digital public services. Therefore, it is important to understand the impact of implementation choices in the digitalisation of public services. This is a relevant subject in digital governance. However, current knowledge about this impact is still very limited. This chapter aims to fill this gap by focussing on interoperable digital public services. In this context, the IDPSIO model is developed to provide help understanding the implementation impact from different angles. The development of the model is based on the review of relevant theories and key concepts related to public policy context, interoperability and implementation orientations. IDPSIO stands for interoperable digital public services implementation orientation. This model recognises four implementation orientations for the digitalisation of interoperable public services: integration, technology, governance, and legal. The model has been applied and tested in ten interoperable digital public services across the European Union (EU) as case studies. The main findings are that the impact of the implementation orientation of interoperable digital public services can be theorised, and the chosen implementation orientation has a significant impact.

Keywords Public services · Digital governance · Public policy · Interoperability · Implementation orientation

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1 Introduction

Public administrations realise public policies, among other ways, by the provision of public services (Thijs et al., 2017). Røhnebæk and Strokosch (2019) conclude that there is a knowledge gap in the existing literature in understanding the impact of public service processes. The main goal of this chapter is to posit a theory for explaining how and why choices are made on the implementation orientation for the digitalisation of interoperable public services. The decision-making process of the implementation orientation is a research phenomenon of relevance for several reasons. One of them is that public administrations are under increasing collaboration needs. This implies interoperability requirements[1] for the digitalisation of public services. Another reason is that public administrations are under high performance expectations that require the provision of public services of public value. Furthermore, public administrations have a political agenda including public policy goals to be attained and digital public services are instrumental in supporting it. Digital public services are essentially ICT solutions, and it is suggested they should be managed as that (European Commission, 2019c; Kubicek et al., 2011).

The process resulting in an operational ICT solution is known as implementation (Pressman & Maxim, 2014). It has a life cycle consisting of different phases, depending of the selected paradigm, like analysis, design, development, and testing (Pressman & Maxim, 2014).

Implementation orientation is the focus/anchor that the implementation will follow. It should be highlighted that, in general, there are alternative implementation orientations potentially available for selection to management information systems (MIS) decision makers.

The resource-based managerial capabilities paradigm[2] advocates for choosing the implementation orientation among alternative ICT resources managerial capabilities (Bakara et al., 2016). Examples of resource-based implementation orientation are the integration orientation (Marchand et al., 2000), the technology orientation (Marchand et al., 2000), the governance orientation (Marchand et al., 2000), and the legal orientation (Santosuossa & Malerba, 2014).

It is recognised that the substance of all the above orientations needs to be met. This means that, indeed, the implementation covers the data resources, ICT resources, governance resources, and legal and regulatory framework. All of them play the role of constraints configuring a complex system of interrelations between them. Variations in one of the constraints will influence the other. Each implementation orientation implies a competitive alternative with respect of the rest.

[1] Interoperability is the ability of organisations to interact towards mutually beneficial objectives, involving the sharing of information and knowledge between these organisations, through the business processes they support, by means of the exchange of data between their ICT systems (European Commission, 2017).

[2] Examples of other perspectives are life cycle-based paradigm like ADM (The Open Group, 2018) and quality-based paradigm like model-driven architecture.

Best design IS practices suggest managing competitive orientations by "trading" them (Atkinson, 1999). This implies to use an anchoring management perspective to select an interoperability orientation for the digitalisation of public services and, later, to adjust the other interoperability aspects to the selected orientation (Tversky & Kahneman, 1974). For example, if a public administration CIO selects that in the taxes public policy area, the implementation orientation is to be semantic driven (i.e. base registries first), then taxes-related digital public services needs to be implemented taking into consideration this orientation as the entry point and later taking into consideration the legal, organisational, and technological aspects.

These decisions are not made in isolation. The alignment between organisational structure and strategic decisions has been extensively studied in the management literature (Henderson & Venkatraman, 1999; Wang, 2014). Therefore, it seems reasonable to expect that the organisational context of public administrations influences implementation orientation decisions.

In summary, digital public services implementation is an instance of organisational change through the implementation of ICT (Lindgren & Jansson, 2013). In this context, the implementation orientation is an outcome of a decision-making process contingent of the organisational context (Henderson & Venkatraman, 1989) to attain public policy goals (Stewart et al., 2007).

This chapter aims to contribute to address the knowledge gap in the existing literature on theorising the impact of digital public service processes as identified by Røhnebæk and Strokosch (2019). We focus on the decision-making process for the choice of an implementation orientation for the digitalisation of interoperable public services. We argue that the resulting digital public services might be different depending on the implementation orientation selected. Therefore, our context bound research question to understand the former impact it is:

How does public policy context influence the interoperable digital public services implementation orientation?

Arguably, it is also relevant the theoretical contribution of this chapter providing decision-making support to choose the implementation orientation between competitive digitalisation alternatives.

In order to answer our research question, the chapter is structured in the following way. Section 2 introduces the key concepts dealing with public policies, interoperability, and digital public services implementation. Section 3 presents our theory building research, and Sect. 4 presents the findings of a limited confirmatory research. In Sect. 5, we present a discussion on the conducted research. Finally, Sect. 6 presents the main conclusions.

2 Key Concepts

The nature of our research question is covered by the concepts on e-government (Yildiz, 2007). These concepts are generally characterised by competing influences from public administration, information systems (Scholl, 2007), and other adjacent disciplines like interoperability, and digital public services implementation. In the following three subsections, we summarise the key concepts as far it concerns to our research question.

2.1 Public Policy Context

A public policy (i.e. on dependent seniors, on inheritances, on legal entities identification, etc.) generally belongs to a public policy area (i.e. health, taxes and customs, modernisation of public administration/digitalisation, etc.). By delegation of powers, we consider the extent that a public administration delegates, sharing included, the provision of public services to other administrative tiers in the concerned public policy (Treisman, 2007). Delegation of powers is a substantial aspect of the configuration of any public administration. In this research, we will limit the delegation of powers construct to the provision of digital public services. This construct is contingent to a public policy. A public administration might have a low delegation of powers in terms of taxes and a high delegation of powers in terms of health. Delegation of powers has nothing to do with the state structure being federal or unitary. Assuming a theoretical continuum of degrees of delegation of powers, we could set a range from a highly centralised public administration, with a limited delegation of powers, to a highly delegated public administration with an extensive delegation of powers. France is an example of a centralisation of powers (Thijs et al., 2017), and Spain is an example of an extensive delegation of powers.

Given that there is substantial literature supporting the influence of organisational structure in decision-making (Stocker & Evans, 2016; Venkatraman, 1989) and implementation of digital public services (Wise, 1990), we find strong support to the argument that delegation of powers needs to be considered selecting an implementation orientation for the digitalisation of interoperable public services.

By regulatory state (Moran, 2002), we consider the level of granularity of the requirements (Liskin et al., 2014) in the legislation corpus of the concerned public policy.[3] Regulatory state is a complex construct. In this research, we will limit the regulatory state construct to the level of granularity of the requirements contained in the legislative acts that are of interest for the provision of (interoperable) digital public services. This construct is contingent to a public policy. A national public administration might have a different regulatory state in the food area than in the

[3] Likewise, we consider that there are no alternative enactments of requirements from the sensemaking process of interpreting the information in a legal act (Daft & Weick, 1984) by different individuals.

cadastral area. We consider the two following levels of granularity for the requirements in the legislation, high level and detailed level. High-level regulatory state contains generic/abstract functional requirements like principles and/or recommendations with considerable degrees for transposition/execution and of not binding nature.[4] On the other side, the detailed-level regulatory state implies a limited degree for transposition/execution, and it contains specific/concrete functionalities requirements, solution components, data, procedures, and/or technical specifications or standards to be used (Liskin et al. 2014).[5] The European Interoperability Framework (European Commission, 2017) is an example of high-level regulatory state, and the European Single Procurement Document legislation (European Commission, 2016) is an example of a detailed-level regulatory state. It is interesting to observe that the EU has published guidelines for drafting legislation relating the granularity of the requirements to the binding nature of the legislation. For example, "*(directives) … are drafted in a less detailed manner in order to leave Member States sufficient discretion when transposing them. If the enacting terms are too detailed and do not leave such discretion, the appropriate instrument is a regulation, rather than a directive*" (European Union, 2015).

Given that there is substantial literature supporting the influence of requirements in decision-making (Kotter, 2010) and IT implementation (Nielsen and Pedersen, 2014), we find strong support to the argument that regulatory state needs to be considered selecting an implementation orientation for the digitalisation of public services.

The dominant paradigm in the provision of public services is characterised by the quality criteria (European Commission, 2018a; Van Dooren et al., 2010). In this sense, digitalisation of public services is considered a critical aspect for the modernisation of public administrations and strongly supported by political will (EU2017.EE, 2017).

A public service is provisioned by, or on behalf of, a public administration in fulfilment of a public policy servicing to a user either citizen, business, or another public administration. Digital public services need to fulfil seamlessly public policy convergence.[6] The question on how to do it is fundamental (Stocker & Evans, 2016). Following Knill (2005), this can be achieved by implementing interoperable digital public services with convergence anchors, meaning instruments enabling peer-to-peer collaboration across the tiers of the concerned public administration and with third (cross-border) public administrations in support of the cohesion on the achievement of the public policy goals. We relate public policy convergence to the concept of government horizontal integration (Scholl & Klischewski, 2007).

[4] Generally, this type of legal texts is labelled as soft law with a coordination motivation (Guzman & Meyer, 2010).

[5] Generally, this type of legal texts takes the form of hard law.

[6] Cohesion on the achievement of the public policy goals across the tiers of the concerned public administration.

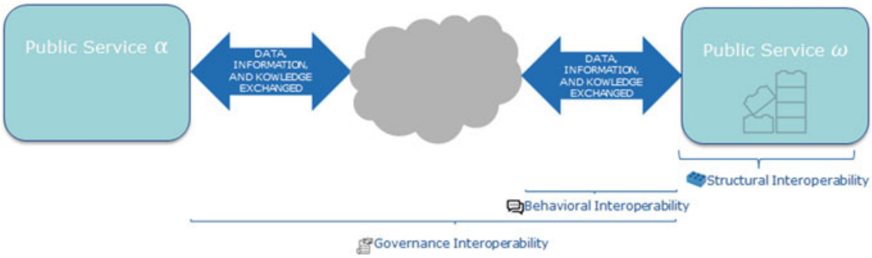

Fig. 1 Multidimensional nature of interoperability in digital public services

2.2 *Interoperability Requirement for the Digitalisation of Public Services*

Digital public services[7] are arguably considered the dominant paradigm in service delivery modes when digitalisation is an alternative, in occasions, to the limit of considering digital first in the implementation of public services (European Commission, 2019a, 2019b, 2019c).

Digital public services need to be interoperable (European Commission, 2017). Interoperability is a requirement to effectively implement electronic government (Sundberg, 2018) and a top priority for public administrations (Hellberg & Grönlund, 2013).

Studies have progressively added understanding on the interoperability construct moving from a technical only perspective, with Clark's work (1997) as the seminal paper on technical interoperability, to an holistic approach adding legal, organisational, semantic, and technological perspectives as equally important (European Commission, 2017). This multiple perspectives approach means that there is no prevalent interoperability requirement over the other. According to Abril and Pignatelli (2019), interoperability in digital public services is a dimensional construct with three first-order dimensions (structural interoperability, behavioural interoperability, and governance interoperability—see Fig. 1) and four second-order dimensions (legal, organisational, semantic, and technological interoperability—European Commission, 2017) per each first-order dimension.

Knowing the multidimensional nature of interoperability in digital public services, the question comes to what makes interoperable a digital public service? According to European Parliament and Council of the EU (2015), a key interoperability enabler is a resource substantially contributing to the saliency of interoperability in a digital public service.

Some key interoperability enablers play a role as convergence anchors. The power of a convergence anchor is the degree of support to achieve the goals of the concerned public policy. We argue that such power is contingent to a given context. This means

[7] A digital public service is a public service provisioned through a digital service delivery model. See http://data.europa.eu/dr8/ServiceDeliveryModel in European Commission (2019c).

that a given key interoperability enabler might have different convergence anchor power in different contexts. The following key interoperability enablers are of interest in this chapter due to their convergence power:

- Shared legal frameworks as identified in Santosuosso and Malerba (2014). Their convergence anchor influence is based on their legally binding nature (Knill, 2005).
- Shared governance frameworks as identified in Weill and Woodham (2002), Hellberg and Grönlund (2013), and Kubicek et al. (2011). Their convergence anchor influence is based on their functioning impact via communication and harmonisation (Knill, 2005).
- Shared knowledge bases as identified in Choo (1998) and Tanriverdi (2005). Open government data platforms are a special form of shared knowledge bases (Danneels et al., 2017). Their convergence anchor influence is based on their sense-making nature (Weick, 1979) influencing the enactment of common understanding from the existing organisational information (Abril, 2010).
- Shared platforms of ICT resources as identified in European Commission (2017) and Fichman and Kemerer (2001). Their convergence anchor influence is based on the impact of the availability of common problem-solving instruments (Knill, 2005).

2.3 The Choice of the Implementation Orientation for the Digitalisation of Interoperable Public Services. A Digital Governance Challenge

Even though implementation orientation is a theme in the MIS literature, and digital public services are essentially ICT solutions, implementation orientation has been neglected in e-government research.

Implementation of digital public services is an instance of organisational change (Lindgren & Jansson, 2013). Implementation orientation is the focus/anchor selected for the implementation aligning any other aspect to this focus/anchor (Marchand et al., 2000; Santosuosso & Malerba, 2014). This orientation is an outcome of a decision-making, among several alternative choices, contingent to the organisational context (Henderson & Venkatraman, 1989) to attain public policy goals (Stewart et al., 2007).

The alternative implementation orientations for the digitalisation of interoperable public services considered in our research are integration orientation, technology orientation, governance orientation, and legal orientation.

The integration orientation is characterised by a focus/anchor on data resources and on information management capabilities to manage information resources over their life cycle (i.e. scanning, collecting, organising, processing, maintaining, etc.) to understand societal needs, to embed data throughout the policy cycle, and to develop a culture of data analytics (OECD, 2018).

The technical orientation (Marchand et al., 2000) is characterised by a focus/anchor on ICT resources like solutions and infrastructure and on ICT management capabilities to manage the provision of services (i.e. business operations, decision-making, internal support, etc.) to users and the consumption of services by ministries and agencies (OECD, 2018).

The governance orientation (Marchand et al., 2000) is characterised by a focus/anchor on the governance resources (Grant et al., 2007) and on governance management capabilities/archetypes to manage the effective use of information (i.e. sharing, security, privacy, etc.).[8]

The legal orientation (Santosuossa & Malerba, 2014) is characterised by a focus/anchor on legal and regulatory frameworks based on displayed leadership and political commitment to ensure adaptation to rapidly changing technological and diverse social environments with high-level requirements to achieve coherence and effective support to digital public services implementation (OECD, 2018).

3 Theory Building Research

As stated in the introduction, the main goal of this chapter is to posit a theory for explaining how and why choices are made on the implementation orientation for the digitalisation of interoperable public services. The decision-making process resulting in such choice is the phenomenon of focus in the research presented in this chapter (Weber, 2012). Scholars have addressed the relevant topic on what constitutes theory and what is not in both the MIS domain (Gregor, 2006; Weber, 2012) and in the organisations domain (Sutton & Staw, 1995). Our research is primarily of theory building nature as it builds theory since it expands the strategic alignment theoretical framework in the public policy domain. The research adds an innovative theoretical perspective explaining the relationship between public policy context and implementation orientation for the digitalisation of interoperable public services. Following Weber (2012), the theory is presented in terms of constructs, model, and boundary.

It should be noted that although our research is deductive in nature and based on Henderson and Venkatraman (1989), it was created in 2015 in the context of the efforts of the European Commission (EC) supporting interoperability in the digitalisation of European public administrations (EU2017.EE, 2017; European Commission, 2017) in order to avoid cross-borders barriers to the single digital market across the Member States in the EU. Never before formally published, recent relevant literature has been considered to illustrate the main aspects of this theory.

[8] The motivation is to achieve a more agile, effective, and digitally inclusive public engagement, to increase trust in government, and to enhance government transparency (OECD, 2018; Weill & Woodham, 2002).

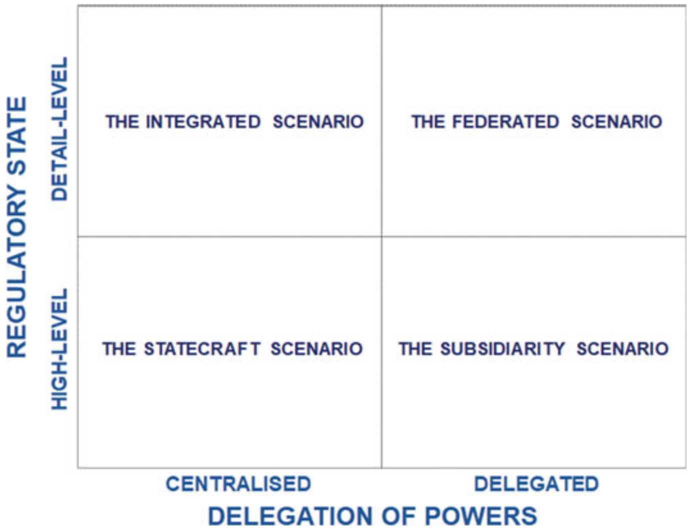

Fig. 2 Context for the interoperable digital public services implementation orientation

3.1 Theory Constructs

The theory covers regulatory state, delegation of powers, and implementation orientation constructs. Based on the concepts presented in the previous section, delegation of powers and regulatory state are relevant to characterise the context for a given public policy regarding digital public services.

There is wide theoretical consensus, although not extensive evidence from research that the configuration of the organisation[9] of a public administration is relevant for the way that the provision of public services is implemented (Wise, 1990).

Likewise, there is overwhelming support in the literature to the concept that (quality) requirements[10] are critical for the implementation orientation of a solution[11] to a given problem (Dick et al., 2017).

Four scenarios emerge by considering the combinations of the upper and lower values in the ranges of values for delegation of powers and regulatory state relevant to characterise the context for a given public policy (see Fig. 2).[12] The concept of

[9] We have mentioned that delegation of powers is a consubstantial aspect of the configuration of any public administration being delegation of powers the extent that a public administration delegates the provision of public services to other administrative tiers in the concerned digital public services.

[10] We have stated that regulatory state construct is the level of granularity of the legal requirements contained in the legislative acts that are of interest for the provision of [interoperable] digital public services.

[11] We have commented that we consider (digital) public services as a solution (Dick et al., 2017).

[12] It is worthy to remind that in each scenario, there is a hierarchy of public administration tiers.

scenario for public policy set up, implementation, and research has been suggested by Stocker and Evans (2016).

Each scenario has the following configuration: a name and a description of the context in terms of delegation of powers and regulatory state. The covered organisational scope in a scenario includes the concerned public administration's tier in a hierarchical structure of administrative tiers and the hierarchically dependent tiers.

The four scenarios are the subsidiarity scenario, the integrated scenario, the federated scenario, and the statecraft scenario.

In the **subsidiarity scenario**, the concerned public administration serves a given public policy area in a context characterised by a high delegation of powers and by a high-level regulatory state. Here, the basic principle is to leave to the lower tiers what can be better done at these levels for the achievement of the public policy goals (European Parliament and Council of the European Union, 2008). What can be done in this scenario is constrained by what effectively is done in the lower tiers. For example, in the subsidiarity scenario, there is a lot of resistance by the lower tiers of public administrations to share their data resources (i.e. centralisation of data is not an option). So, it is very challenging reaching organisational agreements due to the complexity of the organisation.

In the **integrated scenario**, the concerned public administration serves a given public policy area in a context characterised by a limited delegation of powers and by a detailed-level regulatory state. This scenario is the opposed to the subsidiarity scenario. Here, the basic principle is to avoid ambiguity with the least possible margin for different interpretations in any aspect concerned to the achievement of the public policy goals. In this scenario, organisational information and organisational knowledge in the sense studied in Abril (2010) play a key role while individual's information and individual's knowledge are perceived as sources of potential ambiguity.

In the **federated scenario**, the concerned public administration serves a given public policy area in a context characterised by a high delegation of powers and by a detailed-level regulatory state. Here, the basic principle is to respect the organisational architecture between the different public administration tiers (Law, 2013). Therefore, this scenario implies the creation of an intermediation/brokering tier supporting direct peer-to-peer communication supporting the achievement of the public policy goals.

In **the statecraft scenario**, the concerned public administration serves a given public policy area in a context characterised by a limited delegation of powers and by a high-level regulatory state. This scenario is the opposed to the federated scenario. Here, the basic principle is that public services implementation is a craft activity pursuing strategic alignment with public policy goals identified in the top tier (Bulpitt, 1986).

3.2 Theoretical Model

According to Stocker and Evans (2016), the public policy context directs choices. Based on Lindquist and Wanna (2015) and Stocker and Evans (2016), we formulate the following research hypothesis:

> *The context of a public policy defined in terms of regulatory state and delegation of powers requires a given interoperable digital public services implementation orientation*

In this research hypothesis, delegation of powers and regulatory state are expectedly orthogonal independent variables.

Given that digital public services implementation orientation is about information processing and decision-making, we have chosen the strategic alignment of Henderson and Venkatraman (1989) as the underlying theoretical framework for our research model. This paradigm posits that technological choices (implementation included) are contingent of the organisational context. Building on the concepts of the strategic alignment theory, we introduce the interoperable digital public services implementation orientation (IDPSIO) model, which explains the contingent relation between both the contextual delegation of powers and the contextual regulatory state of a given public policy area with the interoperable digital public services implementation orientation (see Fig. 3). We highlight that the IDPSIO model is relational in nature (i.e. not causal).

As our research hypothesis highlights, the implementation of interoperable digital public services implies a choice between alternative orientations.

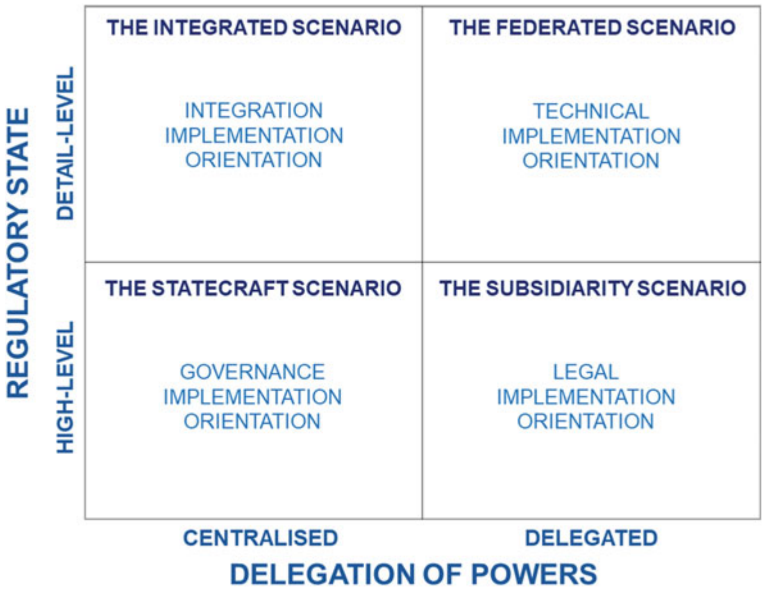

Fig. 3 IDPSIO model

We propose an orientation for the implementation of interoperable digital public services in terms of legal, organisational, semantic, and technical interoperability. They definitely represent alternative choices in the sense that implementation managers need to make a decision between the sequence to address all of them.

Inspired in the concept of fit between ICT resources and strategy (Henderson & Venkatraman, 1999; Wang, 2014), we advocate that the choice be based on the best fit between the context and a key interoperability enabler with convergence anchor power that enables peer-to-peer collaboration between digital public services across the tiers of the concerned public administration and with third (cross-border) public administrations. Our perspective of fit is of matching nature (Venkatraman, 1989) between the scenario and the interoperable digital public service implementation orientation.

The key interoperability enabler, whose convergence anchor best matches the scenario, will be the rational choice of implementation orientation because it maximises the convergence power attaining public policy goals.

The orientations considered by the IDPSIO model are the legal orientation, the integration orientation, the technical orientation, and the governance orientation.

In **the subsidiarity scenario**, it is suggested the **legal orientation**. This managerial choice is rooted in the legal paradigm (Ziegler, 1988) where a formal set of rules (of law) articulates an order that underlies a phenomenon of interest. This order constraints decisions yielding legal determinacy—i.e. predictable and legitimate outcomes—and juridical certainty—i.e. predictable interpretations—(McBarnet & Whelan, 1991). In our case, the order will be based on legal interoperability and the phenomenon of interest the implementation of interoperable digital public services. In this legally driven oriented implementation, the public policy convergence anchor is a **shared legal framework** of (re)usable[13] legal resources that enables:

- structural interoperability by reusing and/or sharing legislation (i.e. legislation catalogue, interoperability reference architectures);
- behavioural interoperability with legislation on exchanging capabilities of data, information, or knowledge with internal/external peers (i.e. interoperability frameworks); and
- governance interoperability with legislation on governance agreements (i.e. GDPR).

The convergence anchor power of a shared legal framework resides in several aspects like the common legally binding nature, the feasibility on the execution of the legal text, the comprehensiveness and quality (i.e. absence of ambiguity, the contribution to juridical certainty) of the legal text, etc.

In the subsidiarity scenario, there is a lot of resistance by the different tiers of public administrations to share data resources making integration implementation orientation very dificult (i.e. centralisation of data is not an option). So it also would

[13] We limit the term "usability" to services, data, standards, and frameworks while we limit the term "reusability" to leverage of existing software or software knowledge to construct new software (Frakes & Kang, 2005).

be for the governance implementation orientation because the high degree of delegation of powers implies complexity in reaching organisational agreements. The technical implementation orientation is the potential evolution after a maturity in the shared legal framework. In fact, there is likely a cycle between the legal and the technical implementation orientations.

In **the integrated scenario**, it is suggested the **integration orientation**. This managerial choice is rooted in the organisational interpretation system paradigm (Daft & Weick, 1984) where problem solving is enabled by "a single version of the truth". In our case, the interpretation system will be based on semantic interoperability for the implementation of interoperable digital public services. In this semantically driven oriented implementation, the public policy convergence anchor is a **shared knowledge base** of usable data, information, and knowledge resources that enables:

- structural interoperability by using and/or sharing of data, organisational information, and organisational knowledge (i.e. data set catalogue, base registries, catalogue of ontologies);
- behavioural interoperability with exchanging capabilities of data, organisational information, and organisational knowledge with the environment (i.e. representation, data mappings); and
- governance interoperability with semantic interoperability agreements (i.e. ontologies).

The convergence anchor power of a shared knowledge base resides in the comprehensiveness and quality of the organisational knowledge. The technical or governance implementation orientation is the potential evolution after a maturity in the shared knowledge base.

In **the federated scenario**, it is suggested the **technical orientation**. This managerial choice is rooted in the garbage can model (Cohen et al., 1972) where solutions are "waiting for problems". In our case, "solutions" will be based on technical interoperability "waiting" for the implementation of interoperable digital public services. In this technologically driven oriented implementation, the public policy convergence anchor is a **shared platform of ICT resources** (i.e. the platform) that enables:

- structural interoperability by reusing and/or sharing of software components (i.e. service registry service, networks, reusable building blocks, common (back office) services);
- behavioural interoperability with ICT exchanging capabilities of data, information, or knowledge with internal/external peers (i.e. intermediation services, interfaces); and
- governance interoperability with technical interoperability agreements (i.e. protocols, choreography rules).

The convergence anchor power of a shared platform of ICT resources resides in the comprehensiveness and quality of ICT resources. The legal implementation orientation is the potential evolution after a maturity in the shared platform.

In **the statecraft scenario**, it is suggested the **governance orientation**. This managerial choice is rooted in the institutional paradigm (North, 1990) where an institution guides the internal and external interactions between the different organisational resources. In our case, the institution will be based on organisational interoperability for the implementation of interoperable digital public services. In this organisationally driven oriented implementation, the public policy convergence anchor is a **shared governance framework** of (re)usable organisational resources that enables:

- structural interoperability by reusing and/or sharing of interoperable digital public services (i.e. public services catalogue);
- behavioural interoperability with organisational exchanging capabilities of data, information, or knowledge with internal/external peers (i.e. service delivery mode); and
- governance interoperability with organisational interoperability agreements (i.e. service level agreements, governance structures).

The convergence anchor power of a shared governance framework resides in the comprehensiveness and quality of governance instruments. The legal or integration implementation orientation is the potential evolution after a maturity in the shared governance framework.

It needs to be stressed that to select an implementation orientation for the digitalisation of public services does not mean neglecting the other three alternatives. On contrary, the rest of choices need to be aligned to the selected (focus/anchor) orientation. This means that, in a concerned public administration, we might observe two public policies with a different implementation orientation in each. This fact does not imply a lack of interoperability if the digital public services in such respective areas were interoperable.

3.3 Theory Boundary

The boundary state space of the theory (Weber, 2012) is circumscribed to the four scenarios defined in a given public policy context in terms of regulatory state and delegation of powers. The boundary event space of the theory (Weber, 2012) is circumscribed to the interoperable digital public service implementation orientation choice that agents like public administration ICT portfolio managers and CIOs make facing several competitive alternatives.

4 Confirmatory Research

The research presented in this chapter has performed a limited confirmatory effort (Pinsonneault & Kraemer, 1993) to test the validity of the theory. The confirmatory research design for answering our research question follows the three principles as presented in Goldkuhl (2016) being them the policy principle (i.e. policy driven), the co-design principle (i.e. work practice and in relation to digital means), and the theorising principle (i.e. parallel feedback and tuning to the theory).

4.1 Confirmatory Research Design

For collecting the evidence of the three constructs in our posited theory, we accessed secondary data. The adopted implementation orientation construct is generally observable in documents of strategic nature (such as de España, 2015; Republic of Estonia, 2020) produced by the interested public administration. The regulatory state construct is observable in the official journals of the public administrations (see e.g. European Union, 2020). Finally, the delegation of powers construct is documented in various secondary sources (Thijs et al., 2017).

Because the three constructs in the research model (i.e. regulatory state, delegation of powers, and implementation orientation) have the same nature (organisational), and they all are high-level constructs; we decided that our confirmatory research has to be empirically replicable as far it concerns to the collection of evidence. Epistemologically, we selected a qualitative perspective employing case study, one per public policy, for the collection of our limited observations. These were complemented with structured interviews for the collection of evidence. Case study is extensively used in MIS research (Benbasat et al., 1987). The unit of analysis in our confirmatory research is given by the theory boundary, this means, any interoperable digital public service provisioned by an EU public administration as the principal entity. This principal entity is concerned in decision-making processes to choose the implementation orientation of interoperable digital public services between competitive alternatives via agents (Eisenhardt, 1989), like public administration ICT portfolio managers and CIOs. The limitation to EU public administrations in our unit of analysis is due to practical reasons of accessibility to their ICT portfolio managers and CIOs.

The eligibility criteria for case study were the following:

- The candidate public service had to be digital, operational, and provided by a public administration in the EU;
- Administered during (i.e. in parallel to) the deployment of EIRA (European Commission, 2019c) by the European Commission to petitioner public administrations in their organisations;
- The EIRA use case selected by the host public administrations had to be to document a digital public service in production[14];
- None eligible candidate case study was rejected; and
- Up to maximum ten case studies.

[14] The EIRA use case of documenting a digital public service in production allowed the transfer of knowledge of how to use EIRA to the public administration taking a digital public service they are familiar with. Other EIRA use cases, like documenting the high-level and/or detail-level requirements of a target digital public service, were of no interest for our research.

The protocol for case study consisted of eight steps having reliability as the goal. Step #1 for preparation, steps #2 to #6 using secondary published data, and steps #7 and #8 using structured interviews. The structured interviews performed in steps #7 and #8 followed the following principles: With the key informants, performed on-site at the premises of the key informants, in workshops that required between up to three days. English language was the communication language.

Step 1: Preparation for the case study. EU Member States and the European Commission participate in the ISA^2 Committee through agents supervising the ISA^2 program (EIRA included) and the deployment at national level of ISA^2 initiatives (European Parliament and Council of the European Union, 2015). These EU agents request for the active support of the European Commission in the deployment of EIRA in their respective public administrations (see eligibility criteria). The public administration designates an agent as the interface/owner of the support delivered by the Commission. National agents, in representation, of his/her national public administration send a formal invitation to the Commission for performing the deployment of EIRA. The agent was commonly ICT portfolio managers and CIOs. With their endorsement, we gained access to key informants who (i) gave us access to documentation related to strategy for digitalisation of public services as a base to enact the adopted implementation orientation and (ii) were interviewed for gathering evidence and validation.

Step 2: Identification by the agent of the digital public service(s) to be analysed/documented using EIRA. This digital public service is the unit of analysis of the case study by the researchers. This decision was entirely out of the control of the researchers.

Step 3: Identification of the legislation in the concerned public policy.

Step 4: Analyses of the level of granularity of the requirements in the legal texts in (European Union, 2020). As stated in the conceptual backgrounds, we consider the following two discrete well-differentiated levels of granularity for the requirements in the legislation. High-level regulatory state contains generic/abstract functional requirements like principles and/or recommendations with considerable degrees for transposition/execution and of not binding nature. On the other side, detail-level regulatory state implies a limited degree for transposition/execution, and it contains specific/concrete functionalities requirements, solution components, data, procedures, and/or technical specifications or standards to be used (Liskin et al. 2014). As a result of this step, regulatory state was identified. National languages used in national legislation implied a difficulty.

Step 5: Analysis of the extent that the public administration delegates the provision of the studied public service(s) to other administrative tiers. This was done accessing to secondary data (Thijs et al., 2017). As stated in the conceptual backgrounds, we consider the following two discrete well-differentiated levels of delegation of powers: mostly centralised and mostly delegated. As a result of this step, delegation of powers was identified.

Step 6: Analysis of the implementation focus/anchor in the selected digital public service(s). This was done studying the documentation related to the strategy for digitalisation of public services provided by the key informants. Additionally, other published studies were used to increase the validity of the identification of the implementation orientation of the selected digital public service like (OECD, 2018). As stated in the conceptual backgrounds, we consider the following four discrete well-differentiated orientations: The integration orientation, the technology orientation, the governance orientation, and the legal orientation. As a result of this step, implementation orientation was identified.

Step 7: Triangulation of findings in the step 4 (regulatory state identified), step 5 (delegation of powers identified), and step 6 (implementation orientation identified) in structured interviews. Concerning regulatory state, construct validity was tested with triangulation questions covering in a comprehensive way the interoperability dimensions (i.e. structural, behavioural, and governance). Doing this, the questions on the structural interoperability dimension followed the script of items of the Interoperability Quick Assessment Tool, IQAT (Tambouris et al., 2018). The questions on the behavioural and governance interoperability dimensions followed the script of items of the Interoperability Maturity Assessment of a Public Service, IMAPS (European Commission, 2018b). Concerning delegation of powers, construct validity was tested with triangulation questions regarding the positioning by the key informants of extent that their public administration delegates the provision of the studied public service(s) to other administrative tiers in the range centralised vs. delegated. Concerning implementation orientation, construct validity was tested with triangulation questions regarding the positioning by the key informants of the implementation focus/anchor in the studied public policy area. Finally, the findings on regulatory state from step 4 and step 7 were confronted and discussed, the findings on delegation of powers from step 5 and step 7 were confronted and discussed, and the findings on implementation orientation from step 6 and step 7 were confronted and discussed. Successful triangulation in the three constructs was a requirement for the next and final step.

Step 8: Testing the IDPSIO model power. This consisted in confronting the successfully validated findings in step 7 on regulatory state, delegation of powers, and implementation orientation with respect the IDPSIO research model. Confirmation would imply support to the IDPSIO research model.

4.2 Confirmatory Research Administration

Case study was conducted in each of the following ten[15] European public administrations[16] in a four years period from January 2015 to December 2018: Estonia (Information System Authority, e-service portal/X-Road, 2015), The Netherlands (Tax and

[15] Case studies were also conducted in Norway (DIFI, 3Q2018) and with regional Flemish government (Informatie Vlaanderen, 3Q2018). Unfortunately, they are not reported due to lack of secondary data for triangulation.

[16] Some of the identification information of cases has changed due to various circumstances like reorganisation.

Customs Administration, entrepreneur tax intake, 2015), European Union (DIGIT, national interoperability framework observatory, 2016), Belgium (Fedict, service catalogue, 2016), Czech Republic (Ministry of Interior, Czech Point, 2016), Spain (Ministry of Public Administrations, citizen's folder, 2016), Denmark (National SundHeds, medical e-prescriptions, 2017), Poland (Ministry of Digital Affairs, access to base registries, 2017), Sweden (DIGG, composite service of basic information on companies, 2018), and Italy (AgId, one-stop shop for business registration, 2018). Successful replications in our administered case studies suggest support to the external validity of regulatory state, delegation of powers, and implementation orientation constructs (see Table 1).

Table 1 Case studies performed

Case study #	Interoperable digital public service	Public policy area	Public administration	Place	Year of study
1	e-service portal/X-Road	Modernisation public administration/digitalisation	Information system authority	Estonia	2015
2	Entrepreneur tax intake	Taxes and customs	Tax and customs administration	The Netherlands	2015
3	National interoperability framework observatory	Modernisation public administration/digitalisation	DIGIT	European Union	2016
4	service catalogue	Modernisation public administration/digitalisation	Fedict	Belgium	2016
5	Czech Point	Modernisation public administration/digitalisation	Ministry of interior	Czech Republic	2016
6	Citizen's folder	Modernisation public administration/digitalisation	Ministry of public administrations	Spain	2016
7	Medical e-prescriptions	Health	National SundHeds	Denmark	2017
8	Access to base registries	Modernisation public administration/digitalisation	Ministry of digital affairs	Poland	2017
9	Composite service of basic information on companies	Modernisation public administration/digitalisation	DIGG	Sweden	2018
10	One-stop shop for business registration	Modernisation public administration/digitalisation	AgId	Italy	2018

4.3 Confirmatory Research Findings

The overall findings of the ten case studies were the following:

Three public policies were observed in the ten performed case studies (see Table 1). Most of the interoperable digital public services (eight out of ten) supported the "modernisation of public administration/digitalisation" public policy.

In relation to regulatory state, our observations in case studies #3, #4, #5, and #8 show that this context variable for the interoperable digital public services was of high-level granularity, while our observations in case studies #1, #2, #6, #7, #9, and #10 show that the context regulatory state was of detail-level granularity (see Table 2). Remarkably, the public policy area "modernisation of public administration/digitalisation" with eight out of the ten case studies (see Table 2) has a variety of granularity of requirements in the legislation, as it shows in that four case studies have detail-level regulatory state and four case studies have high-level regulatory state. The unexpected amount of case studies in the same public policy with a close to even distribution on the granularity of requirements provides limited, given the number of performed case studies, confirmatory support to the IDPSIO model from the perspective of regulatory state.

In relation to delegation of powers, our observations in case studies #2, #3, #4, and #6 show that this context variable for the interoperable digital public services was of delegated powers, while our observations in case studies #1, #5, #7, #8, #9, and #10 show that the context delegation of powers was of centralised powers (see Table 2). Again, the unexpected amount of case studies in the same public policy showed a close to even distribution on the types of delegation of powers provides limited, given the number of performed case studies, confirmatory support to the IDPSIO model from the perspective of delegation of powers (see Table 2). Therefore, given the almost even distribution in both contextual variables, our observations in the performed case studies did not show any apparent dependency between them. This finding also supports the IDPSIO model as orthogonality between the two context variables is implicit by our posited theory.

In relation to the implementation orientation, our observations in case studies #1, #7, and #9 show that this variable was identified as of integration implementation orientation for the interoperable digital public services studied. Our observations in case studies #2, and #6 show that this variable was identified as of technical implementation orientation for the interoperable digital public services studied. Our observations in case studies #3, and #4 show that this variable was identified as of legal implementation orientation for the interoperable digital public services studied. Finally, our observations in case studies #5, #8, and #10 show that this variable was identified as of governance implementation orientation for the interoperable digital public services studied (see Table 2). The unexpected amount of case studies in the same public policy showed a close to even distribution on the four considered implementation orientations which provides limited, given the number of performed case studies, confirmatory support to the IDPSIO model from the perspective of implementation orientation (see Table 2). Finally, on the power of the IDPSIO model, four

Table 2 Public policy scenario, in terms of regulatory state and delegation of powers, and implementation orientation per performed case study

Case study #	Interoperable digital public service	Public policy area	Public administration	Place	Year of study	Public policy			Interoperable digital public service implementation orientation (step 6)
						Regulatory state (step 4)	Delegation of powers (step 5)	Scenario (step 4 and step 5)	
1	e-service portal /X-road	Modernisation public administration/digitalisation	Information system authority	Estonia	2015	Detail-level	Centralised	Integrated	Integration
2	Entrepreneur tax intake	Taxes and customs	tax and customs administration	The Netherlands	2015	Detail-level	Delegated	Federated	Technical
3	National interoperability framework observatory	Modernisation public administration/digitalisation	DIGIT	European Union	2016	High-level	Delegated	Subsidiarity	Legal
4	Service catalogue	Modernisation public administration/digitalisation	Fedict	Belgium	2016	High-level	Delegated	Subsidiarity	Legal
5	Czech Point	Modernisation public administration/digitalisation	Ministry of interior	Czech Republic	2016	High-level	Centralised	Statecraft	Governance
6	Citizen's folder	Modernisation public administration/digitalisation	Ministry of public administrations	Spain	2016	Detail-level	Delegated	Federated	Technical

(continued)

Table 2 (continued)

Case study #	Interoperable digital public service	Public policy area	Public administration	Place	Year of study	Public policy			Interoperable digital public service implementation orientation (step 6)
						Regulatory state (step 4)	Delegation of powers (step 5)	Scenario (step 4 and step 5)	
7	Medical e-prescriptions	Health	National SundHeds	Denmark	2017	Detail-level	Centralised	Integrated	Integration
8	Access to base registries	Modernisation public administration/digitalisation	Ministry of digital affairs	Poland	2017	High-level	Centralised	Statecraft	Governance
9	Composite service of basic information on companies	Modernisation public administration/digitalisation	DIGG	Sweden	2018	Detail-level	Centralised	Integrated	Integration
10	One-stop shop for business registration	Modernisation public administration/digitalisation	AgId	Italy	2018	Detail-level	Centralised	Statecraft	Governance

case studies provided confirmatory support to the research hypothesis of integration implementation orientation in the integrated scenario, two case studies provided confirmatory support to the research hypothesis of technical implementation orientation in the federated scenario, two case studies provided confirmatory support to the research hypothesis of legal implementation orientation in the subsidiarity scenario, and two case studies provided confirmatory support to the research hypothesis of governance implementation orientation in the statecraft scenario (see Table 2). This means that the ten case studies suggest support to the research hypothesis as predicted by the IDPSIO model.

5 Discussion

We have organised the discussion in relation to our research in terms of limitations. From a theory building perspective, the IDPSIO model explains how and why an implementation orientation best fits a public policy context. In relation to the why the theory posits that the discriminant factor among the implementation orientations is their associated public policy convergence anchor. Although we have theorised the bases of the convergence power for each implementation orientation, we assess this as a starting and limited contribution requiring further research addressing the convergence power for each implementation orientation.

We argue that delegation of powers and regulatory state contribute to the parsimony of the characterisation of the organisational context of public administrations on a concerned public policy as far it concerns to the decision-making process for the digitalisation of interoperable digital public services. Indeed, this statement should be further investigated.

Another point for theoretical discussion on the IDPSIO model is that the public policy context is limited to a discrete scale of four scenarios. This limitation implies that a public policy context is profiled as “mostly” in a scenario regardless the potential aspects that, with less extension, would fall in the other scenarios. This limitation gives the IDPSIO model a “proxy” nature, which is very common in decision support systems. This means that the theory does not claim that the advocated implementation orientation is optimal. The theory needs to be interpreted in a best possible effort in the sense that the “other three” will provide less converge power with respect the public policy goals attainment.

Likewise, it is also subject of discussion the binary scale for delegation of powers and regulatory state. For example, increasing the scale of delegation of powers from [mostly centralised, mostly delegated] to, let us say, a ternary scale while keeping the scale of regulatory state [high level, detail level] the number of scenarios would be six. This discussion (i.e. to increase the number of scenarios) would imply to theorise in relation the implementation orientation best fit for all and each (.sic) of the scenarios.

From a confirmatory research perspective, further research should be performed to test the validity of the research hypothesis in each scenario of the IDPSIO model, for any public policy area. Likewise, the orthogonality of delegation of powers and regulatory state needs to be fully tested. In this respect, the development of reliable measures based on questionnaires for delegation of powers, regulatory state, and implementation orientation variables is highly advisable.

Our limited confirmatory research was performed applying the three principles for e-government research as presented in Goldkuhl (2016) being them the policy principle (i.e. policy driven), the co-design principle (i.e. work practice and in relation to digital means), and the theorising principle (i.e. parallel feedback and tuning to the theory). As a result of our confirmatory research, a point for discussion raised. We propose that the first principle of Goldkuhl (2016) requires some subtle clarification. As illustrated in Table 2, e-government design research might require comparing aspects of a digital public service supporting a public policy. This might be a conceptual challenge if the digital public services considered support different public policies. Although this was not the case in our research, for the sake of conceptual clarity, we see the need for further research on the feasibility of analysis of digital public services across public policies. This would be beneficial in order to have solid theoretical bases to conduct benchmark studies on digitalisation of public services.

6 Conclusions

As stated earlier, the main goal of this chapter is to theoretically address the knowledge gap, as pointed out by scholars in past research, on the impact of digital public service processes. Our research question focusses on one of these processes as the phenomenon to be studied: the decision-making process of the implementation orientation for the digitalisation of interoperable public services by public administrations ICT portfolio managers and CIOs. Our research contributes to fill this gap by positing a theory for explaining how and why, as advocated by Gregor (2006), the studied phenomenon happens. Particular attention has been devoted to the rigour building this theory. Our theory building process adheres to the guidelines of Weber (2012).

The IDPSIO model is a theory that explains how the studied phenomenon happens because it provides a contingent association between the public policy context and the studied phenomenon helping to understand the impact of the public policy context in the studied phenomenon.

In essence, the how is explained in the theory by the best matching fit, in the sense introduced by Venkatraman (1989), between a scenario and an implementation orientation. Our research provides a theory for defining the public policy context in terms of orthogonal regulatory state and delegation of powers variables resulting in four public policy context scenarios: The integration, the federated, the subsidiarity, and the statecraft scenarios. The IDPSIO model posits that public policy context is a requirement for the choice of the implementation orientation for the digitalisation of interoperable public services. Specifically, the integration orientation for the implementation of interoperable digital public services requires the integrated scenario, the technical implementation orientation requires the federated scenario, the legal implementation orientation requires the subsidiarity scenario, and the governance implementation orientation requires the statecraft scenario.

The IDPSIO model not only addresses how the impact happens but also why. This means, why a given implementation orientation is the best fit with respect to alternative implementation orientations.

The theory posits that each implementation orientation has a different public policy convergence anchor supporting the goals attainment of the concerned public policy. The best fit between a public policy context scenario and an implementation orientation is determined by the alignment of the convergence anchor of the implementation orientation with the context scenario. Furthermore, this best fit provides the highest possible public policy convergence power with respect to alternative orientations.

Although we do not consider stricto sensu that empirical confirmation was required, we performed a limited confirmatory research applying the three principles for e-government research as presented in Goldkuhl (2016). We report that they were of help and supported our theory building not only by providing limited validity confirmation but also fine-tuning to the theory.

Our findings from our empirical observations suggest support to our research hypothesis implying a twofold answer. Firstly, our observations suggest, as posited by the IDPSIO model, that the implementation orientation in interoperable digital public services is influenced by the granularity of the requirements in the legislation and, secondly, by the extent that the public administration delegates the provision of the studied digital public service(s) to other administrative tiers.

Therefore, and as a consequence of this twofold answer, our observations support that the implementation orientation of interoperable digital public services has, as a requirement, a specific public policy context defined in terms of regulatory state and delegation of powers.

Additionally, we argue that our research provides value to practitioners. The IDPSIO model is a proxy that provides decision support for enabling the identification of the context of a given public policy in one out of the four scenarios (see Fig. 2). Value for practitioners consists of the decision making support that the IDPSIO model provides choosing the orientation for implementing interoperable digital public services based in the public policy context for the provision of the concerned digital public services defined by the delegation of powers and regulatory state (see Fig. 3). In simple terms, according to IDPSIO, practitioners should identify firstly the context of the digital public service to be digitalised in terms of the existing delegation of powers provisioning digital public services in this public policy area and the granularity of the requirements in the legislation to be considered. This will position the to-be digitalised public service in a scenario, that according to the IDPSIO, has a suggested implementation orientation.

Following Charalabidis and Lachana (2020a, 2020b) and Viale Pereira et al. (2018), the contribution of this chapter in relation to the scientific elements of digital governance is the solution path nature. Indeed, the theory posits that in order to assure (.sic) the implementation of interoperable digital public services, it is relevant to select the best implementation orientation because, firstly, a mismatch selecting the wrong orientation might imply a risk for the implementation itself as it might fail. This mismatch is identified in Nielsen and Pedersen (2014) between IT portfolio decision-making ideals and incompatible organisational contexts. Secondly, and best case, the best orientation will increase the efficiency of the interoperable digital public services implementation process. Furthermore, the theory argues that decisions made regarding the implementation orientation of interoperable digital public services are relevant because they will affect the level of support of the implemented interoperable digital public services to the public policy goals (convergence power).

As a counterexample, let us assume that for the implementation of a taxes digital public service, the public policy context is the subsidiarity scenario. Also, let us assume that it has been decided, in conflict with the IDPSIO model, that the implementation orientation will have an integration implementation orientation (i.e. a central base registry with detailed data from the individuals/business). Our theory holds that this orientation is worse than the legal orientation posited by the IDPSIO model. Furthermore, we argue that this integration implementation orientation will have a lot of difficulties to pass the inception phase and eventually it might fail.

Finally, quoting the observation of Winston S. Churchill assessing democracy as “the worst form of government except all those other forms that have been tried from time to time”, mutatis mutandis, we argue that although the suggested orientation, by the IDPSIO model in each scenario, for implementing interoperable digital public services might not be optimal it will have more chances to succeed, as far it concerns to the support of the goals of the concerned public policy, than the other alternative orientations.

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Agent-based Modeling in Digital Governance Research: A Review and Future Research Directions

Prakash C. Sukhwal and Atreyi Kankanhalli

Abstract Digital governance involves the application of information and communication technology (ICT) for achieving efficiency and effectiveness in government functions for all stakeholders. In addition to the expenditure on ICT, government bodies face key challenges arising from complexity in digital governance due to uncertainty, nonlinearity, and heterogeneity in processes and stakeholders, which need to be further understood and resolved. To that end, agent-based modeling (ABM) offers a powerful technique to represent and research complexities, uncertainties, nonlinearity, and heterogeneity in a digital governance ecosystem. In this chapter, we provide a systematic review of the literature over the last two decades, which has applied ABM for analyzing digital governance phenomena. Based on the review, with 78 relevant studies, we contribute by summarizing the current state of research in this area, identifying the literature gaps, and outlining directions for future research. Specifically, our study highlights issues related to ABM design, implementation, validation, and adoption that remain unexplored. Salient future research directions include theory development with greater involvement of stakeholders, empirical frameworks' development for ABM implementation with focus on scalability, interlinking of ABM with existing government knowledge bases, and applying ABM to less studied domains of digital governance.

Keywords e-governance · Digital governance · Agent-based modeling (ABM) · Literature review · Future research

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1 Introduction

Public sector governance refers to the structures and processes through which roles and responsibilities are assigned across government agencies and their stakeholders in order to achieve its functions (Almqvist et al., 2013). Through effective governance, government organizations can be held accountable to the public and to businesses. In addition to maintaining accountability, governments around the world face other challenges as well (The World Bank Report, 2020). *First*, individuals and businesses expect governments to raise the quality and range of services offered. *Second*, governments need to reduce the costs incurred while trying to meet these expectations. In order to achieve their goals, satisfy expectations, and reduce costs, governments globally are increasingly using information and communication technology (ICT) to transform their functions through digital governance.

Digital governance refers to the phenomenon in which ICT is applied for the purposes of process integration, effective communication, and information exchange, dissemination of policies to stakeholders, gaining feedback, and enhancing accountability of government organizations (Erkut, 2020). The underlying premise of digital governance is the use of ICT to help governments to manage their work and engage the people, public and private organizations (Rossel & Finger, 2007). In the context of governments using ICT, the term "electronic" precedes "digital." Thus, "e-governance" was initially used—but with widespread deployment of digital technology, the term is being replaced by "digital governance" (Lim, 2019). Accordingly, we will use digital governance in our article to represent both terms, as is common in the literature (e.g., Misuraca & Viscusi, 2014).

Digitization aims to streamline governance for various stakeholders. For government agencies, digitization can offer both internal and external benefits. Potential internal benefits include administrative efficiencies, interoperability among government agencies, and integration of government systems and processes. Externally, with digitization, governance can become more citizen-centric, help improve services, and lead to better policy formulation (Pereira et al., 2018), e.g., through increased government–citizen collaboration via online platforms. In addition, government bodies can make effective use of data they collect for information generation and dissemination of insights (via data analytics) to businesses (Erkut, 2020), as well as to foster public–private partnerships (Hodge & Greve, 2007). For society at large, digitization of governance can promote efficient usage of public funds and improvement in government services, such as business registration services, licensing services, and payment-based services (Gasmelseid, 2007). Other potential benefits include better awareness and compliance of laws (Regner et al., 2010), reduced corruption, and improved transparency through digital means (Wimmer, 2011).

With the expected benefits, governments across the globe continue to spend significant and increasing amounts on ICT, e.g., governments across the Middle East and Africa spent close to 12.8B USD on ICT in 2019, and this figure is expected to cross 15B USD by 2023 (IDC, 2020). According to Deloitte Insights (2020), the value of the global government cloud alone is estimated to be 49.2B USD. As another example, the Singapore government is spending 2.5B USD on ICT in 2020, a 30% increase over the previous year (CNA, 2020). Indeed, digital capabilities are seen as key to increase resilience during crises, such as the current COVID-19 pandemic.

Other than the expenditure on ICT, government bodies face key challenges arising from *complexity* in digital governance due to *uncertainty*, *nonlinearity*, and *heterogeneity* in processes and stakeholders. Complexity in public sector governance stems internally from various factors, such as changing government strategies and plans, interdependent and frequently interacting sub-organizations with diverse roles and hierarchies, and disparate systems providing multiple services (Gasmelseid, 2007). Externally, *uncertainty* and complexity exist due to changing social, political, economic and environmental landscapes, and conflicts among stakeholders. Conflicts can arise out of expectation mismatches or lack of consensus between government organizations and stakeholders, such as citizen versus business interests on consumer privacy (Choi & Robertson, 2014). *Nonlinearity* is seen in the processes and interactions among stakeholders and in the relationships in socio-economic phenomena (Pereira et al., 2018). For example, there are nonlinear interactions of learning and reacting among opponents in war situations (Cil & Mala, 2010). Another example of a nonlinear relationship is between the levels of poverty and fuel prices (Smajgl & Bohensky, 2013).

Further, *heterogeneity* exists among the various stakeholders, i.e., government agencies, people, and businesses. Diversity is observed among government agencies (Kankanhalli et al., 2019), with a mix of public-facing and other agencies having different functions and security requirements. For example, defense agencies do not have the same transparency requirements as other public agencies, as their sensitive information is needed for protecting the security of the country. Thus, ministries like defense and homeland security are governed differently from public-facing agencies, such as education, taxation, and transportation.

The public also has heterogeneous needs based on multiple attributes. For example, individuals differ in terms of gender, age, race, education, income levels, religion, and belief systems, with various demographic groups having their own set of needs and expectations from government. In terms of ICT use, the digital divide (disparities in access to and use of ICT) is a major concern for governments (Pee et al., 2010). Thus, digital governance needs to cater to these diverse needs and expectations.

Business organizations can be differentiated on the basis of characteristics, such as size and sector. Particularly, small, medium, and large businesses have differing needs (Asadullah et al., 2020). Governments must also address the diverse needs of different industry sectors. For example, certain sectors have high need for manpower and workers (e.g., construction and healthcare sectors), infrastructure (e.g., IT sector), or regulation (e.g., banking and defense contractors), or a combination of these requirements. In addition, other organization types, such as cooperative firms and non-government organizations (NGOs), also come under the purview of public sector governance.

The task of designing governance systems and underlying ICT must take into account the above complexities, uncertainty, nonlinearity, and heterogeneity, which makes the study of digital governance highly challenging. According to prior research, "The combined effect of the uncertainty, dynamic interactions and subsequent events, and the complex interdependencies among the variables in the system inhibit the analysis of governance" (Streit & Borenstein, 2009, p. 11490).

A key approach for researchers to understand the complexities, heterogeneity (Lempert, 2002), nonlinear relationships, as well as the emergence of macro- from micro-behaviors via interactions in an ecosystem (Carley, 2002), is through simulation-based methods, such as cellular automata (CA), and agent-based modeling (ABM). *ABM* is a bottom-up approach of computer simulation where actions and interactions of autonomous agents, both with each other and the environment, are explicitly modeled in a computer program (Macal & North, 2005). Compared to other simulation techniques, ABM offers various benefits, such as allowing for a more natural and realistic model of the system under study, enabling flexibility of modeling, and permitting the incorporation of other sophisticated techniques, such as neural networks (Bonabeau, 2002). Thus, agent-based models have been proposed to analyze complex ecosystems (Kim & McGraw, 2012) in diverse domains, such as bio-terrorism (Carley et al., 2006), health care (Isern & Moreno, 2016), and energy (Busch et al., 2017).

Given the nature of digital governance where the technology and ecosystem keep evolving, needing revision and testing of policies and plans before rolling them out (Sridhar & Mandyam, 2010), conventional modeling techniques may be less useful (Macal & North, 2005). ABM is a suitable technique to handle the uncertainties, heterogeneity of stakeholders, dynamic and nonlinear relationships within such complex ecosystems, as well as to study the micro- to macro-effects of interventions on the system (Carley, 2002). ABM can help study human and non-human actors' behaviors in diverse situations, consider a plethora of outcomes, and suggest ways to move toward a more preferred outcome. With the above-mentioned merits, ABM is gaining importance in various fields, including information systems (Benbya et al., 2020).

At the same time, while the interest in digital governance is increasing, the use of novel methods like ABM for its examination is still understudied. Rather, we identified works which review *specific aspects of digital governance*, such as online services and quality (e.g., Acco Tives Leão & Canedo, 2018; Arias & Maçada, 2018; Madsen & Hofmann, 2019), business processes and sustainability (Soma et al., 2016; Syed et al., 2018), and public perception of digital governance (Twizeyimana & Andersson, 2019). In addition, we found studies which review adoption of ICT by employees and government agencies (Rehouma & Hofmann, 2018; Sánchez-Torres & Miles, 2017), as well as the *role of specific technologies in governance*, such as block chain (Batubara et al., 2018) and artificial intelligence (AI) (De Sousa et al., 2019). There are also articles which have reviewed governance in terms of e-participation of citizens (Alryalat et al., 2017; Irfan et al., 2019; Simonofski et al., 2017) and *in the context of smart and sustainable cities* (e.g., Pereira et al., 2018; Ruhlandt, 2018; Tomor et al., 2019). Thus, we observed a lack of studies that review the prior research utilizing ABM to study digital governance phenomena.

As ABM is a powerful technique to model complexity in digital governance, it offers great potential for research and practice by taking a computational approach toward better governance and policy formulation. In this chapter, we contribute to extant literature in multiple ways. *First*, we provide a thorough and systematic review of the studies applying ABM to analyze digital governance phenomena. *Second*, through synthesis of the reviewed literature, we identify the current state of research in this area. This will further contribute to the "science base" (Charalabidis & Lachana, 2020) of digital governance and help to avoid repeat research. *Third*, we identify the gaps in understanding and outline directions for future research. The rest of this chapter is organized as follows. Section 2 explains our research methodology, including choice of timeline, search query, and sources to locate relevant studies. Section 3 presents findings of our review. We analyzed the papers according to various aspects i.e., over time, journals/conferences, research methods, domains, levels of analysis, and theories. Issues for research are highlighted in Sect. 4, followed by future research directions and the conclusion in Sect. 5.

2 Research Methodology

We followed a three-step process for our literature review (Webster & Watson, 2002), covering a broad range of papers from journals and conferences spanning from 2000 to the present. We chose 2000 as the starting year because key indices, such as the "e-Government Index" (West, 2004), "E-government Readiness Index," and "Web Measure Index" (The United Nations, 2003) report that many governments globally were starting to digitize their services around that time. We did not set any constraints on journals or conferences because we wished to cover as many relevant studies as possible. The query we used was inclusive: ("digital governance" OR "digital government" OR "e-governance" OR "e-government" OR "electronic governance" OR "electronic government") AND ("agent-based model" OR ABM OR "individual-based model" OR MAS OR "multi-agent system" OR "agent-based modellng and simulation"). The search was performed on Google Scholar (1410) and major academic databases (1887), i.e., Scopus (635), Web of Science (372), ScienceDirect (496) and IEEE Xplore (384)—number of papers found are given in the brackets.

Our literature search and filtering process consisted of three rounds. In the *first round*, a broad search was done based on the above query and time period on Google Scholar and the above academic databases. For Google Scholar, we started with the first page of search results and went on with subsequent pages till we found no more relevant articles (i.e., stopped at page 10 of the search results). Additionally, we included all search results from the above academic databases in our university's digital library. This first round resulted in 3297 papers shortlisted for abstract filtering. In the *second round*, we scanned the abstracts of the papers from the first round and excluded irrelevant and duplicate papers. Other than duplicates, papers were excluded because they were not about digital governance and ABM. Most of the irrelevant papers appeared in our search due to matching of query words, such as "digital," "simulation," "multi-agent," "modeling" in their abstracts (though that was not the topic of the paper) or in the authors' biodatas. This process resulted in 107 papers.

In the *third round*, we filtered the remaining papers based on their full text. Typically, papers were excluded for three reasons: (i) They mentioned ABM as a part of the introduction or in other places, but used other techniques such as CA, or structured equation modeling (SEM) in their study, or (ii) they focused on corporate governance using ABM, and not public sector governance, or (iii) they focused on either digital governance or ABM, but not both. We considered papers as relevant (or in scope), if (i) authors collaborated with government agencies or took on the view of a government agency when designing their study of IT-based system, (ii) the papers relied on government-supplied information, guidelines or databases for their model design and evaluation of IT-based system, (iii) the papers facilitated the governance process of relevant departments via the IT-based frameworks, or models, or prototypes (more details on this in Sect. 3.7). In this round, we also carried out one level of backward search on the filtered studies to find relevant references, which were published after year 2000. Finally, 78 papers were identified as relevant for our review.

In the next section, we analyze the selected papers by adapting from the digital governance and transformation framework of Charalabidis and Lachana (2020, p. 217, Fig. 1). With our adaptation of their framework, we classified the review papers based on which government domains are involved. Then, we examined which

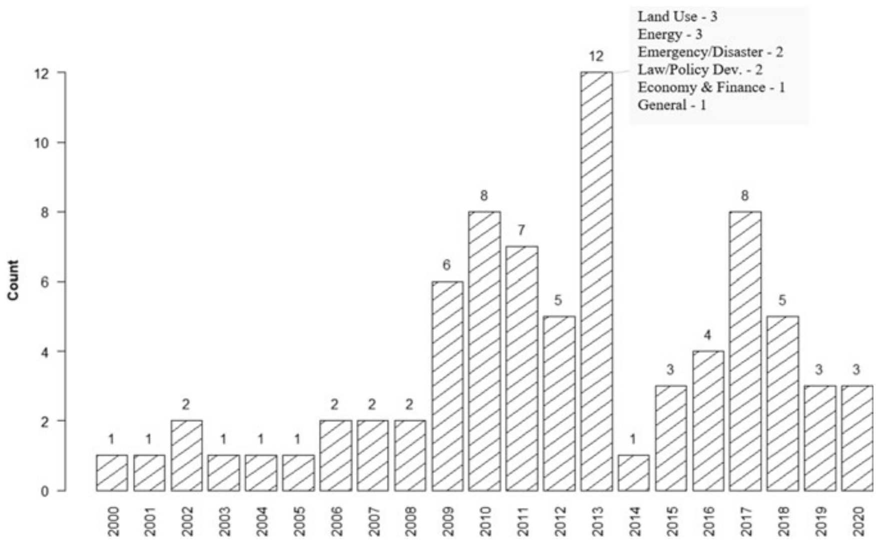


Fig. 1 Number of reviewed papers across time (2000–2020)

theories are being used, what approach is being followed in applying ABM, and how the evaluation of the proposed model is carried out. Last, we analyzed the papers with respect to how they built on extant digital governance systems and/or data.

3 Findings from the Review

3.1 Distribution Over Time

As shown in Fig. 1, the number of papers studying digital governance using ABM remained relatively low from 2000 to 2008, with an average of 1.4 papers a year. This is expected as during this period, government bodies globally were starting to offer online services, following basic automation (West, 2004). The number of papers saw a rise from 2009 to 2019, with an average of 5.6 papers a year. Notably, we see a spike in 2013, which can be attributed to additional papers about land use, emergency response, and energy. After the spike, we observed an average of 3.9 papers per year. With the current COVID-19 pandemic, we expect more papers examining the role of digital governance in pandemic detection and response using ABM in the coming years.

3.2 Distribution Over Journals and Conferences

There were 8 conference papers and 70 journal papers in our review. Table 1 shows the individual counts for the different conferences (last 8 rows of the table) and journals. With respect to disciplines, the reviewed papers cover a range, such as computer science, information systems, engineering, and public administration. The top two journals in terms of counts are *Complexity* and *IEEE Transactions on Smart Grid,* with three papers each. There were ten journals in which two papers each were published, i.e., *ACM Transactions on Modeling and Computer Simulation (TOMACS)*; *ACM Transactions on Management Information Systems (TMIS); Computers, Environment and Urban Systems*; *Environmental Modeling and Software*; *Expert Systems with Applications*; *International Journal of Electronic Government Research*, *International Journal of Geographical Information Science (IJGIS)*; *Natural Hazards; Sustainability*; and *Transportation Research.*

A total of eight papers were published in IS-related journals, with two papers each published in *Expert Systems with Applications*; and *ACM Transactions on Management Information Systems (TMIS);* and one paper each published in *MIS Quarterly*; *Information Systems Research; Information Systems Frontiers*; and *ACM Computing Surveys.* We identified the IS journals using an online knowledgebase (Guide2Research, 2020). These numbers show the potential for more IS research that applies ABM to digital governance, as well as for IS outlets to be more welcoming of such research.

Table 1 Number of reviewed papers across journals and conferences

Journal/conference	Paper count	Journal/conference	Paper count
Complexity	3	Information systems frontiers	1
IEEE trans. on smart grid	3	Information systems research	1
ACM trans. on mgmt. info. sys	2	Informatica	1
ACM trans. on model. and comp. sim	2	Intl. jnl. of agent tech. and systems	1
Computers, envir. and urban systems	2	Intl. jnl. of knowledge and sys. science	1
Environmental modeling and software	2	International studies review	1
Expert systems with applications	2	Jnl of sci. & tech. for forst prod. & proc	1
Intl. jnl. of elec. government research	2	Jnl of the American plng. association	1
Intl. jnl. of geographical Info. science	2	Jnl. of artificial soc. and social sim	1
Natural hazards	2	Jnl. of banking regulation	1
Sustainability	2	Jnl. of cleaner production	1
Transportation research	2	Jnl. of medical systems	1
ACM computing surveys	1	Jnl. of pub. admin. res. and theory	1
AI and law	1	Jnl. of public health policy	1
Annual review of pub. health	1	Military operations research	1
Applied math. and computation	1	MIS quarterly	1
Asia pacific development journal	1	PeerJ	1
Comput. and math. methods in medicine	1	Plos one	1
Decision sciences	1	Production and operations mgmt	1
Ecological modeling	1	Sim. modeling practice and theory	1
Electronic commerce research	1	Simulation	1
Energy policy	1	The scientific world journal	1
Env. and plan. B: plan. and design	1	Water resources management	1
Environmental modeling & assessment	1	Water resources research	1
Env. science and pollution research	1	AAAI conference on AI	1
Ergonomics	1	ACM ICEGOV	1

(continued)

Table 1 (continued)

Journal/conference	Paper count	Journal/conference	Paper count
GeoInformatica	1	CSED Conf	1
Hydrological science journal	1	Conf. on info. sys. and tech	1
IEEE access	1	German conf. on multiagent sys. tech	1
IEEE trans. on intel. trans. systems	1	ICADIWT	1
IEEE trans. on power systems	1	Land usage and cover change conf	1
IEEE trans. on sys., man, and cyber	1	Winter sim. conf	1

3.3 Distribution Over Research Methods

The papers in our review adopted five different research methods—*experiment, prototype, conceptual, conceptual and experiment,* and *review*. As shown in Fig. 2, *experiments* were the top-ranked research method for evaluating ABM applied to digital governance, with 34 papers (44%) adopting this method. The majority of these studies focused on applying ABM to problems related to emergency response, energy, and land use.

Second, 13 papers (17%) developed *conceptual frameworks followed by experiments* to test those frameworks. These papers mainly focused on law/policy development, land use, and defense. *Third*, 12 papers (15%) developed and tested *prototypes* that involved using either ABM alone or in conjunction with other techniques and/or data sources. Their focus varied evenly across emergency/disaster, energy, and land use. *Fourth*, 10 papers (13%) presented *conceptual frameworks* or methods to study various phenomena related to digital governance. The major focus here was on law/policy development frameworks.

The remaining 9 (11%) were review papers that reviewed ABM applications for land use (Frayret, 2011), emergency/disaster (Hawe et al., 2012), transportation (Chen & Cheng, 2010), health care (Isern & Moreno, 2016; Tracy et al., 2018), energy (Hoekstra et al., 2017; Ketter et al., 2018), and law/policy development (Furtado et al., 2019; Giabbanelli & Crutzen, 2017). These papers were considered as relevant to our review, because they discussed implications for digital governance.

3.4 Distribution Over Domains

The papers in our review covered 10 domains, i.e., *defense, economy and finance, emergency/disaster, energy, health care, land use, law/policy development, supply chain, transportation, water,* as well as *general,* and *others*. Papers that were meant

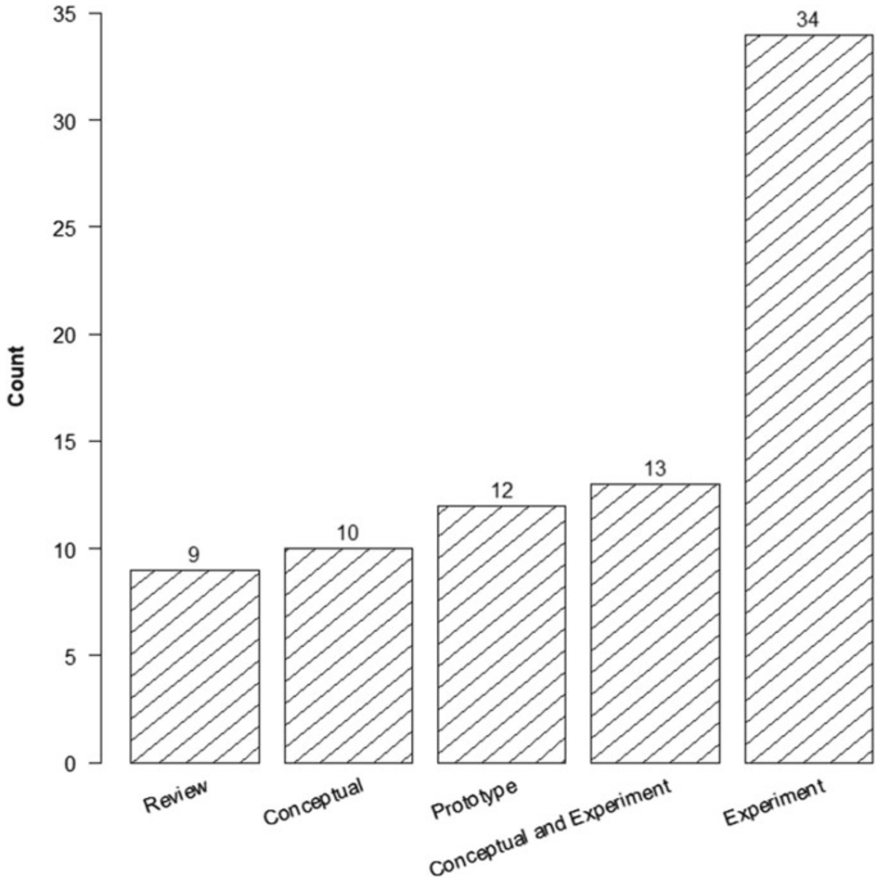


Fig. 2 Number of reviewed papers across research methods

for all domains of government were classified as general, while those that did not fit any of the other categories were classified as *others*.

As shown in Fig. 3, the top 2 domains were law/policy development and emergency/disaster with 13 papers (17%) each, followed by land use and energy with 12 papers (15%) each. In the emergency/disaster domain, ABM was used to study three main phenomena: (1) disaster phenomena in general, including the aftermath of disasters; (2) human evacuation strategies; and (3) formulate and test guidelines for decision making. Disaster phenomena were mainly studied through the process of emergence, a characteristic of ABM, and applied to scenarios, such as fires, floods, and volcanic eruptions (Jumadi et al., 2020; Ruas et al., 2009), domestic political instability and insurgency (Cioffi-Revilla & Rouleau, 2010), and aftermath of disasters (Crooks & Wise, 2013). For example, Crooks and Wise (2013) created a prototype for government bodies to study the aftermath of disasters, with focus on locations of humanitarian assistance hubs. They used social learning theory to understand

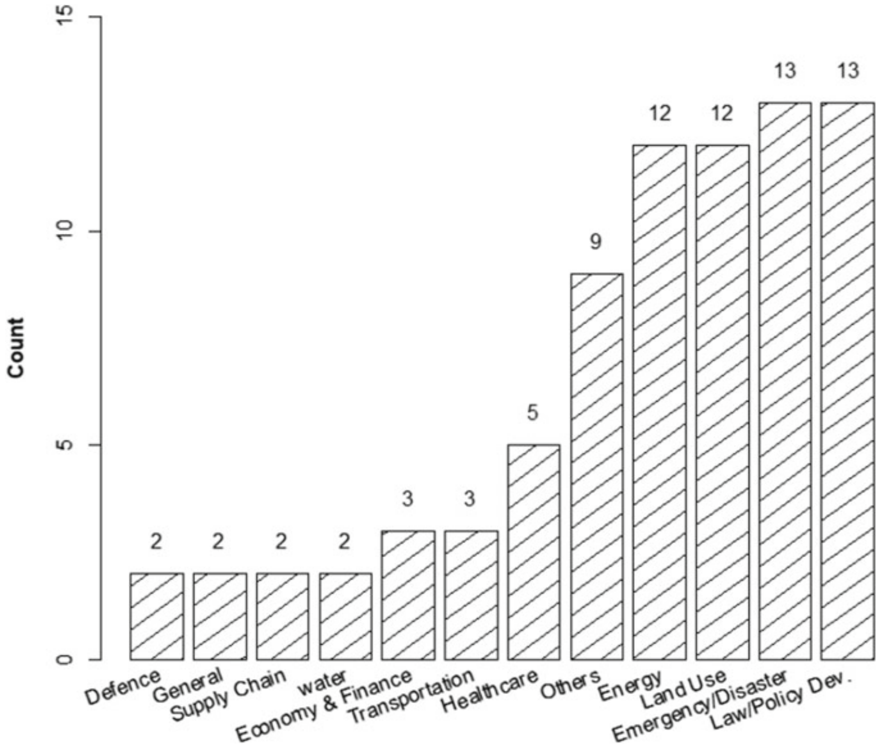


Fig. 3 Number of reviewed papers across domains

how information spreads via micro-level agents, representing affected humans in a disaster-struck geography, and find where assistance hubs should be constructed. Human evacuation strategies were explored for scenarios, such as maritime search and rescue operations (Baber et al., 2013) and bombing during war (Bae et al., 2014). Further, ABM was used to study either the efficacy of existing guidelines or to formulate new ones to address emergency situations, such as bio-attacks (Carley et al., 2006), pandemics (Arora et al., 2012), floods (Dawson et al., 2011; Dutta, 2011), and for large-scale emergency response (Hawe et al., 2012; Liu & Lim, 2018), and disaster management (Inan et al., 2018).

Under the law/policy development domain, ABM was used in 13 papers to study three main phenomena: (1) to increase collaboration with stakeholders for governance purposes of law/policy development; (2) to develop methods or frameworks to test the efficacy of government laws/policies; and (3) to formulate new laws/policies in problem areas. Among them, three papers were found examining collaboration with stakeholders. These studies focused on ways to involve stakeholders in the law/policy-making process (Scherer et al., 2013; Wimmer et al., 2012), and collaborative governance (Choi & Robertson, 2014). Three papers focused on developing and testing laws/policies (Babic et al., 2017; Sengupta & Bennett, 2003;

Sridhar & Mandyam, 2010), while three papers (De Nijs et al., 2017; Furtado et al., 2019; Oughton et al., 2018) used complex adaptive system methodologies for developing laws/public policies. Four other papers were found to apply ABM to develop laws/policies in specific areas, such as copyright laws for digital content (Regner et al., 2010), laws for childhood obesity prevention (Seifu et al., 2018) and changing food behaviors of citizens (Giabbanelli & Crutzen, 2017), and increasing compliance by reducing societal resistance (Zia et al., 2019). For example, Seifu et al. (2018) built an ABM based proto-type to help Baltimore policymakers understand obesity as a central phenomenon and formulate obesity control/prevention laws focusing on micro-level agents, representing children. The policymakers in the study found the work to be very useful to gauge the potential efficacy of various policies under development.

In the land-use domain, the 12 papers were found to focus on three phenomena: (1) general study of land usage and methods; (2) rate of urbanization or changing land covers; and (3) governance, planning, and guidelines. For general study of land usage, five papers were found. These papers used ABM to develop spatial models (Bone & Dragićević, 2009; Brown et al., 2005), study impacts of land management on the ecosystem and biodiversity (Habib et al., 2016), study the patterns of public space use by individuals (Cheliotis, 2020), and the potential of ABM for forest-based industries (Frayret, 2011). Two papers used ABM to understand the drivers of urbanization and the future urban landscape for various possible rates of urbanization (Liu et al., 2013; Tian et al., 2011). Five papers studied guidelines, governance, and planning for land resources. These papers aim to understand how urbanization-related guidelines (Smajgl & Bohensky, 2013), governance of land resources (d'Aquino et al., 2002), and future urban planning (Waddell, 2002; Yu et al., 2013) can benefit from ABM and contribute to policymakers' aim of sustainable management of land resources. For example, Yu et al. (2013) used ABM to study land-use planning to achieve sustainable management of land resources. They modeled humans in a given geography as micro-agents and studied the change in land usage under various natural, social, and other constraint variables. This could help policymakers formulate land-use planning strategies based on different development goals.

Under the energy domain, the 12 papers examined various needs and aspects of energy management. Of these, five papers focused on studying electric power networks, scaling, and optimization (Busch et al., 2017; Hoekstra et al., 2017; Hopkinson et al., 2003, 2006; Nguyen & Flueck, 2012), three papers were on smart grid adoption challenges and societal changes (Ketter et al., 2016, 2018; Peters et al., 2013), two papers were on smart grid security and metering technology (Ross et al., 2013; Zhang & Nuttall, 2012), and one paper each studied alternative energy resources (Vasirani et al., 2013), and adaptive pricing (Valogianni et al., 2020). For example, Peters et al. (2013) used design theory along with ABM to propose artifacts for smart grid infrastructure. Modeling behaviors of human micro-level agents, their experiments covering five countries could help policymakers understand how to achieve balance between a wholesale versus retail power trading strategy, while avoiding systematic errors.

Table 2 Number of reviewed papers across methods and domains

	Conceptual	Conceptual and experiment	Experiment	Prototype	Review
Defense		2			
Economy and finance	1	1		1	
Emergency/disaster	1	1	8	2	1
Energy			8	2	2
General	1		1		
Health care			3		2
Land use		2	7	2	1
Law/policy dev	4	5	1	1	2
Others	3	1	3	2	
Supply chain		1	1		
Transportation			1	1	1
Water			1	1	

The land-use domain saw a steady stream of papers during our review period, indicating its salience in utilizing ABM. Other common domains of ABM use gained research interest later, i.e., 2006 for emergency/disaster and 2010 for law/policy development, while energy domain applications did not show a clear pattern. The first paper on studying disease outbreak using ABM (Epstein et al., 2002) came a year after the SARS outbreak in 2003. However, we observed that the number of applications of ABM in healthcare governance to develop containment strategies and healthcare guidelines remains relatively low. We expect this to change in the next few years due to the COVID-19 epidemic.

As shown in Table 2, out of 10 conceptual papers, the most (4 papers) covered application of ABM to law/policy development. These papers proposed methods or frameworks to implement intellectual property rights for digital content (Regner et al., 2010), collaborative governance (Choi & Robertson, 2014), public policy and decision making (Oughton et al., 2018), and societal resistance modeling (Zia et al., 2019). Other conceptual papers focused on methods or frameworks to model individual and crowd behaviors (Smajgl et al., 2011; Zhou et al., 2010), to simulate socio-ecological systems (Lippe et al., 2019), to study importance of social networks in disaster management (Baber et al., 2013), to model the economy (Markose, 2013), and government initiatives (Gasmelseid, 2007).

Out of the 13 papers that developed conceptual frameworks followed by experimentation, the most (5 papers) examined law/policy development. The main focus of these studies was policy development and evaluation (Sridhar & Mandyam, 2010; Sengupta & Bennett, 2003; De Nijs et al., 2017) or collaborative development of policies by engaging stakeholders (Scherer et al., 2013; Wimmer et al., 2012). A further 2 papers each were found that applied ABM to defense (Cil & Mala, 2010; Ilachinski, 2000) and land-use (Brown et al., 2005; Yu et al., 2013) domains with this approach. Finally, 1 paper each was found in economy and finance (Streit & Borenstein, 2009), supply chain (Hogenboom et al., 2015), and emergency/disaster (Inan et al., 2018) domains following this approach. We did not find conceptual or conceptual with experimentation studies in energy, health care, transportation, and water domains.

Out of the 34 experiment-only papers, most papers (8 papers each) used ABM in emergency/disaster and energy-related simulation studies. For instance, these papers covered bio-war and pandemic disasters (Arora et al., 2012; Carley et al., 2006), fires, floods, and volcanoes (Dawson et al., 2011; Jumadi et al., 2020; Liu & Lim, 2018; Ruas et al., 2009), insurgency (Cioffi-Revilla & Rouleau, 2010), and bombing (Bae et al., 2014). Another seven papers focused on land use, three each on health care, and the others category, and one each in law/policy development, transportation, supply chain, water, and the general category.

Among the 12 prototype papers, 2 papers each used ABM for examining phenomena in the domains of emergency/disaster (Crooks & Wise, 2013; Dutta, 2011), energy (Nguyen & Flueck, 2012; Ross et al., 2013), and land use (Habib et al., 2016; Waddell, 2002). Further, 1 paper each was found developing prototypes for economy and finance (Deissenberg et al., 2008), law/policy development (Seifu et al., 2018), transportation (Chen et al., 2009), and water (Galán et al., 2009) domains. Last, 2 papers developed prototypes under the others category (Gaud et al., 2008; Farjad et al., 2017).

Out of the 9 review papers, 2 papers each covered ABM applications in health care (Isern & Moreno, 2016; Tracy et al., 2018), energy (Hoekstra et al., 2017; Ketter et al., 2018), and law/policy development (Furtado et al., 2019; Giabbanelli & Crutzen, 2017) domains. Finally, 1 paper each reviewed applications of ABM in emergency/disaster (Hawe et al., 2012), land use (Frayret, 2011), and transportation (Chen & Cheng, 2010) domains.

3.5 Distribution Over Level of Analysis (LOA)

The ABM technique can be applied to multiple agent levels, ranging from individuals and groups, to cities, countries, or systems, e.g., energy grids, manufacturing, transportation, or socio-political systems. As shown in Fig. 4, 54 papers (69%) in our review applied ABM to model individuals or groups of individuals, 11 papers (14%) studied systems, 4 papers (5%) studied city-level phenomena, and the rest 9 (12%) were review papers on specific domains as mentioned earlier. None of the papers in our review performed a country-level study. We can see that there is still limited research using ABM to model digital governance problems at city, system, or national levels, which offers an opportunity for future research.

As shown in Table 3, for papers that applied ABM to model individuals or groups of individuals, the focus was to study micro- to macro-level emergence of behaviors for problem areas in different domains. The top 2 domains found in our sample

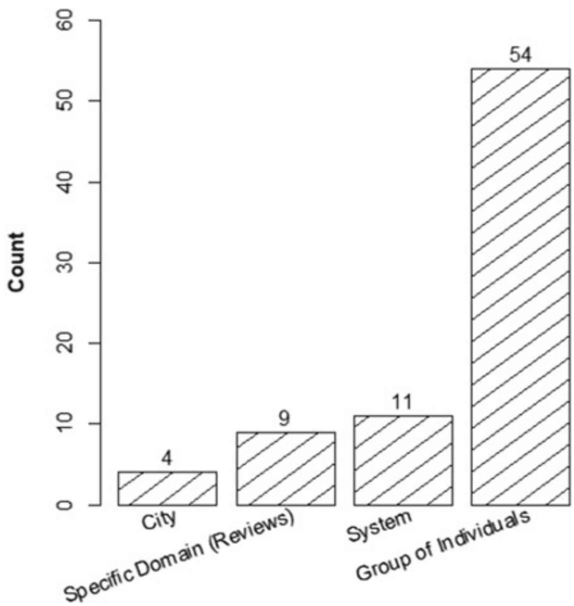


Fig. 4 Number of reviewed papers by level of analysis

Table 3 Number of reviewed papers across LOA and domains

	Group of individuals	System	Specific domain (reviews)	City
Defense	2			
General	2			
Economy and finance	2	1		
Emergency/disaster	9	1	1	2
Energy	4	6	2	
Others	8			1
Health care	3		2	
Land use	10		1	1
Law/policy dev.	10	1	2	
Supply chain	2			
Transportation		2	1	
Water	2			

were land use and law/policy development with 10 papers each, followed by emergency/disaster with 9 papers. For papers that applied ABM to study systems, the most (6) papers were in the energy domain, with 2 papers on transportation systems, and 1 each in economy and finance, emergency/disaster, and law/policy development domains. For studies that applied ABM at the city-level, 2 papers tackled emergency/disaster problems, and 1 was about land use.

The use of ABM to study phenomena concerning individuals or groups of individuals was consistently observed throughout our review period, with a rise post 2006. The two other categories, i.e., city and system-level studies, were not as prevalent. The reason for this could be that ABM is used to model a phenomenon or system as a collection of individual behaviors, where macro-behaviors emerge from the interactions among individual agents (Macal & North, 2005). Thus, it typically involves starting with individuals or groups that are parts of the systems under study.

3.6 Distribution Over Theories

We found 38 different theories/perspectives used in our reviewed papers. As shown in Table 4, the top 3 theories employed were complex adaptive systems (CAS) with 5 papers, game theory with 4 papers, and theory of epidemiology with 3 papers. Next, there were three papers each utilizing complexity theory, computational theory, design theory, economic theory, and theory of social learning. Another 30 theories were used in 1 study each. Some studies used multiple theories, while 45 studies did not refer to any theory.

Table 4 Theories used in reviewed papers

Theory	Paper count	Theory	Paper count
CAS theory	5	Holonomy	1
Game theory	4	Innovation diffusion theory	1
Epidemiology	3	Intellectual property rights	1
Complexity theory	2	Macro-economic theories	1
Computational theory	2	Organization science theory	1
Design theory	2	Political science theory	1
Economic theory	2	Queuing theory	1
Social learning theory	2	Relative deprivation theory	1
Appraisal theory	1	Routine activities theory	1
Auction theory	1	Self-categorization theory	1
Bargaining theory	1	Social comparison theory	1
Behavioral science	1	Social network theory	1
Design science theory	1	Syndromic surveillance	1
Discrete choice theory	1	Systems theory	1
Distributed systems theory	1	Theory of crowd behavior	1
Theoretical econometrics	1	Theory of governance	1
Emergent norm theory	1	Parking policy	1
Enforcement theory	1	Theory of planned behaviour	1
Herd theory	1	Urban economic theory	1

3.7 Relation to Digital Governance Systems and Data

Of the 78 reviewed papers, 59 studies carried out some form of experiment or prototyping. The remaining studies were either conceptual discussions or reviews of relevant digital governance topics (Fig. 2). In the studies involving experiment/prototype, ABM built on existing digital governance systems or used data from such systems. Table 5 lists key examples of this nature. Further, we found that in ten of these papers, intelligent agents were modeled through ABM, e.g., for understanding public space use and socio-spatial human behavior (Cheliotis, 2020), and for electric power and communication simulation (Hopkinson et al., 2006).

4 Issues for Future Research

From our reviewed papers, we derived issues and suggestions to improve the application of ABM in the field of digital governance. For this purpose, we divided the ABM process into four stages (see Fig. 5), i.e., *model design, model implementation, model validation*, and *model adoption*, and identified the issues for each stage as described below.

Table 5 Examples of ABM building on existing digital governance systems or data

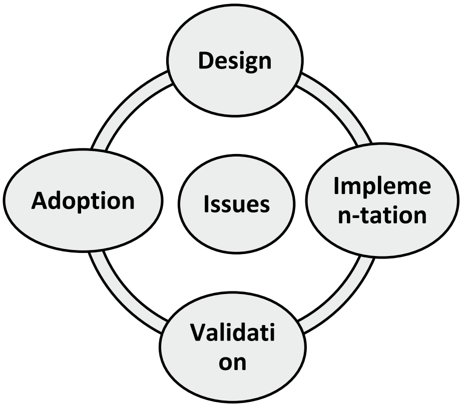
Artifact	Example
Existing systems	• Combining ABM with mobile agent technology to transform existing traffic control systems into intelligent traffic management systems that better deal with uncertainty in dynamic environments (Hernández et al. 2002; Chen et al., 2009) • ABM building on spatial software, such as ArcGIS, to solve problems ranging from disaster management, resource (e.g., land, and water) planning using spatial data (Bone & Dragićević, 2009; Sengupta & Bennett, 2003; Jumadi et al., 2020; Farjad et al., 2017) • ABM building on energy management systems to help city administrators plan against load surges, outages, and other forms of dynamic stress (Hopkinson et al., 2003, 2006; Nguyen & Flueck, 2012; Ross et al., 2013), and increase adoption (Zhang & Nuttall, 2012) • ABM building on public healthcare systems to optimize treatment plans for the youth (Giesen et al., 2015) • Using ABM to help government agencies manage distributed e-government services by coupling with service-oriented architectures (Gasmelseid, 2007) • Using ABM to model pricing in trading agent platform for supply chain market (Hogenboom et al., 2015) • Using ABM to propose adaptive pricing for electricity systems to help energy policymakers better manage demand fluctuations (Valogianni et al., 2020) • Linking ABM with Swarm platform and RoboCup Rescue for fire evacuation (Ruas et al., 2009)

(continued)

Table 5 (continued)

Artifact	Example
Existing data	*Disasters* • Nationally available data on past disasters such as floods, earthquakes, population distribution, urban growth and traffic networks used to study flood vulnerability of individuals and formulate evacuation guidelines (Crooks & Wise, 2013; Dawson et al., 2011) • Rainfall, water-level data sets of the last three decades, and urban growth statistics were used to guide ABM to analyze socio-economic impacts of floods due to sea-level rise (SLR) on coastal cities helping city administrations on potential threats (Dutta, 2011) • Escape plans and evacuation guidelines were tested for efficacy using nationally available inundation data from 2011 Brisbane flood (Liu & Lim, 2018) • National data on administrative boundaries, volcanic hazard zones, shelter locations, land use, census microdata, and road networks were used to validate the evacuation model in the event of a volcanic eruption (Jumadi et al., 2020) • National data on earlier pandemics (e.g., small pox, flu) and demographics were used to help create pandemic related guidelines for government agencies (Arora et al., 2012; Epstein et al., 2002; Parker & Epstein, 2011) • National repositories of dedicated disaster management plans (DISPLANs) to create flood related unified knowledge repository for disaster planning (Inan et al., 2018) • National data on census, school district boundaries, and other publicly available information used to configure real cities for bio-war study (Carley et al., 2006) • National geospatial and traffic data used as model parameters to formulate evacuation guidelines during bombing scenarios (Bae et al., 2014) *Resource Planning* • Socioeconomic georeferenced databases of the region was used in ABM to study domestic water management and pricing problem (Galán et al., 2009) • Data on soil properties, land usage, and meteorological data was used to help city planners better understand water uses and users in the city (Berger et al., 2007) • Data on land use, distance to shoreline, together with Digital Shoreline Analysis System (DSAS) model was used to help city planners understand the land usage change in coastal areas (She et al., 2017) • Data on wind power generation, electricity prices, combined with electric vehicle characteristics to study feasibility of storing wind power in electric vehicles (Vasirani et al., 2013) • National meteorological data together with socio-economic survey data, and crop farm data to formulate water usage guidelines (Berger et al., 2007; Galán et al., 2009) *Economy* • GIS data, economic data, and energy prices data available from Eurostat was used to model and understand the European economy (Deissenberg et al., 2008) • Data on Brazilian economy was used for computational experiments (Streit & Borenstein, 2009) *Defense* • Combat related data available to defense agencies (e.g., Intelligence and Enemy Tactics Techniques and Procedure Databases) that captures the inter-relation of various components involved to study emergent phenomena in multi-dimensional combat (Cil & Mala, 2010; Ilachinski, 2000)

Fig. 5 Stages of ABM application



The *model design* stage deals with proposing frameworks and methods to apply ABM, either alone or in conjunction with other techniques, to study the phenomenon of interest. This stage identifies the theories, assumptions, agents, variables involved, and various components in the overall architecture of the model. In Table 6, we highlight the issues for digital governance research relevant to this stage.

The next stage of *model implementation* refers to the ways to use available simulation tools, and combine multiple tools with ABM, to either conduct experiments or develop prototypes for analyzing the problems for different scenarios. In Table 7, we highlight the issues for digital governance research relevant to this stage.

Model validation deals with methods to validate/evaluate the results emerging from the experiments and prototypes using surveys, interviews with stakeholders, use of additional datasets, or knowledge gathered from review of relevant literature. Model validation helps enhance the understanding of the phenomena under study, calibrate and improve the implemented model by uncovering its shortcomings, and fine-tune the model's parameters. In Table 8, we highlight the issues for digital governance research relevant to this stage.

The final stage of *model adoption* refers to the stage when an agent-based research model, after prototype, is taken up by relevant users for whom the model was being developed. Model adoption is often a result of the model's utility, ease of use, performance, robustness, and users' trust in the model. In Table 9, we highlight the issues for digital governance relevant to this stage.

It is to be noted that the issues and directions presented in Tables 6, 7, 8 and 9 are not necessarily independent of each other and could be related.

5 Other Research Directions and Conclusion

Our review shows that the application of ABM in digital governance has gradually grown in the last two decades. The number of papers increased on average from 1.2

Table 6 Issues and future directions for ABM design

Model design issues and future directions
1. More attention to be paid to theory development (Parker & Epstein, 2011) and application of theory at more granular levels (Bichler et al., 2010), e.g., for disease transmission study or study of markets
2. Need to include more environmental variables and scenarios to make ABM more realistic (Giesen et al., 2015; Malleson et al., 2009; Streit & Borenstein, 2009; Waddell, 2002), e.g., including black swan events, probability of natural disasters, social unrest or wars in oil price models
3. Greater emphasis on individual agent's cognitive structure when perceptions are of importance in the study (Cioffi-Revilla & Rouleau, 2010), e.g., for modeling insurgency and political instability
4. Parameterization of agents and rules is still largely a trial and error process, which requires a lot of effort from the ABM designer. There is a need for more precise guidelines on parameterization of human behaviour (Smajgl et al., 2011; Zhou et al., 2010), e.g., crowd, socio-ecological modeling
5. Need to develop empirical frameworks for social networks and the agent environment (Frayret, 2011; Smajgl et al., 2011), e.g., for socio-ecological and forestry modeling
6. Research should focus on the study of individual interaction behavior among different agents at a micro-scale level (Liu et al., 2013), e.g., for rural to urban conversion
7. Improve agents' decision rules in the model by introducing game theory, genetic algorithms, neural networks (Ding et al., 2016), e.g., for building demolition waste management
8. Need to go beyond traditional models to capture the complexities of real-life situations (Farjad et al., 2017; Ross et al., 2013), e.g., for smart grid, and water resources management
9. Need for more examples of complexity-based approaches for supporting public policy (Oughton et al., 2018); e.g., for infrastructure development
10. Need to pay more attention to the openness and scalability of designed systems (Chen & Cheng, 2010); e.g., transportation planning studies should be designed to scale based on city sizes and traffic conditions
11. Need for a finer split of agents into groups (Chang et al., 2013); e.g., adding behavioral details of agents to crime models will help to elucidate the effect of various configurations on criminal opportunity (Malleson et al., 2009)
12. Need to include policy stakeholders, general public, and social learning of stakeholders when designing a computational simulation model for policy formulation (Chang et al., 2013; Seifu et al., 2018)

papers per year from 2000 to 2005 to nearly 4 papers per year from 2014 to the present. However, the majority of the 78 publications remained concentrated in non-IS journals, with 8 papers being published in IS journals. This indicates a significant opportunity for IS research in this area.

The studies in our review were mainly related to four domains—*emergency/disaster, land use, energy,* and *law/policy development*. However, under these domains, the problems examined remained relatively limited. First, emergency/disaster studies largely focused on fire and flood-based evacuation scenarios, and related planning. Other disasters, such as earthquakes, volcanic eruptions, tsunamis, terror attacks, disease outbreaks, civil violence, and crime received less

Table 7 Issues and future directions for ABM implementation

Model implementation issues and future directions
1. Linking ABM to state-of-the-art software, other knowledge bases or techniques to create hybrid systems (Bae et al., 2014; Berger et al., 2007; Chang et al., 2013; Chen & Cheng, 2010; Crooks & Wise, 2013; Ding et al., 2016; Hoekstra et al., 2017; Parker & Epstein, 2011; Ruas et al., 2009; Wimmer et al., 2012), e.g., linking swarm platform and RoboCup Rescue for fire evacuation, linking ABM to GIS and other statistical packages for better decision making in land-use policy formulation
2. Need to broaden the applicability of developed tools/techniques to other areas and situations (Hawe et al., 2012; Jumadi et al., 2020; Sengupta & Bennett, 2003; Vasirani et al., 2013; Waddell, 2002; Zhou et al., 2010), e.g., developing more generalized models of citizen evacuation applicable to not just floods, but also fires and other natural disaster so as to help policymakers create and be prepared with a common set of guidelines when disasters hit—**both design and implementation**
3. ABM applications with real data demand great computational power (Galán et al., 2009)
4. Ability to inject additional resources or intervene at certain stages in the simulation (Arora et al., 2012; Giabbanelli & Crutzen, 2017)

Table 8 Issues and future directions for ABM validation

Model validation issues and future directions
1. Need for more validation of the models before using them for policy making (Bone & Dragićević, 2009; Malleson et al., 2009; Tian et al., 2011; Tracy et al., 2018; Smajgl & Bohensky, 2013; Zhang & Nuttall, 2012), e.g., for crime/burglary management
2. Need to add evaluation components to tools that compute predefined indicators (Habib et al., 2016; Waddell, 2002), e.g., add evaluation component to verify the results of agent-based simulations before using them to support policy formulation in the areas of land use, transportation planning, and urban management
3. Lack of data points or necessary databases of good quality to perform model calibration and validation of results (Busch et al., 2017; Cheliotis, 2020; Galán et al., 2009; Hawe et al., 2012; Hopkinson et al., 2003; Markose, 2013; Seifu et al. 2019; Yuan et al. 2017), e.g., lack of georeferenced databases for land and water resource planning
4. The empirical validation of interdisciplinary models that integrate different scientific branches is challenging (Galán et al., 2009), e.g., for water management

research attention. These incidents can be studied more comprehensively in future, in order to guide governments on their detection, management, and response policies.

Second, the main focus of studies under the land-use domain was on urbanization. While urban expansion is an important problem, a large part of the land area in many countries worldwide is still rural, with villages and forests. Future research can examine governance of rural areas including forests using ABM to help model the challenges (e.g., deforestation) and opportunities to government bodies and allow for better utilization of public resources.

Third, studies under the energy domain have mainly focused on electric power related issues and their management. We believe that it will be fruitful for future studies to examine alternative energy resources, such as wind and solar energy, that

Table 9 Issues and future directions for ABM adoption

Model adoption issues and future directions
1. ABM usage is scarce for policy development (Bone & Dragićević, 2009; Furtado, 2019)
2. Need to build trust in the model results to encourage usability (Berger et al., 2007)
3. Need for systematic guidelines for building and applying empirical ABMs in practice (Smajgl et al., 2011)
4. Need to provide support for traceability which contributes to better understanding and transparency of models (Scherer et al., 2013; Wimmer et al., 2012), e.g., providing helpful description of the steps that lead to certain decisions in a criminology model
5. Limited understanding of computational simulation models by policymakers (Seifu et al., 2019)
6. A major challenge is to ensure the sustainability of using ABM in practical planning situations (Berger et al., 2007); e.g., government officials using ABM need to have both technical and managerial skills to understand, apply, and maintain the models
7. Need to present model assumptions to users and warn them when assumptions are violated (Sengupta & Bennett, 2003)
8. Need to evaluate the maturity of the technology during adoption (Valogianni et al., 2020)

are becoming more relevant due to increasing pollution and climate change. *Fourth*, studies in the law/policy development domain covered relatively limited policies, considering the vast number and range of government policies. Thus, future research can seek to through light on understudied policy areas. Further, more research is required on collaborative policy development and collaborative governance, which still remaining challenging. Last, more research can target less studied domains, such as defense, water, and transportation. Other than the identified domains, certain socially important domains, e.g., agriculture, education, women's empowerment, race relations, domestic violence, and child health, require more research attention.

In terms of the *methodology of the studies*, ABM was applied to digital governance mainly through experimentation, but the number of useful prototypes arising from the studies remained low. It will be worthwhile to see more prototypes being built and tested in future, which can be adopted by end users. While experimentation and prototype development are key steps toward using ABM for digital governance, it is important to utilize and develop conceptual frameworks, theories, and methods for ABM that are not restricted to narrow problems and have applicability to problem classes. Thus, more research is required to *develop sound theories, methods, and guidelines* to systematically apply ABM to digital governance. This will lead to greater clarity for policymakers and social scientists on how to apply ABM in policy development and digital governance.

In terms of the *level of analysis*, human agents are at the heart of digital governance and this is rightly observed in the majority of the reviewed studies. While most studies had individuals or groups of individuals as the focus of their ABM design, there is still a need to better design the granularity of agents, as many studies do not offer a fine-grained representation of agents (Chang et al., 2013). For example, evacuation-related studies can focus on the physical abilities of citizens, in addition to their genders and age groups while defining agents. Another example can be seen in studies on e-participation of citizens where, in addition of their demographics, the ability to access the platforms can be included in the agent design.

In terms of *building on existing digital governance systems and data sources*, we observed papers combining ABM with existing national data sources and systems, such as traffic operations and monitoring software (Chen et al., 2009; Hernández et al. 2002). However, some studies built the governance system directly through ABM, i.e., without improving on existing systems (e.g., Ketter et al., 2016; Parker & Epstein, 2011). Additionally, with respect to *emerging technologies* for digital governance, we found that AI agents were used in only ten papers. Thus, future research can build on the advances in AI to guide ABM driven studies of digital governance.

Further, we highlighted key issues in the design, implementation, validation, and adoption of ABM for digital governance research in Tables 6, 7, 8 and 9. Salient barriers to adoption were found, including the lack of relevant databases for validating ABM studies, policymakers' lack of expertise in using ABM, and the lack of collaboration in the governance process. The *first* barrier could be addressed to some extent by government initiatives on thorough data collection and sharing data with some important sectors, such as health care. The *second* barrier could possibly be addressed by educating policymakers on the potential of simulation techniques, such as ABM, in the field of digital governance. All of these addressal mechanisms need to be researched, implemented, and tested for their efficacy. The *third* barrier can be addressed by devoting more research toward collaboration of relevant stakeholders in the digital governance process. This in turn can help alleviate the trust issue of stakeholders, as highlighted before.

In conclusion, this chapter contributes to the scientific knowledge base of digital governance by providing a timely review of the state of literature on the use of ABM in digital governance, identifying gaps in our understanding, and providing future directions for IS research in this important area.

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Perspectives and Future Research Directions for Digital Governance

Government 3.0: Scenarios and Roadmap of Research

Alexander Ronzhyn and Maria A. Wimmer

Abstract The broad diffusion of so-called disruptive technologies in the public sector is expected to heavily impact and give a strong digital boost to public service provisioning. To ensure acceptance and sustainability, the benefits and challenges of using disruptive technologies in public service provisioning need to be well researched. This chapter applies scenario-based science and technology roadmapping to outline potential future uses of disruptive technologies. It develops a roadmap of research for Government 3.0. Based on a literature review of disruptive technologies in Government 3.0, thirteen scenarios sketch possible use of internet of things, artificial intelligence, machine learning, virtual and augmented reality, big data and other disruptive technologies in public service provisioning. Subsequently, gap analysis is applied to derive a roadmap of research, which outlines nineteen research actions to boost innovation in public service with the use of disruptive technologies, thereby building on engagement of and interaction with expert stakeholders from different fields. We conclude with recommendations for a broader and more informed discussion about how such new (disruptive) technologies can be successfully deployed in the public sector—leveraging the expected benefits of these technologies while at the same time mitigating the drawbacks affiliated with them.

Keywords Government 3.0 · Disruptive technologies · Roadmapping · Scenarios · Scenario-based science and technology roadmapping

1 Introduction

Over the years, digital government evolved along with the evolution of the underlying technologies. While the first digital services provided by the government addressed the improvement of efficiency and interoperability in internal and external processes (Yildiz, 2007), the emergence of the Web 2.0 and of the social media led towards more participatory and collaborative approaches such as e-participation and co-creation in

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digital government. Scholars call this evolution Government 2.0, as a reference to Web 2.0 (Baumgarten & Chui, 2009; Bonsón et al., 2012; Chun et al., 2010). Further advances in technology, ubiquitous computing, the exponential increase in collected and produced data, and the emergence of completely new technologies demanded further adaptations from the governments worldwide. Driven on the one hand by the promises of the new disruptive technologies and on the other by the public demand of smarter, more adaptive solutions, a new generation of digital government was coined Government 3.0 (Charalabidis et al., 2019).

Government 3.0 is characterised by two core strands: (i) technological: the next-generation digital government makes use of disruptive technologies such as artificial intelligence, machine learning, big data, virtual and augmented reality, Internet of things; (ii) by the orientation towards customised services and data-driven evidence-based decision-making (Viale Pereira et al., 2018). In this regard, Government 3.0 corresponds to the fourth stage in Janowski's classification: *Contextualisation or Policy-Driven Electronic Governance* (Janowski, 2015). The Government 3.0 concept builds on the earlier generations of Government 1.0 and Government 2.0 (Charalabidis et al., 2019).

The increasing penetration of digital technologies (in particular the Internet) into the fabric of the society puts significant challenges related to transparency, accountability and privacy. As modern technologies become more sophisticated and prominent in the lives of people, the more significant becomes the debate of the underlying ethical values of these technologies and solutions. This is exceedingly relevant in regard to public services, which operate with privacy-sensitive citizen data. Handling privacy-sensitive citizen data in public services requires well-established data governance policies to avoid data leaks or misuse. Issues in this regard include not purely technical requirements of robust approaches to data storage and use. Also, the sharing and reuse of sensitive data between government departments or even different governments needs responsible governance. Finally, the inclusion of all of the citizens is crucial to prevent from "digital divide" (Dey et al., 2016; Easton-Calabria & Allen, 2015). As with the use of disruptive technologies, public services may become automated. Automated decision-making in such public services based on data may suffer from hidden biases and discrimination (Roselli et al., 2019; Sun & Medaglia, 2019). Given the effect such automated decision-making can have on the lives of citizens, it is crucial to address these challenges at the stage of service development and not after the services are running and may already have done harm (Ronzhyn & Wimmer, 2019; Yapo & Weiss, 2018).

In order to realise the full potential of new technologies in Government 3.0 and to properly address the aforementioned challenges, further research is needed. The research roadmap introduced in this chapter outlines main areas of future research, formulated based on an expert analysis and elaboration of a number of possible future scenarios involving disruptive technologies in public service. Methodologically, the work is based on an adapted approach of policy-oriented science and technology roadmapping (Wimmer et al., 2007), leveraging scenario building and expert analysis (Janssen et al., 2007).

The remainder of this chapter is as follows: the next section provides an overview of disruptive technologies in Government 3.0. Section 3 introduces the science and technology roadmapping and the future scenario technique. Subsequently, the thirteen future scenarios and resulting research needs for Government 3.0 are outlined in Sect. 4. The roadmap actions are documented in Sect. 5. The chapter concludes with a discussion of implications and a summary of the main findings.

2 Disruptive Technologies in Government 3.0

As already indicated in the introductory section, the implementation of public services taking advantage of disruptive technologies is one of the core characteristics of Government 3.0. *Disruptive technologies* can be defined as technologies, whose application has potential to drastically alter the processes and operations in a particular domain (Kostoff et al., 2004). As evident from this definition, the disruptive potential of technologies is relative and depends on the specific domain of application: some technologies might be defined as disruptive in certain areas, while offering only incremental improvement in others. The Gov 3.0 project (Gov3.0, 2018; Viale Pereira et al., 2018; Wimmer et al., 2020) studied a number of relevant disruptive technologies that can be deployed in the public sector:

Artificial intelligence (AI) and machine learning (ML). ML is the field of study that enables computers to learn without being explicitly programmed (Chui et al., 2017), while AI refers to the capabilities of the machines to realise cognitive functions associated with human intelligence, particularly in relation to solving complex problems (Russell & Norvig, 2009). AI and ML are already used in pattern identification (including facial recognition), social bots, natural language processing (NLP), for the purposes of gaming-based simulation in different domains from military to healthcare (Luger, 2005). The disruptive potential lies in the possibilities of automated decision-making and capability to deal with large amounts of real-time data, including unstructured data, which poses significant challenges for more traditional approaches (Guo et al., 2016).

Internet of Things (IoT). The International Telecommunication Union defines IoT as "*a global infrastructure for the Information Society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies*" (ITU, 2012). IoT is a network of sensors and actuating devices (often small and cheap to allow wide use) that is used as an infrastructure, e.g. in smart city solutions (Gubbi et al., 2013).

Virtual and augmented reality (VR, AR). VR refers to immersive interactive simulation of dynamic realistic worlds with the help of computer graphics (Burdea & Coiffet, 2003). AR is about enriching the view of the real world with virtual elements (Lee, 2012). Both AR and VR are primarily used for visualisation, for example in planning, transportation, surveillance, etc. (Bermejo et al., 2017; Huang et al., 2014). Potentially, these technologies can contribute to deliver public services remotely, which is particularly relevant in pandemic times.

Big data analytics. Different approaches to the analysis of big data can allow extracting more value from the data and provide better insight into the citizen needs, resulting in more relevant, customised and even anticipative citizen services (Chen & Hsieh, 2014). Increase in the computational capacities and advances in data analysis methodologies (such as ML) drive the innovation in this area.

Policy modelling and simulation. Policy modelling is an approach of using quantitative and qualitative models and techniques, along with underlying theories to analytically evaluate causes and effects of policies on a society (Ruiz Estrada, 2011). Simulation models can help explaining causal effects and influence factors of public policies and in turn enable better informed decision-making (Majstorovic et al., 2015).

Gamification. Gamification was identified in the Gov 3.0 project as a technique with disruptive potential (Ronzhyn et al., 2020; Wimmer et al., 2020). Gamification refers to the introduction of game elements into non-game situations (Huotari & Hamari, 2017). It has been used to engage more people in using e-participation services (Taylor & Richter, 2015) or to positively influence and nudge people's behaviour (Kazhamiakin et al., 2016; Schouten et al., 2017).

Above outlines of disruptive technologies indicate that these technologies are deeply interconnected in their application. AI can make decisions trained by machine learning and based on the analysis of big data collected using IoT devices and sensors. AR and VR can help gamifying public services, thus making them more attractive to citizens. Simulations make use of AI and big data. Therefore, introducing these technologies in public sector requires consideration of the interconnectedness of these technologies to leverage synergies.

3 Methodology to Generate Future Scenarios and the Roadmap of Research

To develop a roadmap of research of Government 3.0, an adapted approach of policy-oriented science and technology roadmapping was used. The approach crystalised over the years and has evolved during the previous roadmapping endeavours: developing the e-government research roadmap (Codagnone & Wimmer, 2007), ICT-enabled governance and policy modelling (Bicking & Wimmer, 2011; Charalabidis et al., 2012), defining grand challenges of policy-making and governance (Majstorovic & Wimmer, 2014). The applied methodology has been previously described in Ronzhyn et al. (2019) and exemplified in Viale Pereira et al. (2020) and Ronzhyn et al. (2020). Therefore, in this section, we only provide a short description of the main steps of the methodology. Figure 1 illustrates the sequence of steps taken to develop the research roadmap.

In the *first step*, existing literature on disruptive technologies applied in the public sector was analysed (1039 articles, see Gov 3.0, 2018). Furthermore, existing projects were analysed and synthesised to gather insights on recent and current research in

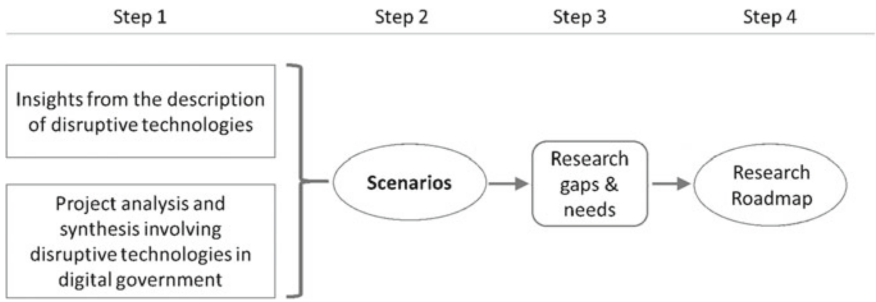

Fig. 1 Research design to formulate the research roadmap of Government 3.0

the relevant areas of using disruptive technologies in public service provisioning (281 projects, see Gov 3.0, 2019). The literature analysis and synthesis of existing projects allowed to gain understanding of the state of the art in the domain and build solid foundations for developing future scenarios of using disruptive technologies in different settings of public service.

In *step two*, future scenarios were developed by the project partners to spot the use of disruptive technologies in public service based on scenario technique. Scenarios have been widely used in the research and envisioning of possible futures, both in public and private sectors (Ratcliffe, 2000; Schwartz, 1996). Scenarios are narratives created to describe or explore possible future states in a specific area of interest (Johnson et al., 2012). The aim of scenarios is to improve the understanding of a specific issue under consideration and possibly serve as an instrument for decision-making by providing additional perspectives on the topic (Ratcliffe, 2000). Scenarios are well suited for exploring situations with significant degree of uncertainty. Often, multiple scenarios are built to describe vastly different future developments. The aim of scenario building is not forecasting but gaining a wider view on the topic of study and identifying possible issues that remain overlooked using traditional methods of qualitative or quantitative research (Berkhout et al., 2002; Peterson et al., 2003). In the Gov 3.0 project, a total of thirteen future scenarios (described in the next section) were developed, envisioning possible future uses of disruptive technologies in different application areas of digital government. The scenarios were subsequently presented to experts in four different workshops, organised at scientific events worldwide.

In *step 3*, the research gaps and needs were extracted from the expert input collected at the workshops (Wimmer et al., 2020). The researchers employed a method of qualitative content analysis (Flick, 2007; Strauss & Corbin, 1990) to extract the list of research needs. The research needs were used to formulate specific roadmap actions in *step 4*.

The benefits of applying gap analysis and roadmap development are twofold: firstly, scenarios of future development in digital government (cf. step 2) provide a glimpse in possible futures of the domain, which can be contrasted with insights and state of play of current research and development of step 1. Secondly, the roadmap suggests specific actions that need to be completed to realise futures sketched in the scenarios.

The next two sections outline the scenarios of future developments in Government 3.0 and the research roadmap developed in the Gov 3.0 project.

4 Future Scenarios and Research Needs of Government 3.0

In the Gov 3.0 project, thirteen future scenarios were developed and discussed during four workshops involving experts from the field of public administration and academia. Each scenario was discussed at least twice to ensure that as many opinions are collected as possible. The thirteen scenarios are briefly summarised below, indicating the application area and the disruptive technologies or concepts involved. Extensive descriptions and visualisations of the scenarios are available in (Gov 3.0, 2019). At the workshops, each scenario was accompanied by a diagram showing the main aspects of the scenario as well as information exchange between the stakeholders involved in the scenario. Scenarios were also modified based on the feedback of the workshop participants.

Scenario 1: Smart City AI-aided emergency monitoring system. In this scenario, an AI system integrated into Smart City makes decisions automatically based on data from a large number of IoT sensors as well as results of social media monitoring (see Viale Pereira et al., 2020 for a more detailed description and visualisation of the scenario).

Scenario 2: Intelligent citizen portals using chatbot interface. In this scenario, citizen portals equipped with chatbot interface (leveraging NLP) provide cross-border services (moving, registration of vehicle) and implement once-only principle (see Ronzhyn et al. 2019 for a more detailed description and visualisation of the scenario).

Scenario 3: VR and AR for emergency training. The scenario suggests using VR and VR to simulate emergency scenarios at specific buildings. After this more immersive and realistic training, employees are better prepared for dealing with an actual emergency (see Wimmer et al. 2020 for a more detailed description and visualisation of the scenario).

Scenario 4: Open data lifecycle. Scenario describes the leveraging of the open government data along the full open data lifecycle.

Scenario 5: Digital government through cloud computing. Scenario describes offering cloud computing as PaaS (Platform as a Service), allowing the municipalities to benefit from the improved computational power and lower maintenance costs.

Scenario 6: Using IoT to monitor soil erosion and degradation. In the scenario, IoT devices are used to monitor changes in the quality of soil. The collected data is then analysed by an AI system that provides policy recommendation and action plans.

Scenario 7: Gamification in energy consumption. This scenario describes the use of a mobile app with a game-like points system that encourages both individuals and businesses to improve their energy consumption habits (see Ronzhyn et al. 2020 for a more detailed description of the scenario).

Scenario 8: Gaming-based simulation and policy modelling. In the scenario, gaming-based simulation is used to gather input on the stage of policy formulation and testing.

Scenario 9: Natural language processing in tourism. The scenario describes the use of NLP system to analyse social media data and formulate improvements for the different institutions in the tourism sector.

Scenario 10: Blockchain for vehicle lifecycle management. In this scenario, blockchain is used to store the information about vehicles for optimal management across different countries.

Scenario 11: Using e-ID and e-signature for verified health data sharing. The scenario describes the use of e-ID and e-signature to ensure the ownership of health data and increase its value.

Scenario 12: Co-creation of APIs using open government data (OGD). The scenario is about the reuse of OGD through the open APIs, co-produced by citizens and businesses.

Scenario 13: Community awareness platforms for behavioural change. In this scenario, the OGD, data from sensors and social media are used to create a platform that helps to raise citizen awareness about pressing societal issues.

A total of 70 experts, academics, public officials, government representatives, private sector representatives and students participated in the workshops. Most experts came from Europe (63 persons from 17 European countries); others came from the Americas (4), Asia (2) and Australia (1). The diversity among experts allowed gathering varied and original input based on experts' individual backgrounds and experiences. Internal evaluation of scenarios involved discussions among the Gov 3.0 project team, who primarily have an academic background.

The scenario workshops allowed identifying 62 research needs, which served as a basis for the elaboration of the research roadmap. Table 1 lists the identified research needs (i.e. keywords and terms of relevant research concepts) in relation to the specific technologies described in the scenarios.

The next section describes the research roadmap of Gov 3.0, which was extracted from the state of play analysis (literature review and project analysis), the future scenarios and the research needs identified above.

5 Research Roadmap

The research needs identified during the roadmapping workshops were analysed in iterative steps by the project partners. Table 1 shows the resulting final roadmap of Government 3.0. It consists of nineteen actions addressing the research needs. For each action, a brief description is provided along with methodical indications as well as objectives and actors involved. The research roadmap provides a guidance for researchers to study and address particular research needs in their future work.

Table 1 Research needs identified along the future scenarios

Disruptive technology or concept	Identified research needs (relevant scenario(s) of Gov 3.0 spotting the research need(s) are provided in brackets)
Big data	Data accuracy (1), Social media data analysis (1, 13), Data quality (1,4)
Open linked data	Stakeholder engagement (4), Data quality (4), Open Data lifecycle (4), Organisational change (4)
IoT	Data Accuracy (1, 6), Standardisation of sensors (6), Cost–benefit analysis of IoT solutions (6), Optical recognition, advanced sensing (6), Maintenance and sustainability of sensors (6), Legislation in IoT domain (6), Blockchain for data storage (6)
Smart city	Making sense of large amounts of urban data (1), Real-time data-based decision-making (1), Decision support systems (1), Public trust (1)
AI/ML	Real-time urban data analysis (1), Transparency of decision-making (1), Analysis of unstructured data from Social Media (1), Policy-making based on data (6), (Real-time) decision-making (1, 6), Legal issues in automated decision-making (1,6), Ethical decision-making (1)
AR/VR	Data privacy (3), 3D mapping technologies (3), Modelling of environments in VR (3), Use of beacons for AR (3)
Cloud computing	Organisational change (5), Cloud services privacy and security (5), Legal aspects (5)
Natural language processing	Analysis of social media postings (1, 9, 13), Sentiment analysis (9), NLP in multiple languages (9), Opinion mining (9)
Blockchain	Blockchain regulation (10), Stakeholder engagement (10), Benefits/drawbacks of blockchain in digital government (10), Ethics (10)
Once-only principle	OOP-related technologies (2), OOP methodologies (2), OOP regulation (including private sector) (2), Data privacy (2)
Other technologies (community awareness platforms, gaming-based simulation, eID, e-signature, policy modelling, service modules)	Community building (13), Citizen engagement strategies (13), Network analysis (13) Social media data analysis (13), Re-using service building blocks (2), Game theory (8) Game development (8), Decision support systems (8), Interoperability, standards (11) Personal data use across different databases (11), Ethics (11), Biometric technologies (11) Encryption techniques (11)

(continued)

Table 1 (continued)

Disruptive technology or concept	Identified research needs (relevant scenario(s) of Gov 3.0 spotting the research need(s) are provided in brackets)
Other concepts (co-creation, gamification)	Co-creation in specific areas of digital government (12), Liquid democracy tools (12) Citizen engagement strategies (7, 12), User-centric services (12), Behavioural change (7, 12)

The roadmap actions spotted in Table 2 can be divided into three main groups of research: case studies and empirical research on the use of disruptive technologies in Government 3.0 (indicated at the top); technology-specific research and innovation (indicated left and right and linked to particular disruptive technologies and concepts); and research on soft factors (indicated at the bottom). The correspondence between roadmap actions and these three groups is shown in Fig. 2. The research actions are indicated with R and the corresponding number in Table 2.

Case studies and empirical research on the use of disruptive technologies in Government 3.0 include actions not limited to the specific disruptive technologies but address all disruptive technologies and concepts used in Government 3.0. R1 "Analysis of first implementations" is useful in further developing and fleshing out the concept of Government 3.0. R2 "Analysis of application areas for the disruptive technologies" suggests deeper research in the practical application of disruptive technologies. The topic can be addressed through empirical research where sufficient data is available; otherwise, the theme can be addressed theoretically using previously developed relevant theory or surveying the opinions of experts. To investigate possible adverse issues stemming from the introduction of new technologies and to develop appropriate mitigation actions, R3 suggests research targeting negative impacts of digital government disruption.

Technology-specific research and innovation includes actions that concern the use of specific disruptive technologies. In the *Smart City* context, researching R4 "Real-time analysis of data coming from multiple sources" is particularly important, as the data from sensors, IoT devices, citizen sourcing and social media should be used together to maximise the benefits within the Smart City (as illustrated in scenario 1 in the previous section). R5 addresses the necessity to formulate adequate and universally applicable rules for automated decisions in smart cities that can be used by the designers of Smart City systems, ensuring both the transparency and interoperability of solutions.

The automated decision-making using *ML/AI* is one of the definition aspects of Government 3.0. R6 suggests research and formulation of transparency requirements for automated algorithms used in digital government, ensuring that ML-based decisions are understandable by the public affected by them. R7 in turn suggests researching the legal issues of automated AI-based decision-making in government.

Table 2 Government 3.0 research roadmap

No	Key action	Description of action and suggested methods	Objective	Actors
1	Analysing existing implementations of disruptive technologies in Government 3.0	Analysis of cases of first exploitations of disruptive technologies in Government 3.0. Realised through case study research of the first implementations	Better understand the benefits and negative aspects of the disruptive technologies in public sector, as well as objectives of such implementations	Researchers
2	Analysing application areas for the disruptive technologies	Deeper research in the practical application of the disruptive technologies. The topic can be addressed through empirical research, where sufficient data are available. Otherwise, the theme can be addressed theoretically using previously developed relevant theory or surveying the opinions of experts	Identification of application areas for disruptive technologies, targeted benefits of their implementation	Researchers
3	Researching negative aspects of the introduction of services based on disruptive technologies	Research of the negative aspects affecting the specific domains (e.g. increased costs of the transition) as well as society as a whole (e.g. increasing digital divide). Short- and long-term effects are to be considered. Qualitative and quantitative empirical methods should be applied	Identification of possible drawbacks of the implementation of disruptive technologies and conditions under which such implementations may not be justified	Researchers, Government institutions

(continued)

Table 2 (continued)

No	Key action	Description of action and suggested methods	Objective	Actors
4	Conducting real-time analysis of data coming from multiple sources	In the Smart City context, data from many different sources can be collected, aggregated and analysed as an input for decision-making. Real-time analysis of heterogeneous data poses unique challenges, which need to be addressed through the development of new approaches, technologies and algorithms	New approaches, technologies and algorithms, facilitating real-time aggregation and analysis of data in Government 3.0 services	Researchers
5	Researching universal automated decision algorithms in Smart City environment	To ensure ethical and transparent use of data for decision-making in smart cities, adequate universal rules for automated decision are necessary that can be used by the designers of Smart City systems, ensuring both the transparency and interoperability of solutions between different implementations. Qualitative and quantitative methods, and ethics by design approaches shall be applied	Clear rules regarding the creation of algorithms for automated decision-making	Researchers

(continued)

Table 2 (continued)

No	Key action	Description of action and suggested methods	Objective	Actors
6	Researching transparency of algorithms used for automated decision-making	Need to research and formulate transparency requirements for automated algorithms for the use in digital government, ensuring that ML-based decisions are understandable by the public affected by them. Qualitative and quantitative methods as well as trustworthiness and transparency by design are suggested	Ensuring transparency of algorithms for automated decision-making in Government 3.0. Transparent and understandable by general public algorithms will ensure public trust towards the solutions	Researchers

(continued)

Table 2 (continued)

No	Key action	Description of action and suggested methods	Objective	Actors
7	Researching legal issues of automated AI-based decision-making in government	Research of the possible solutions to the legal issues arising during the implementation of the automated decision-making in government. Formulating legal requirements for the AI systems used in digital government in terms of accountability of autonomous agents and transparency of decisions made by algorithms. In some situations (e.g. emergencies), the consequences of the decisions may be very significant, so clear regulation is necessary Approaches to ensure legal compliance in combination with design approaches are needed	Develop legal frameworks addressing the new legal challenges arising from the application of the implementation of AI system for automated decision-making, addressing the issues of accountability, transparency and ethics	Researchers, policy makers

(continued)

Table 2 (continued)

No	Key action	Description of action and suggested methods	Objective	Actors
8	Developing standards of IoT for data collection and interoperability	As more IoT devices and sensors are developed, it is necessary to ensure common standards and interoperability guidelines for the devices and data collected This action is particularly important for citizen sourcing and citizen science projects, where data from private sensors are used. To ensure the usability and accuracy of these data, standards need to be developed and agreed upon. Design science research methods and co-creation approaches shall be applied	Developing a common standard for sensors and ensuring the interplay between sensors of different types and from different producers	Researchers, policy makers
9	Organisational change and adaptation of government processes to the pervasiveness of big open and linked data (BOLD) in government	Research into how the administration processes need to be adapted and modified in the age of Government 3.0. Pervasiveness of big open and linked data used for various purposes in digital government may lead to the disruption of the established processes in administration	Existing processes need to be adapted and new processes developed to accommodate changes brought on by the introduction of increased use of BOLD	Researchers, government institutions, policy makers

(continued)

Table 2 (continued)

No	Key action	Description of action and suggested methods	Objective	Actors
10	Development of data governance in the age of data-based decision-making	Both the increased amounts of data used by the government and higher standards of accuracy of data need to be accounted for when developing standards, methods and processes of data governance in digital government. Efficient use of citizen data should be ensured by data governance standards compliant to GDPR and other regulations	Ensure that the proper data governance strategies are used for dealing with increasing amounts of data collected and used by Smart City systems and other digital government implementations	Researchers, policy makers
11	Citizen-oriented implementation of cloud computing in government services as PaaS	Citizen-related issues like privacy, security, inclusivity, usable and personalised services are to be researched in the context of the use of digital government using Platform as a Service (PaaS). Including the implementation of digital cloud-powered services across borders	To develop guidelines and approaches for the best implementation of citizen-oriented distributed PaaS-based services in digital government. Usability, security and privacy are the main requirements for the implementation of these services	Researchers, policy makers
12	Researching the use of OOP in relation to the information stored by private sector companies	Research of risks and implications of the potential increase of the scope of OOP to some areas of the private sector, including some of the information stored by private companies (like insurance information)	Theoretical understanding and guidelines for the possible uses of private-owned data within the once-only principle approach	Researchers, policy makers

(continued)

Table 2 (continued)

No	Key action	Description of action and suggested methods	Objective	Actors
13	Creation of digital government service modules, implementing disruptive technologies	Research of the possibilities of implementing disruptive technologies within service module approach: creation of building blocks leveraging disruptive technologies, which can be implemented by different digital government platforms. Design science research methods are most suitable	Development of guidelines and requirements for the creation of service modules that use disruptive technologies for realisation of their functions. Realisation of the roadmap action will facilitate the development of the services modules that can aid in the realisation of Government 3.0 concept	Researchers
14	Cross-border interoperability of eID and e-signature technologies	Research of cross-border interoperability of eID and e-signature. While eID/e-signature themselves are not Government 3.0 technologies, they are important for realisation of the vision of cross-border services. Qualitative research methods are the most suitable in addressing this roadmap action	Conceptual understanding of eID and e-signature use within Government 3.0	Researchers

(continued)

Table 2 (continued)

No	Key action	Description of action and suggested methods	Objective	Actors
15	Developing guidelines and recommendation of data collection in AR/VR systems	As more digital government services use AR and VR as a technology, it is necessary to develop the recommendations concerning the collection and storage of sensitive user data, acquired with the help or through the use of augmented and virtual reality technology. These include behavioural data, personal data (including visual likeness) or any other type of identifiable personal information	Formulation of recommendation regarding the collection and storage of data, acquired during the use of VR/AR-based systems	Researchers, policy makers
16	Identification of drivers to enable governments to create a scalable distributed network with blockchain technology	Addressing the challenge of creation of a scalable distributed network with blockchain technology, with appropriate performance and security, through identification of the main drivers enabling the realisation of the concept within Government 3.0. Case study analysis and qualitative methods of research focusing on best practices will help to address this research need	Clear formulation of drivers that would enable a creation of a blockchain solution for digital government	Researchers

(continued)

Table 2 (continued)

No	Key action	Description of action and suggested methods	Objective	Actors
17	Regulation of blockchain technology in digital government, compliance with GDPR, right to be forgotten	There is a need to develop an appropriate regulation of blockchain technology, especially the analysis of the compliance of blockchain technology with GDPR and the realisation of the right to be forgotten in the blockchain-based services. Case studies and qualitative research methods can help realise the action	Regulation of blockchain technology implementation in digital government is developed, considering the compliance with GDPR and appropriately realising the EU citizens' "right to be forgotten"	Researchers, policy makers
18	Research of ethical concerns in disruptive technologies implementations	Ethics is a significant need in relation to the implementation of disruptive technologies, especially in relation to the automated decision-making and use of sensitive individual data. Possible ethical concerns to be addressed include: digital exclusion, algorithmic bias, data manipulation, issues of transparency and accountability in automated decision-making, decisions based on incomplete or extrapolated data and others. Ethical concerns need to be appropriately addressed for every realisation of Government 3.0 service	Creation of clear ethical framework that contains the guidelines for addressing the ethical concerns during the implementation of government services making use of disruptive technologies	Researchers, Government institutions

(continued)

Table 2 (continued)

No	Key action	Description of action and suggested methods	Objective	Actors
19	Researching different models for citizen engagement using disruptive technology-specific methods	Technologies like VR, AR, immersive game-based simulations for policy modelling pose new problems of engagement at the same time offering new solutions. It is necessary to research different approaches for citizen engagement with focus on co-creation and disruptive technology-specific methods	Novel approaches to citizen engagement are developed, considering the peculiarities and specific challenges of the disruptive technologies	Researchers

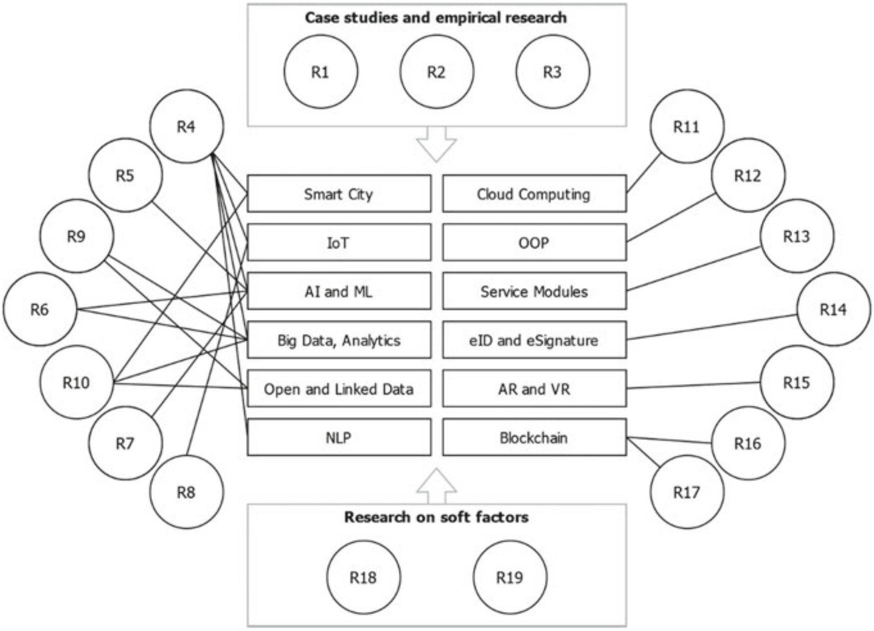

Fig. 2 Classification of research actions in the roadmap

Realising these two actions will help to ensure the public's support of Government 3.0 by addressing the issues of transparency and accountability of government.

In regard to *IoT* in digital government, developing a common standard for sensors and ensuring the interplay between sensors of different types and from different producers are important research needs. R8 "Standards of IoT for data collection and interoperability" is particularly important for citizen sourcing and citizen science projects, where data from private sensors is used.

For *big, open and linked data (BOLD)*, a lot of research has already been conducted, especially in relation to the technological challenges of collection and analysis of big data. Still, it is necessary to address BOLD in terms of organisational change and ensuring optimal data governance practices. R9 suggests investigation of how the administration processes need to be adapted and modified in Government 3.0, while R10 spots research to ensure that the proper data governance strategies are used for dealing with increasing amounts of data collected and used by Smart City systems and other digital government implementations.

For *cloud computing*, R11 targets privacy, security, usable and personalised services, also addressing the specific challenges of adopting Platform as a Service (PaaS) or Software as a Service (SaaS) models in digital government. R12 suggests further research in the implementation of the *once-only principle* in relation to the privacy-sensitive data stored in public sector registers and other digital applications of the public sector. Related, R14 involves studying cross-border interoperability in relation to *eID and e-signature*, which are crucial for realising the cross-border services. R13 addresses the development of standards and frameworks to be used to describe and develop relevant *service modules* in digital government. For *VR and AR* technologies, R15 suggests researching recommendation and formulation of regulation for data collection and aggregation from AR/VR systems. Finally, in relation to the use of *blockchain* in government, R16 suggests research on the identification of the main drivers to enable governments to create a scalable distributed network with blockchain technology, while R17 supposes deeper research of appropriate regulation of blockchain technology, especially the analysis of compliance of blockchain technology with the General Data Protection Regulation (GDPR) and how to address the right to be forgotten in the blockchain-powered services.

Research on soft factors covers actions addressing research on soft, non-technological factors. Ethics is a significant need that has been identified as such for many technologies. Ethical issues are especially evident in automated decision-making and when dealing with personal sensitive information. Possible ethical concerns include: exclusion of certain individuals, algorithmic bias, datasets that lead to the bias in ML, issues of transparency and accountability in automated decision-making, decisions based on incomplete or extrapolated data and others (see an elaboration of ethics along with disruptive technologies in Government 3.0 in Ronzhyn and Wimmer 2019). However, research in this field is relatively scarce. R18 suggests researching ethical concerns along with the diffusion of disruptive technologies in digital government.

Citizen engagement strategies is another issue that requires careful attention. Technologies like VR, AR, immersive game-based simulations for policy modelling pose new challenges of engagement but also offer new solutions. Exploring the ways to increase the rate of government services adoption by the citizens should be one of the research priorities. R19 suggests researching different models for citizen engagement with focus on co-creation and disruptive technology-specific methods.

6 Discussion and Conclusion

While many of the individual disruptive technologies have been extensively researched, the implications of the use of such technologies in digital government are often not studied thoroughly. According to the roadmap, not only the possible uses of the technologies in government should be studied (R1, R2) but also the organisational changes needed to accommodate the growing reliance of governments on big, open and linked data (R9), growing demands for secure data storage and use (R10), distributed systems (R11) interoperability (R8) and cross-border services (R12, R14). While interoperability and standardisation were prioritised targets of previous digital government generations (Charalabidis et al., 2019), we already spotted in the introduction that these previous generations are the basis for Government 3.0, so these factors remain important research assets for leveraging the benefits of disruptive technologies, e.g. of IoT, in Government 3.0.

Automated decision-making as the central concept in Government 3.0 is associated with further research gaps, related to the algorithms for decision-making (R5, R6), data analysis (R4), legal (R7) and data governance issues (R10). Creating regulations and developing common standards should be prioritised as they are crucial for realising services based on disruptive technologies. Technical and regulatory barriers need to be addressed before such services are implemented on a large scale (R15, R16, R17). For AR/VR technologies, current research is focused on technological issues and realisations (Lopes & Lindström, 2012; Porwol & Ojo, 2017); however, the roadmap highlights some digital government specific challenges that need to be addressed, particularly the data collection (R15), including visual data and other personal information (Adams et al., 2019). As application of such systems in government services is still uncommon (and mostly limited to pilot projects), timely formulation of recommendations shall ensure that most of the implemented systems will offer privacy and security "by design".

Some of the roadmap actions explicitly require interdisciplinary and inter-stakeholder collaboration, like elaboration of an ethical framework for disruptive technologies used in digital government (R18), while others would benefit from closer partnership with government actors and policy makers.

As it is a research roadmap, researchers are the target audience; they are the main actors responsible for implementing the roadmap actions. Still, it is worth noting that other actors like policy makers and government institutions play a role in addressing the research needs spotted. Policy makers (on local, national and international levels) are important stakeholders for some of the research actions that involve development of guidelines (R9, R15), standards (R8), and regulations (R7, R10, R11, R12, R17). After the guidelines for the use of the technologies are developed, they need to be implemented in form of policies, laws and official standards. Clear standards will accelerate the development of new solutions based on disruptive technologies and improve the quality and efficiency of Government 3.0 services. For a number of actions, public administrations need to be involved. R9, for example, requires to develop pilot projects to test new governance models, before they are implemented on the larger scale. Similarly, R3 requires input and cooperation from public administration to produce results. Collaboration with public officials is crucial for tailoring the recommendations to the real-life situations and reducing the gap between theory and practice. Ethical concerns (R18) is another area where the input of the government institutions is crucial.

Before concluding, we acknowledge the following limitations of the approach used for building the roadmap: As mentioned before, scenario technique used to develop the roadmap is a heuristic method in its nature. Scenarios are not meant to present the final and definitive views of the future in the domain but rather serve as a means for exploration of potential futures. Furthermore, as the ideal future state is not presented in the scenarios, it does not permit the roadmap to be specific on what to avoid to move towards an ideal state. Therefore, the findings from applying the scenario technique elicit only a slice of possible issues that need to be addressed in relation to disruptive technologies in Government 3.0. This shortcoming is compensated by including the project analysis in the methodology and by involving experts for further input. The opinion of experts and practitioners of digital government allowed fleshing out and specifying better the findings of the future scenario technique, ultimately formulating research needs in the form of concrete roadmap actions. Still, the presented list of research actions is not exhaustive, and with continuing development of the disruptive technologies (and even introduction of new technologies), the roadmap needs to be reviewed and adapted to reflect the evolutions. Furthermore, while initial efforts have been made in the theory development of the digital government domain (Charalabidis & Lachana, 2020a, 2020b), further work is necessary for the scientific development of the field. One final limitation that needs to be acknowledged is the inherent optimism of the outlined futures used for the creation of the roadmap. One possible outcome of application of the disruptive technologies is that they may disrupt society more broadly. While some of the roadmap actions address the possible disruption on some levels (e.g. R3, R7, R18), more research is necessary on this topic. Still, the current nineteen roadmap actions provide an important contribution to envision future innovative digital public services and specifically the role of disruptive technologies in Government 3.0.

To conclude, this chapter presented future scenarios and a research roadmap for digital government, particularly for Government 3.0. Based on the previous research and expert input, thirteen scenarios were constructed to illustrate possible uses of disruptive technologies and concepts in digital government. The scenarios were used in workshops to elicit expert input on the research needs and roadmap actions. Sixty-two research needs were collected and were fed into the roadmap actions, addressing these research needs. Similar needs between technologies were subsequently combined in broader roadmap actions, resulting in a total of nineteen actions for the research roadmap, grouped into three categories: case studies and empirical research on the use of disruptive technologies in Government 3.0; technology-specific research and innovation; and research on soft factors. Comprehensively addressing these research actions is recommended to fully realise the potential of disruptive technologies in Government 3.0 and properly address the arising challenges. We also stress that further research is needed to continuously identify evolving research needs along the evolution of new technology. This includes in particular research to investigate the relationships between technological advancements and the societal impact such advancements generate. Further, it requires theoretical development to understand and guide both future research and practice.

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Building Digital Governance Competencies: Baseline for a Curriculum and Master Programme

Gabriela Viale Pereira, Alexander Ronzhyn, and Maria A. Wimmer

Abstract Emerging technologies and digital transformation in government and society, called Government 3.0, put forward new training needs for graduates in the area. The ERASMUS+ research project "Scientific Foundations Training and Entrepreneurship Activities in the Domain of ICT-enabled Governance" (Gov 3.0) established the scientific domain of Government 3.0 as a vivid scientific domain, encompassing electronic government, ICT-enabled governance and digital government towards decision support for public value creation. To ensure the necessary competencies in achieving such public value creation along the digital transformation of government and society, training needs were analysed and discussed as part of the project Gov 3.0. The result is a baseline for a digital governance curriculum, providing a description of a generic training programme for digital governance and its implementation in the European context. It is complemented with a Master Programme in Digital Governance to build up a comprehensive understanding of the domain of digital government with particular focus on emerging technologies that have the potential to disrupt public governance. The programme deepens the fundamental understanding of digitalization contexts and related organizational modernization of the public sector, knowledge of information systems in the public sector, knowledge of the decision-making systems in public sector and public sector automatization.

Keywords Government 3.0 · Training needs · Curriculum development · Digital governance Masters programme

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1 Introduction

Considering the novelty of the Government 3.0 field (Pereira et al., 2018), there is a need for identifying the capacities and competences of professionals to meet the demands of emerging technologies and transformation in government and society and therefore to frame the new training needs for graduates in the area. Charalabidis and Lachana (2020b) have identified training curricula as one of the crucial factors in establishing the Digital Government Science Base. While considerable research in the digital government domain focuses in either a specific region or country or a specific domain of study, a holistic or a transdisciplinary perspective is missing (Sarantis et al., 2019). Among the challenges, Sarantis et al. (2019) identified towards the development of a universal view and understanding of digital government are: (a) the lack of defined roles, responsibilities, competencies and skills to efficiently cover the digital governance training needs; (b) a dichotomy between a specialized programme of digital governance or a multidisciplinary one that combines different fields; (c) the need for a digital governance training programme at an inter-regional or at an international level; and (d) the continuous updating of such a programme taking into consideration the emerging technologies, such as data science and big data, robotics, artificial intelligence, cyber-physical systems, quantum computing and others (Wimmer et al., 2020).

In the ERASMUS + research project "Scientific Foundations Training and Entrepreneurship Activities in the Domain of ICT-enabled Governance" (Gov 3.0), a Master Programme in Digital Governance has been developed, going beyond the existing state of the art in analysing developments from the public and private sector towards establishing the new, important scientific domain of Government 3.0. The work developed under the project aimed at establishing the current baseline of a digital governance curriculum and describing its fundamental aspects. The goal of this chapter is to provide a description of a generic training programme for digital governance and an exemplification of its implementation in the European context.

The Master Programme in Digital Governance aims to deliver a comprehensive understanding of the domain of digital government with particular focus on emerging technologies with a potential to disrupt public governance. The programme deepens the fundamental understanding of digitalization contexts and related organizational modernization of the public sector, knowledge of information technology and information systems in the public sector, knowledge of the decision-making systems in public sector and public sector automatization. The programme aims to train graduates in a high degree of self-reliance, responsibility and practical skills in the IT areas of the public sector. It also fosters excellence in the scientific research within the domain. This chapter presents the main structure and elements of the proposed programme in order to guide higher education institutions in the implementation of a master degree in the field through a network of institutions to ensure the inherent transdisciplinary and holistic perspective of the domain.

The chapter is structured as follows: Sect. 2 describes the methodology for developing the curriculum. Section 3 describes the training modules. Section 4 presents the implementation of the modules through a MOOC on the “Basics of Digital Government Transformation”. Section 5 describes the Digital Governance Master Programme. Section 6 lists recommendations and guidelines for the implementation of the programme. Finally, Sect. 7 concludes the chapter.

2 Methodology for Developing the Curriculum

The training programme developed in Gov 3.0 provides a basis for developing curricula on digital governance at different levels of education. The implementation of the courses and modules can be done as a continuous process in different universities, being adapted to country-specific drivers and challenges. The training programme consists of a set of 32 module material, which was jointly developed by the Gov 3.0 academic partners. The Gov 3.0 project has also jointly developed a Curriculum for a Digital Governance Master Programme. It contains relevant modules, which integrate the delivery of capacities from different domains such as public administration, computer science and information systems in post-graduate level.

For developing the Digital Governance Master Programme, the authors have adapted the methodology for curriculum development suggested by Okudan et al. (2005) as presented in Fig. 1.

The first step was the external benchmarking with the aim to understand what educational programmes in the domain are available worldwide and what are the training needs discussed in the literature. This step resulted in the Report for Worldwide Training Needs on Electronic Governance (D 1.2, Gov 3.0, 2018b), detailing

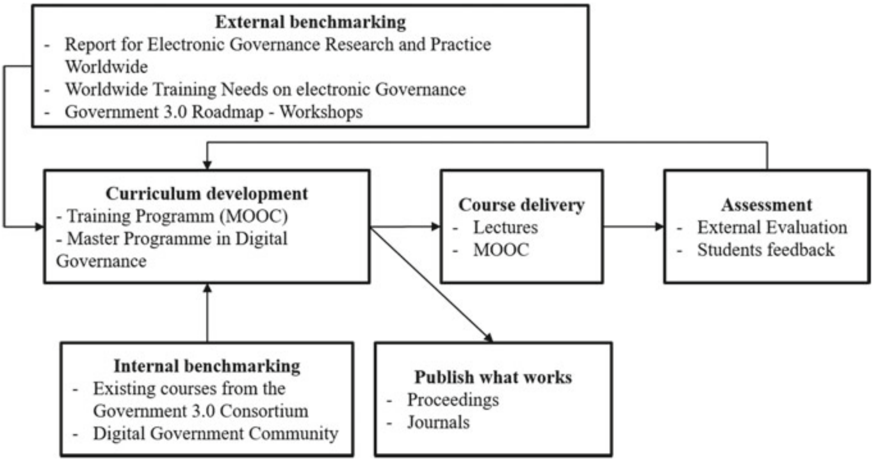

Fig. 1 Continuous curriculum improvement and assessment plan adapted from Okudan et al. (2005)

the catalogue of digital governance programmes worldwide, in the Report on Electronic Governance Research and Practice Worldwide (D 1.0, Gov 3.0, 2018a), and the Government 3.0 Roadmap (D 2.2, Gov 3.0, 2019), listing research and training needs in the area, which were developed along workshops at scientific events (Wimmer et al., 2020).

The second step was an internal benchmarking, where the academic partners of Gov 3.0 identified the programmes offered, which were relevant to the digital government domain. These programmes were analysed with regard to how they could be updated or expanded to include the topics related to Government 3.0. This step was realized through both desk research and a workshop in a digital government related conference, discussing the content of the modules available. The desk research was done by comparing the description and courses of the existing programmes with the results from the external benchmarking to formulate a list of modules and a first classification of courses. The validation of the modules was done through a workshop entitled "On a science base for Digital Government Transformation", held as a pre-conference event of ICEGOV 2019, in Melbourne, Australia, on April 2, 2019. The workshop was moderated by three members of the Gov 3.0 consortium and conducted with 10 e-government experts from different countries. A summary of the identified modules for the Training Programme in Digital Governance was presented, followed by a brainstorming session that focused on (a) the content of the modules and relation to Government 3.0; (b) the courses that should be included in a Master Programme; (c) what modules could be included in the courses; (d) the country-specific modules on the post-graduate levels. Considering the number of participants, the discussion was done in one single group with all participants.

The results acquired during external and internal benchmarking were the basis to define a set of training modules on ICT-enabled governance, consisting of five module groups (described in the following section), to be delivered in post-graduate programmes as face-to-face lectures, following a blended learning approach or in a fully digital form through a Massive Online Open Course (MOOC). They were subsequently used to conceptualize a European Master Programme in Digital Governance. Finally, the training modules were continuously assessed and were validated by an external evaluation (D9.2, Gov 3.0, 2018c) and by student's feedback on the MOOC.

The next three chapters outline the curricula baselines and module materials developed in the Gov 3.0 project.

3 The Gov 3.0 Training Modules

Structurally, the digital governance training modules are divided in five module groups, consisting of a set of modules united around a specific general topic or theme. The proposed module groups are: (1) Government 1.0 (Gov 1.0): Foundations of Digital Government; (2) Government 2.0 (Gov 2.0): Digital Governance and Engagement; (3) Government 3.0 (Gov 3.0): Towards data-driven and evidence-based decision-making and policy making; (4) Ethics and Soft Skills; and (5)

Entrepreneurship (Table 1). The first three module groups correspond to the generations of digital government as described by Charalabidis et al. (2019) and digitization and transformation stages of Janowski's (2015) classification. Ethics and soft skills address the acquisition of competencies and skills to execute relevant and complex projects in Government 3.0 and to address ethical issues and ensure responsible conceptualization of Government 3.0 solutions. Entrepreneurship is added as a relevant subject to spur social innovation and entrepreneurial thinking in realizing holistic digital governance along with the use of disruptive technologies.

The module group 1 provides an introduction into digital government, including the existing ways to evaluate the digital transformation processes with the help of indexes and indicators. The Gov 1.0 module group also covers current efforts in standardization, interoperability initiatives and the questions of managing innovation and digital transformation in the public sector. It is aimed to provide a basis for understanding the contents in the two later module groups.

The second module group includes topics related to Government 2.0, which is characterized by the use of Web 2.0 technologies in public service. The modules in this group discuss open data in governance, e-participation and citizen co-creation, the use of social media for political participation and collaborative governance.

The third module group represents the innovative aspect of the programme and is based on the Government 3.0 roadmap training actions (Gov 3.0, 2019). Separate modules conceptualize and describe applications of machine learning and data mining, big data analytics, smart city government and IoT, algorithmic government and ai, data-driven policy modelling and simulation, augmented and virtual reality, blockchain and smart contracting, game-based simulation and natural language processing.

The fourth module group discusses sustainability and societal challenges and ethics in disruptive technologies, as well as legal foundations, framing the Government 3.0 in the context of wider issues in government and society.

The entrepreneurship module group aims to convey basic knowledge about starting a business. It will take the students through how to organize ideas, get to know the market and customers and develop products and services. In addition, the course introduces entrepreneurship in the context of government and public organizations, explaining the whole cycle from envisioning and designing the digital public service to implementing and scaling it up. There are various reasons why digital government initiatives fail (Anthopoulos et al., 2016) and many of the reasons concern deficiencies in planning and execution of the projects (such as "ambiguous business needs and unclear vision" or "project management issues"). Including entrepreneurship module groups aims to mitigate this risk by providing the graduates with a solid training in the relevant skills presents the structure and briefly outlines each module in the five module groups.

The next sections build on the outlined training programme and describe the MOOC on "Basics of Digital Government Transformation" and the proposed Master Programme to exemplify the realization of the above competence establishment on Government 3.0.

Table 1 Gov 3.0 Training Modules and brief descriptions of each module structured in five module groups

Module	Title	Description
Module group 1: Gov 1.0 foundations of digital government		
1.1	Digital government and information society principles	This module introduces the digital government and information society principles. It aims to present the main concepts, the roots as well as the fundamentals of digital government. The three stages of digital government are also presented in this module
1.2	Digital government and service innovation	Here, the key concepts of digital government and service innovation are considered and relevant dimensions such as the social aspects of digital government transformation, co-production, and transparency are addressed
1.3	Standardization and interoperability	With the increase in complexity of interactions, especially across country borders, the issue of effective cooperation becomes critical. To save money and time, companies and institutions have to work with each other as seamlessly as possible. This can be realized through interoperability and standardization, presented in this module
1.4	e-Identity and e-Signature	The module on e-ID and e-signature aims to present the main concepts of electronic identity and electronic signature along with examples of implementation in Europe and worldwide
1.5	Once-only principle	The module on the once-only principle (OOP) introduces this concept related to digitalization of government, which aims to ensure citizens and businesses should supply the same information to governments and authorities only once
1.6	Cloud computing	This introductory module on cloud computing aims to introduce the students to the basic understanding of cloud computing and its pertinence for the digital government field

(continued)

Table 1 (continued)

Module	Title	Description
Module group 2: Gov 2.0 digital governance and engagement		
2.1	Digital government transformation	This module introduces the concept of digital transformation and its effect in the public sector. The objectives include identifying the drivers of digital government transformation and discussing how governments are reshaping service delivery using technology
2.2	Open government data	This module introduces Open Government Data—what Open Government Data is, how it relates to similar concepts, and what are its main objectives, benefits and pitfalls
2.3	Service co-creation and social media	This module describes the key characteristics of public service co-creation and co-production, including the crowd- and citizen sourcing and co-creation through social media
2.4	e-Democracy and e-Participation	This module introduces the concepts of e-democracy and e-participation. The scope of e-participation and its levels of engagement are presented, as well as a framework for technology and tools for e-participation
Module group 3: Gov 3.0: towards data-driven and evidence-based decision-making and policy making		
3.1	Machine learning and data mining	This module provides an overview of the technologies of machine learning and data mining and their use in public administration
3.2	Datafication/big data analytics	This module introduces concepts of datafication and big data analytics, and their potential for improving public governance and policy making by enabling data- and evidence-based decision-making
3.3	Smart city government and IoT	This module outlines the basic concepts of smart cities and smart city government. Furthermore, Internet of things (IoT) solutions that enable the smart city concept are presented

(continued)

Table 1 (continued)

Module	Title	Description
3.4	Algorithmic government	The module on algorithmic government aims to present the fundamental changes that public administrations are facing, when shifting towards the use of algorithms in governmental processes, such as information collection and decision-making
3.5	Policy modelling and simulation	This module works around the policy lifecycle as a foundation of policy modelling. It describes the main characteristics of policy making and the use of ICTs for policy modelling
3.6	Augmented reality/virtual reality	In this module, augmented reality (AR) and virtual reality (VR) concepts are presented, and how they can improve applications in government and public administration
3.7	Blockchain and smart contracting	This module provides an overview of blockchain (BC) and smart contracts (SC) and how BC and SC applications can affect public administration
3.8	Gaming-based simulation	This module introduces gaming-based simulations (GBS) and how they are used in the public sector, including the specific benefits and challenges of using GBS
3.9	Natural language processing	This module introduces natural language processing (NLP) and its use in government (including text mining, voice transcription and chatbots). Particular focus is placed on the benefits and weaknesses of this technology
Module group 4: ethics and soft skills		
4.1	Legal implications of data-driven decision-making	This module has two key aims: providing general insight into the General Data Protection Regulation (GDPR) and showing how the GDPR affects certain domains and applications of technology in government
4.2	Ethics in government 3.0	In this module, the ethics in digital government are discussed with particular focus on the ethical implication of applying disruptive technologies for the realization of public services

(continued)

Table 1 (continued)

Module	Title	Description
4.3	Sustainability, societal challenges and digital inclusion	This module presents the role of ICT and digital transformation in sustainability and digital inclusion. Digital government and disruptive technologies are discussed within the broader societal context and societal challenges
Module group 5: entrepreneurship		
5.1	Introduction to entrepreneurship related to digital government	New technologies provide substantial business opportunities and governments can attract customers to the new digital services. This module is an introduction to entrepreneurship related to digital public services
5.2	Disciplined entrepreneurship	Many students have thoughts and ideas of new products or services, but not everyone knows how to realize these ideas. This module has the goal of introducing students to the possibilities in turning the ideas into businesses
5.3	Customer and market for entrepreneurs	In this module, information about customer analysis and making the business attractive for the customers is provided. It gives advice to entrepreneurs with creating a beachhead market, evaluating the current market and scaling up the service
5.4	Product and market specification	Identifying the core customers helps to deliver the benefits to the customer better than the competitors. In this module, students will get an idea of how they can learn about their customers and what tools to use to make their business attractive for the customers
5.5	Financial concepts to entrepreneurship	Entrepreneurs often focus more on products and services and how they can create value for customers than how this can transform into profitable businesses. This module focuses on how entrepreneurs can make money, by using pricing models, key factors and examples
5.6	Product design	Entrepreneurs often have a big focus on their product. It is important that the product works for the customers but also provides value for your business. This module focuses on methods for product design

(continued)

Table 1 (continued)

Module	Title	Description
5.7	Public sector innovation	Many entrepreneurs want to present new or improved services or products for use in public organizations. This module focuses on what public innovation is and gives an overview of digital services, infrastructure and digital services usage in public organizations in the EU
5.8	Legal issues in the development of government services	In relation to using data in a public service applications, especially in public organizations, there are many rules and regulations to be aware of. This module introduces the General Data Protection Regulation (GDPR) and how this regulation affects data usage for entrepreneurs
5.9	Social innovation	The goal of doing something good and creating businesses that improve the society is something that interests many entrepreneurs lately. This module introduces social innovation, presents definitions and examples, and explains what motivates and hinders social innovation initiatives
5.10	Information systems in digital governance and entrepreneurship scenarios	Entrepreneurs in relation to digital governance needs to know of the (possible) business models. This module examines the types of information systems in governance and combines information systems that exist with business models to develop new systems. It will also look at case studies

4 The MOOC on "Basics of Digital Government Transformation"

The "Basics of Digital Government Transformation" is a Massive Open Online Course (MOOC) that runs on Moodle Platform and is available through https://moodle.gov30.eu/. Following the Gov 3.0 training modules, the MOOC consists of 5 courses:

- Gov 1.0: Foundations of digital government, including 6 modules of about 12 h of student work;
- Gov 2.0: Digital governance and engagement, including 4 modules accounting for 8 h of student work;

- Gov 3.0: Towards data-driven and evidence-based decision and policy making, with 9 modules of 18 h of student work;
- Ethics and soft skills, including 3 modules of 6 h; and
- Entrepreneurship, including 10 modules accounting for 20 h of student work.

The MOOC covers the three stages of digital government evolution from the basics of information systems (IS), through Government 1.0 (digital transformation foundations) and Government 2.0 (collaborative government) to Government 3.0 (disruptive technologies in data-driven policy making and public service) as well as Entrepreneurship in digital government. Each of the 32 modules consists of a lecture, complementary notes and a quiz. Students must watch the lecture, read the notes and successfully answer all the questions of the quiz in order to complete the module. After the successful completion of the five module groups, students are able to request a certificate on "Basics of Digital Government Transformation" issued by the Erasmus+ Government 3.0 Consortium.

5 The Digital Governance Master Programme

Beyond the provision of a MOOC, an example of how the described curriculum can be developed into a Master Programme is presented in this section. The Master Programme contributes to realize the objectives of the curriculum and to reach the set learning targets for the programme participants. Hereby the pedagogical approach is detailed as well as the programme of a standard four semester/120 ECTS Master Programme.

5.1 Rationale

Digital transformation refers to public sector modernization to improve the provision of public services and stakeholder's engagement through new innovative technologies (Cordella & Bonina, 2012). Driven by the technological transformation, organizational and human changes emerge, requiring new roles and competencies for IT leaders and professionals to deal with new societal and business models (Loebbecke & Picot, 2015). It relates to the concept of digital government as the transformation of public administration to create public value, improve service delivery and increase government responsiveness and openness (Lindgren & van Veenstra, 2018).

The evolution of the digital government domain is represented by distinct stages that characterize public service delivery and government administration (Baumgarten & Chui, 2009; Mukabeta Maumbe et al., 2008). Government 1.0 is characterized by improving internal efficiency, processes optimization and expanding the range of services to citizens and businesses (Janowski, 2015; von Haldenwang, 2004). Government 2.0 is represented by a smart, open and participatory government, with focus on increasing the interaction between government and the public (Baumgarten & Chui, 2009; Bonsón et al., 2012; Chun et al., 2010; Janowski, 2015; Traunmüller, 2010). Government 3.0 emerges from the use of new disruptive technologies in the public sector (Lachana et al., 2018) for the provision of customized services and data-driven evidence-based decision and policy making (Pereira et al., 2018).

The Gov 3.0 project has identified a number of research and training needs (Sarantis et al., 2019), necessary for the effective transition to Government 3.0. Furthermore, a lack of relevant Master programmes was identified especially combining training in technical aspects of digital government transformation (and specifically emerging disruptive technologies) with soft skills and management skills. Such skills and competencies are necessary to work with the public sector to guide those actors through the digital transformation process along with the disruption new innovative technologies bring into the transformation.

5.2 Objectives of the Curriculum

The Master Programme in Digital Governance aims to provide a comprehensive understanding of the domain of digital government with particular focus on emerging technologies that have the potential to disrupt public governance. The programme deepens the fundamental understanding of digitalization contexts and related organizational modernization of the public sector, knowledge of information technology and information systems in the public sector, knowledge of the decision-making systems in public sector and public sector automatization. It aims to provide the graduates with a high degree of self-reliance, responsibility and practical skills in the IT areas of the public sector. It also fosters excellence in the scientific research within the domain.

The aim of the programme is to award a master's degree, where the course integration is ensured by a single study guide, unified assessment rules, a single student agreement and a single joint degree.

5.3 Learning Outcomes

After completing the programme based on the Digital Governance Master curriculum, students should be able to:

- Demonstrate the understanding and use of concepts related to **digitalization** contexts and related organizational **modernization** of the public sector
- Understand of the rise of **digital platforms** in digital government and the opportunities and challenges they create

- Understand the benefits of the disruptive technologies in digital governance and **critically** assess **the areas of application** for such technologies
- Understand the **challenges** associated with introduction of disruptive technologies in digital governance
- Understand the link between **ICTs** and **wider societal challenges**, the role of ICT in achieving the **sustainability goals** and **ethical issues** arising during the implementation of specific public services
- Understand and use **research methods** appropriate for digital government research, including data collection, preparation and analysis methods
- Develop and plan a **research project**, identify its goals, formulate research questions and decide on appropriate methodology to tackle the research questions

5.4 Pedagogical Approach

The programme's curriculum is structured into modules. Within each module, a combination of teaching methods such as lectures, presentations, seminar works and project-based learning is suggested. Supporting materials developed by the consortium and available online may be integrated in delivering the programme's content.

The pedagogical approach includes:

- Lectures that introduce the module subjects and provide students with the theoretical grounds for a deeper understanding of ICT-enabled government. They ensure common understanding of the main topics, themes and methods taught within the Master Programme.
- Presentations, which are used for practical application and deepening of the taught material as well as for the acquisition of practical skills in potential application areas. Student presentations are intended to train the competence to speak and communicate, analyse problems, relate the problems to the existing theory in the corresponding domain, solve them, present the background, the problem, proposed solution and defend their findings.
- Seminars are intended to allow students acquiring specialized knowledge and familiarize with specific tools, technologies and approaches. Exercises, led by experienced tutors, help students deepen their knowledge of the subjects and solve increasingly complex problems. Scientific writing is improved through the elaboration of seminar works related to the programme's subjects.
- Project-based learning involves students designing solutions to real-world problems and training soft skills of cooperation, problem solving and project management.
- Blended learning approach encompasses video lectures, forums and quizzes that allow for a self-learning approach that can be provided through a Massive Online Open Course (MOOC).

The Master Programme is conceptualized with a natural progression: the first semester is focused on providing the foundations through lectures introducing theories, frameworks and case studies; the second and third semester introduce modules with group work, paper development and project-based learning. In the context of the Gov 3.0 project, more than 30 videos have been recorded and implemented in a MOOC, which promotes self-study for the students of the Master Programme, as introductory lectures for the Master Programme, and developing teaching-learning skills for the producers.

5.5 *Programme Structure: An Example of the Proposed Curriculum in a European Context*

Based on the training modules and the Gov 3.0 roadmap (D 2.2, Gov 3.0, 2019, see also chapter 13: Government 3.0: Scenarios and Roadmap of Research), we provide a programme structure as an example of application for a Master Programme on digital governance as illustrated in Fig. 2.

The Master Programme covers the three stages of digital government evolution from the basics of information systems (IS), through Government 1.0 (digital transformation foundations) and Government 2.0 (collaborative government) to Government 3.0 (disruptive technologies in data-driven policy making and public service). Each heading in Fig. 2 forms a module group including a recommendation of workload and distribution of credits based on the planned credit value of the programme.

	IS basics 24 ECTS	Gov 1.0 18 ECTS	Gov 2.0 18 ECTS	Gov 3.0 30 ECTS
Semester 1 30 ECTS	Information Systems (IS) Development and Project Management (6)	Introduction to Digital Government (6) Digital Transformation of the public Sector (6)	E-Participation (6)	Introduction to Government 3.0 (6)
Semester 2 30 ECTS	Legal foundations (3) Entrepreneurship (6) Security in IS and in E-Government (3)	Standardisation and Interoperability (6)	Big Open and Linked Data (6)	Ethical foundations (3)
Summer School				Research project (6)
Semester 3 30 ECTS	Research methods and theories (6)		Collaboration and Smart City Governance (6)	Big Data Analysis (6) AI-based Decision Making (6) Digital Sustainability (3)
Semester 4 30 ECTS	Master thesis (30)			

Fig. 2 Proposed example of a Master Programme on digital governance

For example, for a 120 ECTS Master of Science Programme, the breakdown of the Master across the digital government development stages represents 10% for Gov 1.0, 15% for Gov 2.0, 20% for Gov 3.0, with the IS basics encompassing 15% of the course, the research project, ethics and soft skills representing another 15% and the Master thesis the remaining 25%. The module groups of the proposed curriculum are described as follows:

Basics of Information Systems and Entrepreneurship

The following modules are suggested in this module group:

- Project management
- Information systems development
- Research methods
- Legal aspects of digital governance
- Entrepreneurship and innovation

This module group provides foundations on information systems and entrepreneurship. They form the basis for more advanced contents in subsequent module groups. The modules of this module group should be taught during the first and second semesters. Information system development and legal aspects of digital governance are important for understanding the wider picture. Project management and research methods are instrumental for the third and fourth semesters (particularly for the development of the research project and Master thesis). Since some of these modules may have already been part of the students' education on the undergraduate level, the contents of this module group may be slightly adjusted based on the expected qualifications of the students. Entrepreneurship and innovation should correspond to a minimum of 5% of the total Master Programme as it is an important component of digital governance and training on this topic should be provided to all students.

Gov 1.0: Foundations of Digital Government

The following modules are suggested in this module group:

- Introduction to digital government
- Digital transformation of public sector
- Standardization and interoperability
- Foundations of digital government research

This module group introduces digital government and describes current efforts in standardization, interoperability initiatives (including the European Interoperability Framework (EIF)[1] and the once-only principle (OOP)[2]) and in managing innovation and digital transformation in the public sector. Building on the content of the first module group, the Foundations of Digital Government Research teaches more

[1] https://ec.europa.eu/isa2/eif_en, last access: 24th May 2021.

[2] https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/Once+Only+Principle, last access: 24th May 2021.

specific research methods that may be useful when investigating topics in digital government from a research stance. The modules Introduction to Digital Government and Foundations of Digital Government Research form the basis for the modules of the Gov 2.0 and Gov 3.0 module groups, so they should be provided early in the programme.

Gov 2.0: Digital Governance and Engagement

The following modules are suggested in this module group:

- Open government and data
- E-participation
- Collaborative governance and service co-creation
- Social media in government

The third module group includes topics related to Government 2.0, which is characterized by the use of Web 2.0 technologies in public service, in the context of open government and data, e-participation and social media for political participation. Finally, the module on collaborative governance and service co-creation (with focus on frameworks for decision-making) serves as a bridge between this module group and the fourth one, elaborating the evolution of the concept of smart cities and how it fits into the Gov 2.0-Gov 3.0 progression.

Gov 3.0: Towards data-driven and evidence-based decision and policy making

The following modules are suggested in this module group:

- Introduction to disruptive technologies in digital government
- Big data
- Smart city government/IoT
- Machine learning/data mining in the public sector
- Blockchain and smart contracting in public service
- AI-based decision-making in public service
- Data-driven policy modelling and simulation

This module group focus on the emerging technologies that have the potential to disrupt public governance. The first module on introduction to disruptive technologies provides a background for understanding Government 3.0 as the next evolution of digital government. The six further modules delve deeper into the use of different technologies in the public sector. These discuss big data (including analytics), smart city government (in contrast to the Gov 2.0 module, with a more technological perspective) and IoT, machine learning and data mining (including natural language processing and semantic Web), blockchain (and realization of smart contracting), data-driven policy modelling and simulation and the use of AI for decision-making in public service. While discussing different individual technologies, the modules are united by an overarching scheme: the collection and analysis of data for evidence-based decisions in public service. The content of the modules in this group includes both technological and societal aspects of the technologies. The actual module list in this module group may be adjusted as the uptake and importance of particular technologies in the public sector changes with time. It is important to ensure the adequate coverage of technological and conceptual developments in the digital government.

Research project, ethics and soft skills

This module group includes:

- Research project
- Sustainability and societal challenges
- Ethics in disruptive technologies

The module group offers students a platform to develop their research project, using the knowledge obtained from the previous module groups. The research project should be a practical or research study of a specific case of digital government service. It is meant to be developed after the second semester and is shorter and more practical than a Master thesis that is developed by the students during the last semester. The research project is aimed at preparing students to the thesis elaboration both in terms of learning the methods of research and as an opportunity to narrow down a topic for the final work. It is meant to be elaborated in teams of at least 4–5 students, so to learn also soft skills and project management skills. Two further modules in this module group, sustainability and societal challenges and ethics in disruptive technologies, frame Government 3.0 in addressing broader issues of the digital society. As cross-sectional topics, they are relevant to all the previous module groups.

Master Thesis

The Master thesis is developed during the fourth semester of the programme and grants 30 ECTS upon completion, according to the European regulations. It involves developing a scientific work under the supervision of at least two scientists: a main supervisor from the hosting university and a second supervisor from a partner university or an associated institution. The topic for the Master thesis can include case studies from associated institutions such as public administrations or businesses. The topics definition by the supervisors and the selection by the students should be realized until the end of the third semester. The involvement of partners from businesses and public administrations will ensure the connection of the study to the diverse real-world cases and challenges from a great number of different countries, ensuring wider understanding of digital government transformation in the world and preparing the students for research and work in the globalized world.

The next section presents recommendations and guidelines for implementation of the proposed Master programme.

6 Recommendations and Guidelines for Implementation

The described curriculum addresses several crucial points relevant for the current developments in the digital government domain: internationalization, digital divide, innovation and change management, while providing also training in technology and soft skills.

When examining the digital transformation, it is crucial to consider both national and international levels. **Internationalization** is important both for the government to business (G2B) and government to citizen (G2C) services. Cross-border cooperation and services [Once-Only principle, electronic IDentification, Authentication and trust Services (eIDAS)] become an important area of digital public service development and often the technical realization of cross-border cooperation outpaces the institutional and regulatory efforts (Williams et al., 2018). Disruptive technologies will also likely play an important role in the next generation of cross-border public services (Geneiatakis et al., 2020; Protopappas et al., 2020).

The curriculum also helps **to bridge the gap between different regions** in the European Union. There is evidence of significant digital divide within the EU both between the countries and on the regional level (Szeles, 2018). Ragnedda and Kreitem (2018) identified three levels of digital divide: access to the Internet, digital skills and capabilities, tangible benefits of access. Accessing the benefits of the digital public services and eHealth are on the third level, which can be addressed by the curriculum by providing solid training to the public service officials able to take advantage of the disruptive technologies and design and implement better and more inclusive digital public services. Ensuring the international access to the programme and encouraging the participation of students from countries with lower level of digital government development will allow to build local competences in digital government and bridge the digital divide.

The proposed curriculum for Government 3.0 addresses **the innovation** aspects of the implementation of disruptive technologies in public services. Change management and innovation management remain critical aspects of digital transformation (Nograšek, 2012). Addressing institutional challenges of innovation in government is crucial for the continuing digital transformation (Hinings et al., 2018) and thus an important aspect of the curriculum. Furthermore, the curriculum combines **technology** training and **soft skills** education. It is important to consider legal, managerial and ethical issues of the introduction of digital public services (Pereira et al., 2017). Ethical issues need to be considered at the stage of development and implementation of new government services, otherwise they may contribute to the increasing digital divide (Ronzhyn & Wimmer, 2019).

This chapter provides the baseline for the implementation of a Master in digital governance for the institutions that are willing to realize it. Based on the input used to develop the proposed curriculum and earlier experiences in the Gov 3.0 project (Gov 3.0, 2019), we provide the following 13 recommendations and guidelines for future implementation of the programme.

1. The described curriculum presents a set of modules that reflect the current understanding of the topic by the authors. Disruptive technologies are by definition a rapidly changing topic, so it is important to address the emerging changes and reflect them in the updated curriculum. While at the moment AI and machine learning, big data as well as IoT are the most promising emerging technologies, this situation may change as other technologies reach maturity. For this reason, before the actual implementation of the joint master, it is crucial to critically reflect on the technological state of the art in the public sector and adjust the curriculum accordingly.
2. While the curriculum can serve as a blueprint for the realization of a joint master programme, it is necessary to assess the actual competences of the partners involved in the preparation of the programme. Focusing on the stronger points of each partner will result in a unique and engaging programme.
3. While the proposed curriculum provides a clear structure with progression along the three digital government stages, it is important to ensure attractiveness of the programme by providing some glimpses into the Government 3.0 stage already in the first semester (e.g., by offering the module Introduction to disruptive technologies in digital government). This will underline the uniqueness of the programme (focus on disruptive technologies and Government 3.0) and ensure the sustained interest from the students.
4. The reference module structure as presented in Sects. 3 and 5 gives flexibility to implement a fully-fledged Master of Science Programme with 120 ECTS or realize a more practice-oriented programme (e.g. MBA) of 90 ECTS. The decisions about what modules should be combined, shortened or removed, again need to be considered carefully based on the competences of the partner institutions and current state of the art in digital government.
5. The inclusion of the practitioner perspective is crucial to ensure the relevance of the programme. This can be addressed by engaging associated partners from business and public administration who will contribute with visiting lectures, organizing internships and secondments, using real-life cases for research projects and organizing co-supervision of the Master theses by senior practitioners.
6. Furthermore, we highly recommend diversity of views on the topics by engaging external lecturers from different universities and different backgrounds. As digital government lies on the intersection of several different fields, diversity of viewpoints provided to the students is particularly important.
7. When developing the actual modules, the programme partners should make use of the blended learning approach, implementing the latest education technology achievements, supplementing the content of the lectures with audio-visual materials, MOOC lectures and interactive quizzes where possible. Availability of digital materials will also allow to ensure that the programme is not interrupted due to contingencies associated with pandemics or other events.
8. In the content of the individual modules, it is crucial to provide a balanced view on the possible advantages and drawbacks of the introduction of the disruptive technologies. Implementers should abstain from rose-coloured glasses' view

on the role of technology in the public sector in general and the expected impact of disruptive technologies in particular.

9. Similarly, ethical and legal issues have been significant concerns related to some of the technologies (especially AI and machine learning). These concerns need to be highlighted along the contents of the programme's modules, underlining the controversial nature of some government initiatives (e.g. fears of surveillance state).
10. An interdisciplinary approach is crucial. Technological, organizational, social and political impacts of the disruptive technologies need to be considered carefully and in relation to one another. One of the goals of the joint master programme is to educate people in being critical in assessing possible risks of technological development in the society.
11. Training of the soft skills and promotion of individual competences like critical thinking, creativity, collaboration and teamwork, intercultural skills, problem solving and communication skills should be an integral component in every module of the curriculum.
12. Ensuring contribution to the wider society should be the main aim of the programme implementation. The final repertoire of skills and knowledge learnt by the students should allow them to enter the workforce and contribute effectively. Even if some needed technological competencies will be missing initially, problem solving and research skills acquired during the joint master should allow the alumni to quickly gain knowledge that is required.
13. Finally, the universities implementing the Master Programme should ensure the appropriate evaluation procedures and engage experts in evaluation of their programme. Addressing the possible issues early in the implementation will improve the quality of the programme offered and allow achieving the planned objectives and learning outcomes.

From these unique and excellent foundations in research and collaboration at the innovative edge of digital transformation towards Government 3.0, the proposed Master Programme has the potential to boost the professional capacity in the domain of digital government and public governance, producing highly trained specialists armed with comprehensive understanding, knowledge and skills of the digital government domain and its transformation needs, both from the technological as well as managerial/administrative perspectives.

7 Conclusions

This chapter described a digital governance curriculum and an exemplification of how the structure presented can be developed into a full Master Programme. The training programme has been successfully implemented as a Massive Online Open Course on the "Basics of Digital Government Transformation" and some of the proposed courses have been included in existing Master Programmes in Europe. The programme focuses on the Government 3.0 generation by emphasizing the application of disruptive technologies towards data-driven and evidence-based decision and policy making, as well as arising societal challenges. By doing this, it contributes to addressing the core training demands identified in the Digital Government Science Base (Charalabidis & Lachana, 2020a, 2020b).

The goal of this chapter was to provide a generic training programme for digital governance and an exemplification of its implementation in a European context. The main conclusion of structuring a digital governance programme is that considering the applied and multidisciplinary nature of the domain, there is a need for a dynamic curriculum where pre-conditions and outcomes must be defined towards a specialized curriculum, addressing the needs of particular target groups. The heterogeneity of the target groups, through different profiles and backgrounds, is to be considered in the contextualization of the modules to the different levels of education programmes and regions, where they are implemented. A recommendation is that the proposed training programme should be adapted to address the different challenges and priorities of the different targeted groups and regions by including country-specific modules and practical projects.

Considering also the dynamics of the field, the presented training programme is not exhaustive and with the emergence and continuing development of disruptive technologies, the programme needs to be reviewed and adapted to reflect the evolutions. Still, the current 32 modules provide a strong foundation for a digital governance curriculum with a special focus on the role of disruptive technologies in government.

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E-Justice: A Review and Agenda for Future Research

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Abstract As governments are increasingly adopting digitalization reforms to improve public services, the justice domain is no exception. Although not as rapidly grown as the other e-government initiatives, electronic justice or e-justice practices are developed and implemented to make justice services and their administration more open, accessible, effective, efficient, and less expensive for all actors. On the other hand, there are also specific challenges or risks involved in the digitalization of this area, such as the delicacy of the processes, legal restrictions, ensuring the independence of the judiciary, system design, and good user experience, and high interoperability. As a result of the relatively immature nature and the diversity of e-justice systems being used around the world, an integrated research framework outlining the specific areas and topics of research for e-justice and identifying future research directions is still lacking. In light of this gap, this chapter systematically reviews scholarly research on e-justice to present an integrated research framework. We identify 36 key research publications related to e-justice employing Web of Science and Google Scholar and review them to highlight what we know and do not know about e-justice. The study reveals four broad areas of foci about e-justice research in general: Identification of success and risk factors, assessment of the impact of e-justice implementation, examination of e-justice user satisfaction and experiences, and evaluation of judicial websites. For each of the research areas outlined, theoretical foundations, specific research aims, and main findings, and suggested directions for future research are summarized. A future research agenda informed by the results of the review is proposed.

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1 Introduction

With the ongoing advancements in the technology field, there arise endless opportunities for the public sector to modernize public service delivery. One of the key public service areas that have significantly benefited from these digitalization initiatives is the justice system. Defined as "the use of information and communication technologies (ICT) in the judiciary/justice system", the "electronic justice" (e-justice) concept has been on the agenda of public policymakers for many years. Although not as rapidly grown as the other e-government initiatives, electronic justice or e-justice practices are developed and implemented to make justice services and their administration more open, accessible, effective, efficient, and less expensive for all actors.

Along with that, there is a growing interest in academia to understand the effects of these developments for various stakeholders, and also to examine specific challenges or risks involved in the digitalization of this area. On the other hand, as a result of the relatively immature nature and the diversity of e-justice systems being experienced around the world, an integrated research framework outlining the specific areas and topics of research for e-justice and identifying future research directions is still lacking.

In light of these, the purpose of this chapter is to provide an overview of the extant literature on e-justice and identify the gaps to propose a research agenda for the future. By systematically analyzing the existing studies, it seeks to outline what we know and do not know about ICT use in the justice area and to classify their main focus. Overall, the chapter aims to contribute to developing a "scientific base" for digital governance by documenting the existing knowledge on e-justice area as a sub-field of digital governance, categorizing its focus, and proposing a research roadmap, thus "opening the pathway for systematic and reproducible solutions to identified problems, without the danger of repeating research or missing opportunities for application" (Charalabidis & Lachana, 2020a: 383).

In the following sections, first, the meaning and dimensions of the e-Justice concept/phenomenon are explained in detail, including key applications of e-justice that are examined from various aspects. Then, the main functions and benefits of using e-justice systems are explained, and outstanding examples of e-justice applications from different parts/countries of the world are summarized. Next, the methodology of the study is presented. It is followed by the analysis part, where findings from the systematic review of the studies are outlined and discussed, and an integrated research framework is developed. Finally, a future research agenda informed by the results of the review is proposed.

2 Conceptual Framework

e-Justice, in its simplest form, can be defined as "the use of information and communication technologies in the judiciary/justice system". Using technology in the judicial system is not a new phenomenon. According to Politis et al. (2008: 42), the "first generation" of e-justice applications emerged as the introduction of computers in courts during the 1980s. The next (second) generation that followed the computerization/automation phase was the introduction of the information and communication technologies (ICTs), and most notably the Internet, which started in the early 2000s (Politis & Papasteriadou, 2003; Schneider, 2002). Since then, many e-justice applications have been actively used in the judicial systems of many different countries. As early as 2009, Martínez and Abat performed a systematic study of e-justice systems being used throughout the world.

How do e-justice applications relate to the broader topic of e-government? The argument that e-justice is merely the application of e-government in the judiciary is debatable. For example, Politis et al. (2008: 41) believe that e-justice cannot be a simple extension of e-government in the judiciary because of the autonomous position of the judiciary within the government, due to the separation of powers principle. Besides, e-justice applications not only aim to achieve the automation of the existing structure and functioning of the judiciary, but they also aspire to re-engineer and ultimately transform the justice system.

Within this context, the objectives to be achieved by using technology in the justice system can be divided into two, as administrative and political objectives: On the one hand, from an administrative perspective, the objective is to create a justice system that works easier, faster, cheaper, free from human error as much as possible and in a more citizen-oriented manner (Çam & Tanrikulu, 2012: 207–210; Politis & Papasteriadou, 2003). The political objectives, on the other hand, are to increase the legitimacy of the justice system and citizen trust by making the justice system more transparent, accountable, and auditable (Çam & Tanrikulu, 2012: 207–210; Martínez & Abat, 2009: xiii-xiv; United Nations, 2018: 172).

Both administrative and political objectives are compatible with the 2030 Global Sustainable Development Goals set by the United Nations Development Program (UNDP) (United Nations, 2018: 1, 137, 172, 186). For example, within the "Peace, Justice and Powerful Institutions" Goal, which is the 16th Sustainable Development Goal, the sub-objective of "effective management based on the rule of law" perfectly represents the objectives of utilizing e-justice systems (UNDP, 2019).

Several factors triggered the use of e-justice applications (Kengyel & Nemessányi, 2012). These factors were the increase in e-commerce, and significant competitive advantages in a global economy for a country that has an e-justice system, and the rise of the idea of open justice (Sandoval-Almazan & Gil-Garcia, 2020). Reflecting the idea of open justice, Warren (2014) argued that the ubiquitous use of technology, and especially the advent of social media platforms, necessitated the justice systems to embrace technology to make them more transparent and accountable to the public.

Triggered by these factors, many e-justice systems emerged throughout the World. One of the most important applications at the supranational level is the European E-Justice Portal, which is available at "https://e-justice.europa.eu/". On this website, various information and documents about the EU member countries' judicial systems are presented in 23 different EU languages. These information and documents have been prepared to assist both citizens and other actors of the judicial system such as government agencies, private companies, and lawyers. For example, a citizen can use the European E-Justice Portal to find a lawyer or a notary public. Private companies can learn about the intricacies of judicial processes in EU member countries. Lawyers can access comparative legal analysis across Europe in the area of their legal expertise.

Another remarkable example of e-justice implementation is the Brazilian e-Justice System, which offers certain benefits, as well as some serious problems. On the one hand, Brazilian courts worked relatively faster and cheaper under the new system. Access to justice services has become easier for some citizens. On the other hand, digital divide problems are experienced as it has become harder for members of the lower socioeconomic groups to have access to the e-justice system (Andrade et al., 2012).

Using technology to make justice systems work faster, cheaper, and more citizen-oriented, as well as more transparent, accountable, and auditable is a proposition no one would object to. However, this is a tall order, and whether e-justice applications indeed achieve these purposes need to be measured and evaluated. Therefore, along with the growing interest in e-justice applications around the world, several studies addressed the observable and measurable outcomes of these initiatives. For example, Doty and Erdelez (2002) examined the impact of the increasing use of ICTs at local courts in the state of Texas, USA, and found no evidence of significant gains in service quality or stakeholder satisfaction. On the other hand, Oktal et al. (2016) surveyed 8840 internal users of judicial services in Turkey and found that they found the e-justice system easier to use and more satisfactory. Lupo (2019) argued that e-justice systems should not be evaluated only from an administrative efficiency perspective. They also need to take into account the values of rule of law, judges' independence and impartiality, equality of access, fair trial, and procedural transparency. Yu and Xia (2020) emphasized the complexity of the evaluation of e-justice systems when they discussed in detail the measurement and evaluation of the technology, management, economy, and societal effects of the e-justice systems in China.

Such evaluation studies need to measure two interconnected phenomena: First, whether there is an increase in efficiency arising from automation in the functioning of the justice system; second and more importantly, whether reengineering of the judicial system justifies the resources spent for this purpose (Çam & Tanrikulu, 2012: 205). Contini and Lanzara (2014), however, argue that redesigning judicial systems at the national level is necessary but not enough for evaluating the outcomes and impacts of e-justice systems. By analyzing the Wales, England, Italy, Portugal, and Slovenia examples, the authors emphasized the necessity to examine and ensure the interaction and coordination of national judicial systems not only with each other but also with transnational levels of justice, such as that of the European Union.

Unfortunately, using e-justice systems is not a magic wand to solve all the problems of the justice system (Martínez & Abat, 2009). On the contrary, they have created several implementation problems. After closely examining the e-justice systems in many countries including the USA, Australia, Belgium, Bosnia and Herzegovina, Brazil, England, Spain, Italy, and Russia; Martínez and Abat (2009) identified the most common implementation problems as information security at organizational and/or national level, protection of the privacy of personal data, and judicial personnel's resistance to technological change.

The risk factors that increase the probability of failure in e-justice systems are also examined. These factors can be listed as deficiencies in technological infrastructure, problems arising from language and communication, coordination and communication challenges among different levels of government, problems in increasing and measuring the quality of service in the field of e-justice, lack of information and training experienced by stakeholders about the functioning of the e-justice system, the possibility of weakening the face-to-face relationship between the citizen and the public administration/justice system (Rosa et al., 2013: 250), as well as the presence of groups that resist e-justice systems (Lupo & Bailey, 2014: 356; Unal & Cherry, 2016: 443, 446).

Although all these implementation problems and risks need to be taken into consideration and be dealt with, there is also great future potential in e-justice systems. The technology that will probably have the highest impact on the justice systems is that of artificial intelligence (AI). As early as 2004, Kiškis and Petrauskas suggested the use of artificial intelligence in classifying judicial data in the Lithuanian e-justice system due to the complexity and difficulty of such a classification. Today, it can safely be foreseen that artificial intelligence applications will be increasingly used in most or all e-justice systems in the long run.

The potential uses of artificial intelligence applications in the judicial system are examined with the help of several country examples in a 2017 special issue of the "Artificial Intelligence and Law" journal (Bex et al., 2017). According to these examples, as a future scenario, artificial intelligence will be introduced as an add-on to the existing justice systems. For example, potential plaintiffs, who are undecided about whether to file a lawsuit or not can easily ask for a prediction from the artificial intelligence application about the probable course, cost, and outcome of the case—within a certain margin of error—if they chose to go to court. Based on this prediction, they may decide to file a case or not.

In an alternative scenario, AI will not be complementary to the justice systems, but it will be a replacement. This second scenario predicts a system in which judge, prosecutor, and/or lawyer robots equipped with AI and autonomous decision-making capabilities or purely artificial intelligence employed in the judicial systems without a physical intermediary will take over justice systems. In other words, "judicial public service robots" with artificial intelligence will dominate the judiciary. Despite the risks borne by human errors in the justice system, the preference of not eliminating the "human element/touch" will likely overrule the overwhelming use of AI and/or AI-assisted robots in justice systems, at least in the short term (Morison & Harkens, 2019).

Finally, a second major contribution to e-justice systems comes from big data analysis. The justice data produced and collected by the e-justice systems can be used for big data analysis and data mining (Chatfield & Reddick, 2020; Lyon et al., 2015). Consequently, data-driven public policies can be designed to predict and prevent problems before they arise in the justice system.

3 Methodology

The research methodology adopted for this study is a systematic literature review, which includes systematic identification of the relevant literature on the chosen topic and doing content analysis. (Clarinval et al., 2020; Jabbour et al., 2020). This section details the review protocol that guided the analysis.

The main literature search was conducted in the Web of Science Core Collection (WoSCC) database of Thomson Reuters in April and June 2020. Boolean expressions of "e-justice" or "electronic justice" in the "topic" section (title, abstract, and keyword) were applied for identifying the target publications in the first sequence. Since the keywords are put in the "topic" section, not in the "title" section, some related words like "digital justice" are assumed to be covered by the Boolean search. The year of publication was not indicated in the search. 85 publications meeting the initial search criteria were obtained, including journal articles, book chapters, conference proceedings, editorial material, and a book. Publications not written in English were eliminated from the results; after this step, 74 titles remained. Next, the researchers screened these publications to choose the ones that directly focus on the use of ICTs in justice. Thus, all the selection criteria used in the study resulted in 33 major publications to be reviewed, including journal articles, an edited book, book chapters, and conference proceedings. Besides, the authors screened Google Scholar using "e-justice" or "electronic justice" keywords to analyze any key publications that might have been omitted in the previous search. One journal article, one book chapter, and one conference proceeding that directly addressed the e-justice topic were identified. Ultimately, 36 publications were systematically reviewed in the study.

The analysis part of the study was conducted, first, by recording the type and year of each publication, research questions/purposes of the studies, theoretical frameworks (if any), main findings, and the suggested directions for future research. Next, the studies are reviewed in depth by two researchers to extract some keywords and propose a classification for their foci. Each of the researchers read the publications separately and completed a table containing the extracted keywords for the main research themes and their proposed categorization. The content analysis findings were then compared for each paper. In the case of a disagreement on classification, a third researcher was involved in the process and a consensus was reached. Finally, a categorization of the existing research on e-justice is achieved, revealing four main research streams. Based on this analysis and the identification of the research gaps in the existing studies, a future research agenda on the e-justice area is proposed.

4 Analysis and Findings

4.1 Description of the Publications

A detailed summary of the publications reviewed is provided in Appendix. Looking at the chronological distribution of the publications first, as shown in Table 1, the time span covered by the reviewed publications runs from 2006 through 2020. It is observed that there is a growing interest in the studies addressing e-justice, especially in the last two years (2019, 2020). In addition, 2009 is highlighted as a year that the e-justice topic was trending. The analysis of the three publications published in 2009 (including an edited book with 12 chapters) indicates that they tend to focus on different countries' experiences with e-justice.

Examination of the type of publications reveals that 13 of the 38 reviewed publications are peer-reviewed journal articles, 6 of them are book chapters, 1 of them is an edited book with 12 chapters, and 5 of them are conference proceedings. In terms of the Web of Science Categories, the subject areas of the publications tend to be "Law", followed by "Computer Science Information Systems", "Computer Science Interdisciplinary Applications", and "Information Science Library Science". Moreover, the reviewed journal articles are mainly published in *Social Science Computer Review*; *Informatics*; *Aslib Journal of Information Management; International Journal of Law, Crime, and Justice;* and *Government Information Quarterly.*

The most commonly used methodological approach in the analyzed publications is the qualitative method, including case studies of e-justice implementation based on different countries' experiences. It is followed by conceptual papers addressing different dimensions of e-justice. Notably, there are also a few quantitative studies that develop and test some models in the e-justice area.

Table 1 Chronological distribution of the reviewed publications

Year	Number of publications
2020–June	4
2019	5
2018	2
2017	2
2016	1
2015	2
2014	1
2013	1
2011	1
2010	2
2009	3 (including one edited book with 12 individual chapters)
2006	1

Although not frequently observed, there are various conceptual backgrounds and theoretical lenses used in the reviewed publications, such as formal system theory; collaborative governance framework; public value framework; socio-technical perspective; task-technology fit theory; technology acceptance model and internal user satisfaction model; tight and loose coupling; ICT governance framework; digital convergence; and policy networks.

The content analysis of the publications and related findings are discussed in detail in the following section.

4.2 *Content Analysis and Findings*

Two researchers separately analyzed the titles, abstracts, keywords, and the overall focus of the studies to identify what the common themes and research motivations in e-justice research are. For each study, each researcher manually coded the main research focus with some keywords related to the studies. These two groups of content analysis findings were then compared with each other to propose some common categories of research themes, based on the researcher-identified keywords. Overall, the analysis of the studies revealed that it is possible to extract four main categories of research motivations from the reviewed publications:

(a) Identification of success and risk factors or problem areas for e-justice implementation (lessons learned from country case studies)
(b) Assessment of the impact of e-justice implementation, and developing and testing an assessment framework
(c) Examination of e-justice user satisfaction and experiences, and related technology design principles
(d) Evaluation of judicial websites.

Accordingly, Table 2 presents the categorization of the reviewed publications based on their research focus, sorted by the date of publication.

Most of the reviewed publications fall under a single category of focus, whereas four papers appear to deal with more than one subject related to e-justice. When examined chronologically, the research orientations of the publications tend to be more diverse in the last five years, compared to the earlier years. The main research motivations of the studies, an overview of the major findings in each research area, and avenues for future research are elaborated in detail in the following sections.

4.2.1 Research Focus: Identification of Success and Risk Factors or Problem Areas for E-Justice Implementation

The most commonly addressed issue in the studies stands out as the identification of challenges, risks, and problems experienced in e-justice implementation in different countries, as well as the critical success factors for e-justice projects. More

Table 2 Categorization of the reviewed publications based on their research focus

Publication ID#	Date	Success and risk factors for e-justice implementation (lessons learned from country case studies)	Assessment of the impact of e-justice implementation; along with developing and testing an evaluation framework	Individual experiences and user satisfaction with e-justice; and related technology design principles	Judicial website evaluation
27	2006		X		
26	2009	X			
6	2009	X			
7	2009		X	X	
8	2009		X		
9	2009		X		
10	2009		X		
11	2009	X			
12	2009	X			
13	2009	X			
14	2009	X			
15	2009	X			
16	2009	X		X	X
17	2009	X			
18	2009	X			
25	2010			X	
5	2010	X			
20	2011	X			
24	2013	X			
34	2014			X	
22	2015			X	
35	2015		X		
21	2016			X	
19	2017			X	
3	2017				X
28	2018	X			
36	2018		X		
23	2019	X			
29	2019	X			
31	2019	X			

(continued)

Table 2 (continued)

Publication ID#	Date	Success and risk factors for e-justice implementation (lessons learned from country case studies)	Assessment of the impact of e-justice implementation; along with developing and testing an evaluation framework	Individual experiences and user satisfaction with e-justice; and related technology design principles	Judicial website evaluation
32	2019			X	
4	2019		X		
1	2020	X	X		
2	2020	X			
30	2020				X
33	2020		X	X	
Total		19	10	9	3

specifically, 19 of the 36 publications reviewed focus on the lessons learned from country experiences with e-justice applications in that respect; some of them included comparisons.

Analyzed studies suggest that there are various factors, parameters, and dimensions that could be attributed to all the stakeholders as policy designers, users, partners, and judicial personnel to varying levels. Among these, we have observed various technical, organizational, administrative, and legal concerns that could affect the design, initiation, implementation, sustainability, and smooth functioning of the e-justice frameworks and systems.

First of all, studies in the analyzed literature attribute importance in the design and initiation process. For example, Rosa et al. (2013) point out a finding that "the initial design phase and the continuous development scrutiny. If the initial architecture is poorly planned due to misinterpretations of the requirements, the entire project may be at risk" (p. 254). Kitoogo and Bitwayiki (2010) assert the necessity for strategy, guidelines, and a steering committee for the implementation, an inventory of existing procedures, projects, and synergies for the sake of integration and internal and intra-organizational sharing, raising the awareness concerning existing and future campaigns of e-Justice. Regarding the pre-implementation process, Poullet (2009) asserts that a pilot case or an experimental approach may serve as functional "to progressively convince all the stakeholders of the benefits of the project and to hear from them their expectations about such a project" (p. 187). Similarly, Gascó and Jiménez (2011) give importance to the existence of a pilot project that would be very effective in detecting error or failure possibilities.

Regarding the pre-design processes of e-justice frameworks and systems, some studies warn about the types and styles of how the administration and institutions of the judiciary being set and functioning. It has crucial importance of analyzing how the organizational systems are set up and how they are organizationally and procedurally functioning, among others, before commencing to inject any additions into them. Similarly, Rosa et al. (2013) argue that "the introduction of information systems as a tool to help in an organization structure changes the organization itself. People in the organization have to be aware of these changes. To avoid shocks related to the use of new information systems, people should take part in training sessions. The training sessions should cover two aspects: general ICT skills and specific information system skills." (p. 255).

As simply put by Contini and Cordella (2009) "the right match between the nature of the coupling in the organization activities and procedures and the nature of the information (p. 126) is crucial to evaluate since the effects of ICTs do not define the way in which organisational procedures are performed but rather emerge as a result of their interplay with organisational elements." (p. 130). In a similar vein, Filho and Veronese (2009, p.136) argue that the introduction and development of ICTs into a country's judicial system should be a consolidation of novel technologies with managerial arrangements through law-based standards. According to them (2009, p. 136), the introduction and functionality of the e-Justice system, as managerial arrangements, "are built after a critical observance of everlasting problems". In this context, Fabri (2009) argues that the advancement of ICTs development in the judicial context is just a requirement for the successful implementation of e-Justice, not sufficient for achieving the end targets alone.

Secondly, there are many concerns raised regarding the implementation process. We have observed a great number of risk and success factors. Rosa et al. (2013) argue that the question of how the development team of the e-justice system would be picked, in-house or outsourced, is decisive on the sustainability of the system. "More than the development model, the subsequent maintenance model adopted may also be of significant impact in terms of support and development of new features (Rosa et al., 2013, p. 254). Because, according to them (2013) in e-justice systems, if there is a knowledge gap between design and use deriving of the inconsistency, then this may impair the whole system and functioning. For a related perspective, Kitoogo and Bitwayiki (2010) put forward very substantial considerations as to who will govern the implementation of e-Justice and how given the additional legal issues and challenges to emerge following the introduction of e-Justice initiatives. Gascó and Jiménez (2011) argue that training and communication could be decisive elements to reverse the resistance, in addition to stating that participation and collaboration of key actors are important. Henning and Ng (2009) state that since the e-justice systems represent "the nexus of technological innovation and organisational and institutional change. In order to achieve the expected benefits from ICT in public organisations, work processes need to be re-engineered, whilst responsibilities and authority locations are shifting." (p. 27). Mediation, according to them, constitutes one of the important parameters in the implementation process of e-Justice systems and frameworks.

There would probably be some sort of impracticality, the existence of too many techno-legal barriers, and difficulty in using the infrastructure and the services provided (Velicogna et al., 2020) since the e-Justice frameworks include various stakeholders, including those who never face a series of judicial processes. Fabri (2009) argues that several factors affect the success of e-Justice systems, particularly in the implementation process, as interoperability issues between intra-, inter-organizations, and country systems, ICTs literacy, or negative perceptions at the end-user side but employee and institutional competency at provider side. Gascó and Jiménez (2011) assert that interoperability is the crucial element due to its provision of harmonic and cohesive functioning of different judicial systems and frameworks. The perception of whether the introduction of ICTs is the end goal, or a mediator to reach the end goal is effective on the smooth implementation of e-Justice systems. Martínez (2009) takes attractions to the "plurality of actors with competencies in the administration of justice and the lack of mechanisms" for coordination (p. 98).

Taking a solely organizational point of view, Contini and Cordella (2009) argue that the organizational structures, loosely or tightly coupled, are of crucial importance in the e-justice systems. Contini and Cordella (2009) make a distinction on the effects of ICTs in judicial administration between organizational structures in such a way that the implementation of ICTs under information system perspective to automate existing procedures smoothly seems to have positive effects on the management of tightly coupled systems (p. 130). According to them (2009, 130) loosely coupled e-Justice systems are supposed to be supported through the implementation of either independent or ad hoc implementation of ICTs, particularly emerging as a result of projects starting from the bottom up. Filho and Veronese (2009) assert that e-Justice systems and frameworks are dynamic, not static. Thus, it is important to think of the e-Justice design process is not reflected as an end-product, not to be evaluated as a formation of a steady state. Additionally, according to Martínez (2009), difficulty to get the relevant and necessary information on judicial matters poses a risk for the smooth functioning of the e-Justice system since the judiciary is one of the powers forming the state, independent of executive and legislative powers. Filho and Veronese (2009) take attraction to the risk of integrating novel and revolutionary technological tools in a very competitive and highly changeable environment where things are continuously evolving, including both quantitative and qualitative transformations on the business of courts and judicial personnel. For the sake of systemic integration, Poullet (2009) argues that the internet in general and the ICTs in particular, generally speaking, have the potential to present an opportunity concerning judicial systems but they also require an "absolute need to integrate the different databases" (p. 187).

Potter et al. (2009) argue that countries are supposed to be conscious of their strengths, and should be in continuous need of looking to other centers of expertise around "to weigh up those advances against the demands of local justice system" (p. 181). They (2009) also argue that technology integration and interoperability issues among the different components of the judicial system could deter if the system fails to keep up with the necessary developments as an entity. In addition to cultural issues, conservatist behaviors among judicial personnel and early resistance, and "a reactive approach to technology" (p. 166) use should be taken into full consideration.

Thirdly, we have observed some concerns following the implementation or post-implementation process. For example, Fabri (2009) takes attraction to the lack of project evaluations. According to Wallace (2009), whether and how technology is used "to create an accessible, inexpensive, transparent, and efficient system of justice could be evaluated as success factor" (p. 219). Sarantis and Askounis (2009) state that, though the presence of some challenges deriving from organizational, systems, and other stakeholders' aspects, citizen satisfaction and positive perception regarding the use of ICTs has been substantial on e-Justice systems and frameworks. Particularly some factors concerning design, legal and regulatory framework, actors, stakeholders, cooperation, the transformation of administrative culture, risk management are of importance concerning the smooth functioning of e-Justice systems. Gascó and Jiménez (2011) assert that the adoption and sustainability of ICTs in the judiciary seem to conditional upon access to justice, coordination among institutions, and strengthening the judicial system.

Fourthly, there are also various success/risk factors and concerns pointed out concerning security and privacy issues. Fabri (2009) has found that information and data security issues are of crucial importance. Privacy requirements and security concerns and issues of data protection, in addition to those posed by separation of powers, are at stake for e-justice systems (Poullet, 2009). In a similar vein, Trochev (2009) argues that the decentralized nature of the judiciary may have effects on smooth functioning concerning e-Justice frameworks and systems, resulting in a more sporadic appearance. Trochev (2009) asserts that the e-Justice efforts would have fruits on a persistent base "if only to ease the burden of an overloaded judiciary and to improve its reputation" (p. 200). Borisova and Afanasiev (2019) argue that differentiation between theory and practice may occur (conflicts between the law and departmental acts may emerge). There also could be non-consistent provisions in both judicial and e-Justice systems, and thus, the need for continuous checks throughout the systems is at stake. They state that "the main obstacle for e-justice is a lack of a centralized unified regulatory framework governing the legal relations" (p. 404).

4.2.2 Research Focus: Assessment of the Impact of E-Justice Implementation, and Developing and Testing an Assessment Framework

The content analysis indicates that the second most common motivation in the reviewed studies is the assessment of the impact of e-justice implementation, with 10 publications addressing this matter. Publications that fall under this category usually include case studies of different e-justice technologies or projects, discussing the specific technologies and their effects in the justice area. Also, a few studies develop and test an evaluation framework for measuring the outcomes of e-justice.

The publications listed in this category generally suggest that e-justice systems lead to higher operational effectiveness, efficiency, and standardization in court administration, as well as enhanced openness and accessibility of justice (Chatfield & Reddick, 2020; de Vuyst & Fairchild, 2006). Particularly, access to digitized court documents and electronic data interchange help judges and lawyers speed up trial judgment, and increase access and convenience, simplify procedures, and reduce the cost for the court users (Tokarev et al., 2019; Tyler, 2009). For example, Kramer et al. (2018) argue that e-justice simplifies the actual access to court (and out-of-court) proceedings, by distance court hearings and allowing the online submission of claims. Besides, findings indicate that an important impact of e-justice is the modernization of the judicial systems as a whole (Arias & Maçada, 2020), which in turn expands the quality of public services and transparency of court proceedings, and prevents corruption (McMillan, 2009; Poblet et al., 2009).

Studies also imply that e-justice technologies may affect various justice stakeholders (judges, lawyers, court managers and employees, and ordinary citizens) differently in various contexts. For example, Poblet et al. (2009) highlight a web-based application "Iuriservice" particularly developed for judges, where "the judge describes the problem at hand, and the application responds with a list of relevant question–answer pairs that offer solutions to the issue, together with a list of relevant judgments". Thus, the impact of e-justice systems may be evaluated by utilizing the perspectives of different users, or by employing different evaluation criteria or "values", for example, in terms of their effects on judges' or employees' efficiency and effectiveness, or on citizens' satisfaction, or considering the overall contributions to achieving procedural justice in social security (Adler & Henman, 2009).

In line with this, Arias and Maçada (2020) propose an evaluation framework that integrates technology functionalities, task requirements, and individual characteristics. In a similar vein, Lupo (2015) develops an e-justice assessment framework that combines efficacy-related variables such as system and information quality, user satisfaction, and organizational benefits with variables that focus on the judicial values that e-justice should support, such as independence, equal access, and impartiality.

4.2.3 Research Focus: E-Justice User Satisfaction and Experiences; and Related Technology Design Principles

A third category of focus in the reviewed articles is e-justice user satisfaction and experiences; and related technology design principles. Eight publications listed under this category generally aim to address what the experiences of the users with e-justice systems are, and how the design of the technologies may be improved to fit them better to the specific needs of the justice context.

From the in-depth analysis of the studies in this category, a number of conclusions and avenues for future research emerged. First, it is emphasized that adjusting e-justice systems, particularly court websites, according to the needs of various users of the judicial system, such as judges, lawyers, law-enforcement agencies, actual litigants, the general public and scholars is a must for a successful e-justice system (Trochey, 2009; Poblet et al., 2009). The studies suggest that these users may have different expectations and concerns in using the e-justice interfaces; thus, the design of the applications needs to consider how users with various profiles interact with these systems. For example, internal users are found to prefer a simplified system interface and also expect the technical specialists to have sufficient experience on the system to provide the essential technical support (Oktal et al., 2016). Open data, transparency, and interoperability emerge as additional requirements related to citizen-oriented designs (Cano et al., 2015). Thus, it is proposed that in the design and implementation of e-justice initiatives, consultation with judges and other court staff as well as engagement with other potential users can be highly beneficial to achieving positive outcomes, and to ensure acceptance of the e-justice systems.

Similarly, it is argued that a better task-technology fit may enhance individual performance and public service quality (Arias & Maçada, 2020: 14). For instance, automatic template filling, semantic enrichment of the judicial folder through audio and video processing, and enhanced transcription process are found to be the qualities that judges and lawyers tend to appreciate in e-justice applications (Fersini et al., 2010). On the other hand, in a discussion of the digitalization in justice case, Shahbazov (2019: 53) underline the concerns related to the design of the electronic monitoring systems for offenders. While considered to be useful, “tech-savvy” and “creative” offenders can find ways to get around this technology and restrictions imposed upon them.

A related significant point raised by the reviewed works is that, while contemporary e-justice applications are developed by third-parties with a more user-centric approach and contribute to an innovative and smarter service provision, they may also “open justice services up to the risk of compromising institutional values and destabilizing consolidated practices” (Velicogna, 2017: 14).

4.2.4 Research Focus: Judicial Website Evaluation

In the final category of research orientation, three of the reviewed publications are concerned with the evaluation of judicial websites. They specifically analyze the contents of the judicial websites as to the type, quantity, and quality of information, openness, and participative characteristics. Some publications additionally propose a judicial website evaluation model or offer comparative studies on the judicial websites of different countries.

According to the reviewed publications, judicial websites mainly serve as a source to inform the public and the mass media about court decisions. In line with this, it is emphasized that the availability of up-to-date and accurate information, accessibility, openness, and protection of the confidential data on the websites are the major features that should exist in these systems (Abdulvaliev, 2017; Trochev, 2009). In addition, in one of the studies evaluating judicial websites, one noticeable finding was that most judicial websites are not oriented toward citizen participation or engagement (Sandoval-Almazan & Gil-Garcia, 2020).

Studies also point out that well-maintained and well-designed court websites can be effective in improving the administration of justice and promoting the image of the judiciary in the eyes of the public (Abdulvaliev, 2017; Trochev, 2009; Sandoval-Almazan & Gil-Garcia, 2020).

5 Discussion: A Research Agenda for E-Justice

This section elaborates on a future research agenda for e-justice informed by the results of the systematic literature review. The discussion includes an overview of the gaps in e-justice research identified by the reviewed publications themselves, as well as the insights gained from the analysis of the main motivations, findings, and conclusions in the reviewed publications.

The four main research areas identified in the e-justice research with their main underlying issues are summarized in Table 3.

Constituting the bulk of the studies in e-justice, identification of success and risk factors or problem areas for e-justice implementation is a major concern for research in this area. Analyzed literature in this category draws some potential prospects and point out future directions as well. According to Velicogna et al. (2020), more studies are needed in the direction of ensuring "careful monitoring of the change, early discovery of problems, and the possibility of quick intervention where necessary". Kitoogo and Bitwayiki (2010), taking a comparative perspective, argue that there is a need for studies to "contribute significantly to the sharing of experiences towards the implementation of e-justice that will culminate in a cohesive framework" (p. 48). In a similar vein, Fabri (2009) calls for prospective studies particularly focusing on organizational structuring of judicial administrations with a particular emphasis on the effects of ICTs. Thus, according to Fabri (2009), the presence or lack of a steady "exchange of information between scholars, practitioners, and policymakers to share

Table 3 Main research areas in e-justice domain

E-Justice research area	Description
Identification of success and risk factors or problem areas for e-justice implementation	Investigating the challenges, risks, and problems experienced in e-justice implementation in different countries; Comparing e-justice systems in different countries; Identifying the critical success factors for e-justice implementation
Assessment of the impact of e-justice implementation	Conducting case studies of different e-justice technologies or projects; Discussing the specific technologies and their effects in the justice area; Developing and testing an evaluation framework for measuring the outcomes of e-justice
E-justice user satisfaction and experiences; and related technology design principles	Examining what the experiences of different users with e-justice systems are; Exploring how the design of the technologies may be improved to fit them better to the specific needs of the justice context
Judicial website evaluation	Assessing the type, quantity, quality, security, and accessibility of information on the judicial website; openness, and participative characteristics; development of a website evaluation model

the knowledge that has been attained in different contexts" (p. 13) would be of greater importance. Martínez (2009) asserts that, since the analysis of e-Justice frameworks is not well-developed yet, there is a growing need for papers to focus on the regulation of the ICTs in the administration of justice, examination of sociological perspectives, and how to conduct extended learning programs for the stakeholders, particularly for the operators, in the field.

For organizational and administrative dimensions, Contini and Cordella (2009) pledge for studies to conduct on the ICT development issue for loosely coupled organizations and the studies on the integration of "the loose coupling of judges and prosecutors with the tight coupling of the administrative staff" (p. 131).

Filho and Veronese (2009) point out that, not just normative or judicial perspectives, there is also a need to focus on social, technical, or theory-related studies concerning e-Justice system and frameworks, studies of comparative nature and focusing on harmonization, for intra-, inter-organizational, and governmental levels. In a similar vein, Gascó and Jiménez (2011) propose more conceptual, theoretical, and empirical studies Poullet (2009) directs prospective studies on focusing on data protection, user privacy, and security issues. Sarantis and Askounis (2009) argue that there is a need to evaluate why "the judiciary world seems to be afraid that computers will take away some of its independence"? (p. 133).

Borisova and Afanasiev (2019), taking a comparative perspective, argue that papers and documents about successful implementations of e-Justice cases abroad are of importance when the evolutionary nature of e-Justice systems is taken for granted.

Henning and Ng (2009) point out a need that "future studies should therefore investigate how tension between the need for flexible arrangements (such as collaboration protocols) and the need for accountability can be resolved" (p. 42).

Given the complexity and multidimensional nature of the e-justice systems, the reviewed studies in the assessment of the impact of the e-justice implementation category highlight the requirement for more research on the evaluation of open justice and e-justice implementations. It can be argued that future research needs to analyze a greater number of and diverse justice users with different profiles in impact evaluations of e-justice. For that purpose, it is suggested that quantitative studies may be designed. Particularly, the reviewed publications call for a greater number of empirical studies in developed and developing countries. Furthermore, they imply that issues such as the distributional implications of e-justice or the impact of the "digital divide" should also be considered in evaluative studies of e-justice.

Overall, the reviewed publications in the examination of e-justice user satisfaction and experiences category highlight the need to consider users' perspectives in designing justice-related technologies. Notably, it is observed that the effects of demographic and socioeconomic characteristics of the e-justice users are not sufficiently addressed in the existing studies. Thus, future investigations on e-justice may focus on developing models for user-centered evaluation that integrate individual and organizational dynamics. Also, it is suggested that the generalizability of such studies needs to be improved through quantitative studies with larger samples, and comparisons across different times and places.

Finally, in terms of the research gaps in judicial website evaluation topic, the reviewed publications highlighted the need to know more about the structure, usability, content, and impacts of judicial websites, and how they are linked with e-justice and open justice concepts (Sandoval-Almazan & Gil-Garcia, 2020). It is emphasized that future studies may focus on the main factors, such as political influences, that might relate to the openness, participation, and collaboration features of the judicial websites. Along with that, evaluative frameworks may be developed and updated to better analyze citizen perceptions, attitudes, and behaviors related to judicial websites in light of new information needs, and growing developments in ICTs (Sandoval-Almazan & Gil-Garcia, 2020).

As we have noted in the previous sections, given the relatively immature nature and the diversity of e-justice systems, there is a need for integrated research frameworks outlining the field for e-justice, and thus, we, in this part, aim to identify future research directions. There are four research areas that this study addresses after conducting the SRL. Regarding the first research focus, it should be noted that most of the studies examined fall in this category. However, just as the justice system is country-specific, benchmarking among these fields could hardly yield practical results. However, identification of risk and success factors would be beneficial particularly for policy transfer among justice systems when and where possible. Thus, this research focus should be particularly addressed by both qualitative and quantitative prospective studies. The second research focus is on the assessment of e-justice systems. There are various studies in the related literature focusing on the assessment of e-justice systems, mainly on country-specific. As we argued previously, countries adopt or adapt justice systems from some sources; however, these systems follow their path in time. Thus, studies directed to assess any e-justice systems could also be beneficial for other countries, particularly for newcomers in this regard. Specifically, qualitative case studies could be insightful for this purpose. The third research focus is on a more micro-level when compared to the first two other research focuses. Regarding this focus, we think that efforts directed to the e-justice field could have yielded more practical and end-user results. Therefore, studies targeting this research focus should be more addressed when political and societal motives are at stake. The last research focus is more suitable when benchmarking efforts are taken for granted since website design is crucial when citizens and all other shareholders are taken into consideration. Thus, we plea there should be more research devoted to the last focus if the international audience is targeted. In addition, quantitative large N studies may further help with identifying the patterns in factors affecting e-justice adoption around the world.

6 Conclusion

As proposed by Charalabidis and Lachana (2020b: 216), "the lack of scientific foundations in the Digital Governance domain seems to hinder unlocking the real transformative value and full potential to all its stakeholders, from researchers to industry and

SMEs". They further suggest that "by organizing and documenting systematically the (existing) knowledge and practice of the domain there will be a lot to be gained for societies and administration" (2020: 216). While the advantages of implementing e-justice initiatives have been widely recognized around the world, less is known about the current state of the art on use of ICTs in the justice area. As a sub-field of the digital governance area, an integrated research framework is still lacking in the e-justice domain. Accordingly, this study has systematically reviewed the existing studies to identify what we know and do not know about e-justice, classified the main foci of the existing research, and proposed future directions for research.

Overall, this chapter contributes to the development of a digital governance science base (Charalabidis & Lachana, 2020b: 218), mainly by decomposing the e-justice research domain and proposing a research road map. More specifically, it presents an outline of the existing studies on e-justice using a wide-ranging time span and categorizes them to provide a more integrated research framework. Besides, the study reveals research gaps in the extant literature to promote future investigations on e-justice. Finally, by identifying the critical success factors, risks, and challenges related to e-justice initiatives in the reviewed studies, the study offers practical lessons for practitioners in this area.

The main themes of the reviewed studies generally imply that e-justice research is more oriented toward the analysis of practical problems that may arise in the implementation of ICT projects in the justice area, and understanding the extent to which e-justice achieves the desired outcomes. Although this is reasonable and highly valuable considering the delicacy of the justice services, diversity of the stakeholders, and the complexity added by ICT use, it can be argued that e-justice research needs to develop further in its theoretical foundations as well. In doing so, particular attention needs to be paid to develop evaluative frameworks that include a diverse set of values. As emphasized by Lupo (2015), integration of efficacy-related variables such as system and information quality, user satisfaction, and organizational benefits, with the variables related to judicial values, such as independence, equal access, and impartiality can be fundamental in developing assessment frameworks of e-justice. In addition, it is suggested that the distributional implications of e-justice in light of the digital divide framework are explored further in future e-justice studies.

Lastly, this study has some limitations as well. Concerning the methodology, it should be noted that this systematic literature review is limited to the publications including specific keywords in the title, abstract, and keyword areas, and written in English. The review is also limited to examining the content of publications found in the Web of Science mostly. Therefore, there may be additional publications addressing the e-justice topic, which were left out of the study sample.

Appendix: Description of the Reviewed Publications

	Full citation of the publication	Publication type (conference, book chapter, journal article)	Research question(s)/purposes of the study	Theoretical foundations (if any)
1	Chatfield and Reddick (2020)	Journal article	"What are key enablers and inhibitors for strategic alignment between the open justice ecosystem and the e-justice ecosystem?"	Formal system theory; Collaborative governance framework; Public value framework
2	Velicogna et al. (2020)	Journal article	How do EU institutions manage and perform harmonization and facilitation of judicial cooperation given a dynamic environment where laws, technologies, economies, and cultures of EU and member states co-evolve?	Making a theoretical link between e-justice and the notion of open justice (an initiative to combine the open justice principle and open government discourse)
3	Abdulvaliev (2017)	Conference proceeding	To analyze the quality, openness, and availability of the websites of law courts of the Federal Republic of Germany and the Russian Federation	None
4	Tokarev et al. (2019)	Book chapter	To evaluate the development of e-justice and its impacts in Russia	None
5	Kitoogo and Bitwayiki (2010)	Conference proceeding	Is there a justified need in moving the e-Justice implementation as a sector? If so, what is the current status and developments concerning ICTs in e-Justice in Uganda?	None

(continued)

(continued)

	Full citation of the publication	Publication type (conference, book chapter, journal article)	Research question(s)/purposes of the study	Theoretical foundations (if any)
6	Fabri (2009)	Book chapter	How is the diversity of ways by which the EU members are "harnessing ICTs to support the operation of their legal systems, and it identifies different strategies as well as tools developed" by taking Italy as a case study for comparison?	ICT governance framework
7	Poblet et al. (2009)	Book chapter	To examine the experiences of Spanish judges with Iuriservice, a Web-based system designed to provide the Spanish judiciary with a tool to facilitate knowledge management in daily judicial practice	None
8	McMillan (2009)	Book chapter	To elaborate on the issue of judicial corruption and how automated system functions may help reduce corrupt practices	None
9	Adler and Henman (2009)	Book chapter	To evaluate the impact of ICTs on the operation and transformation of procedural justice in social security	None
10	Tyler (2009)	Book chapter	To discuss the impact of online dispute resolution (ODR)	None
11	Martínez (2009)	Book chapter	How electronic media can be used in the administration of justice to improve the development of e-justice?	None

(continued)

(continued)

	Full citation of the publication	Publication type (conference, book chapter, journal article)	Research question(s)/purposes of the study	Theoretical foundations (if any)
12	Contini and Cordella (2009)	Book chapter	How the institutional context deeply affects the deployment of ICT, tools to improve the management, operational efficiency, and the consistent application of rules to strengthen the governance of the system in the judiciary?	The concepts of tight and loose coupling and their application in the field of organisational theory
13	Filho and Veronese (2009)	Book chapter	How ICTs are included in and are shaping the future of the Brazilian judiciary?	Digital convergence
14	Potter et al.(2009)	Book chapter	The paper looks "at the pressures ICT has created on traditional courtroom workflows, and how Australian courts have responded to them" (p. 166) by tracing the historical path ICTs follow concerning courtrooms and their effects. The paper also evaluates whether, if so how, benefits and drawbacks are uniquely attributed to the country case	None
15	Poullet (2009)	Book chapter	If computerization is at stake for all Courts and Tribunals in Belgium with the help of ICTs for all stakeholders, then what "legislative measures that have been taken, mainly in relation to data protection and legal value of the documents generated by the use of the electronic procedure" would be?	None

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	Full citation of the publication	Publication type (conference, book chapter, journal article)	Research question(s)/purposes of the study	Theoretical foundations (if any)
16	Trochev (2009)	Book chapter	To focus on "websites of Russian courts as the virtual gateways" and discuss challenges of adapting Russian court websites to the needs of various users of the judicial system" (p. 196)	None
17	Wallace (2009)	Book chapter	To discuss Australia's experience in the field of e-Justice from past to date	None
18	Sarantis and Askounis (2009)	Journal article	Description and analysis of the computerization process of the paper-based criminal record system in a public organization in a particular country case (Greece)	None
19	Velicogna (2017)	Journal article	"To analyze EU e-Justice experience with the 'API-for-Justice' project, which investigates the challenges of opening up the European e-Justice Digital Service Infrastructure to external service providers by means of Application Programming Interfaces (APIs)" (p. 1)	Socio-technical perspective
20	Gascó and Jiménez (2011)	Conference proceeding	What factors conditioned the implementation of interoperability modules in the e-justice field? Additionally, the paper also aims to find answers about implementation, success factors, key actors, and lessons to be drawn	None

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	Full citation of the publication	Publication type (conference, book chapter, journal article)	Research question(s)/purposes of the study	Theoretical foundations (if any)
21	Oktal et al. (2016)	Journal article	To develop an evaluation model for the National Judiciary Informatics System (NJIS), and to propose a framework for describing both the dimensions of satisfaction and the acceptance of the e-justice system by the internal users	Technology Acceptance Model and Internal User Satisfaction
22	Cano et al. (2015)	Conference proceeding	To discuss using ICTs, how a more open justice with the citizen as the first requirement for a judicial system can be considered	None
23	Borisova and Afanasiev (2019)	Book chapter	"To reveal collisions and gaps of a legislative framework containing rules of digital technology application in the administration of civil justice to highlight the prospects for the unification of the procedural legislation" (p. 403)	None
24	Rosa et al. (2013)	Journal article	To analyze and make discussions on various e-Justice experiences worldwide and put a special emphasis concerning risk factors on the design, development, and implementation of e-Justice systems. Then, to focus on the development of an e-justice information system of a particular country case (Cape Verde)	None

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	Full citation of the publication	Publication type (conference, book chapter, journal article)	Research question(s)/purposes of the study	Theoretical foundations (if any)
25	Fersini et al. (2010)	Conference proceeding	"The main aim of this paper is to show how JUMAS has provided judicial users with a powerful tool to fully exploit the knowledge embedded into multimedia judicial folders." (p. 51)	None
26	Henning and Ng (2009)	Journal article	"What is the role of legal frameworks for mediation and legitimization of collaborative implementation in inter-organisational e-justice projects?" (p. 27)	the concerted action of multiple policy actors in the context of policy networks
27	de Vuyst and Fairchild (2006)	Conference Proceeding	To evaluate e-justice in Belgium	None
28	Kovalenko and Bernaziuk (2018)	Journal article	"To interrogate and reveal the current issues of financing electronic legal proceedings" in a particular country case (Ukraine) (p. 100)	None
29	Nikolaychenko and Nikolaychenko (2019)	Book chapter	To identify "the features of the regulatory framework and the existence of 'e-justice' in Russia and the world by analyzing barrier-free legal services in the justice administration and the transformation of the procedural duties of the courts" (p. 379)	None

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	Full citation of the publication	Publication type (conference, book chapter, journal article)	Research question(s)/purposes of the study	Theoretical foundations (if any)
30	Sandoval-Almazan and Gil-Garcia (2020)	Journal article	"To explore the characteristics of judicial websites, highlight some differences between judicial and executive branch websites, and propose an assessment framework for judicial websites that can be used to understand both electronic justice and open justice" (p. 336)	None
31	Valeev and Nuriev (2019)	Journal article	To analyze" the general patterns of development of e-justice elements in the administration of constitutional, civil, administrative, and criminal justice" (p. 1)	None
32	Shahbazov (2019)	Journal article	"To provide insights into the attitudes of Azerbaijani students and criminal justice professionals toward electronic monitoring as a method to rehabilitate offenders and deter crime" (p. 52)	None
33	Arias and Maçada (2020)	Journal article	How do electronic lawsuits impact perceived individual performance and public service quality in the federal judiciaries of Brazil and Argentina from the perspective of the employees?	Task-Technology Fit Theory

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	Full citation of the publication	Publication type (conference, book chapter, journal article)	Research question(s)/purposes of the study	Theoretical foundations (if any)
34	Lupo and Bailey (2014)	Journal article	To illustrate and elaborate upon the system design and design management principles for the implementation of e-justice that might impact a system's ability to improve access to justice	None
35	Lupo (2015)	Book chapter	To propose an e-justice assessment framework that integrates efficacy-oriented variables with variables that focus on the judicial values that e-justice should support	None
36	Kramer et al. (2018)	Book chapter	To map and evaluate the development of digitization in the Netherlands, with a focus on civil justice	None

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Digitalisation and Developing a Participatory Culture: Participation, Co-production, Co-destruction

Noella Edelmann

Abstract Although governments and public sector organisations are known for being bureaucratic and hierarchic, they are being encouraged to move to models of digital and more participatory governance. This involves the use of digital tools and methods that are able to support active citizen roles, stakeholder participation and co-production. Whilst the focus is on positive outcomes of participation and co-production, the phenomenon of co-destruction is less the focus of research. This chapter therefore presents on the one hand a review of scholarly literature on digital participation and co-production in public sector organisations and how these topics contribute to the development of participatory culture as defined by Jenkins et al. (2015) and, on the other hand, considers the disruptions, errors and mistakes that may arise through participation and collaboration. The themes presented here provide an analysis of participation, co-production and co-destruction in the context of digital governance and highlight the importance of these themes as part of a research agenda as developed by Charalabidis and Lachana (2020).

Keywords Participatory culture · Participation · Co-production · Co-destruction · Digital governance

1 Introduction

Governments and public sector organisations are traditionally known as bureaucratic and hierarchic, not for being open and participatory. Policy makers and public managers are encouraged to be innovative in order to support participation and provide opportunities for public value creation, whilst at the same time considering resource, administrative, institutional and other constraints (European Commission,

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2021; O'Flynn, 2021; Panagiotopoulos et al., 2019). One way public sector organisations can do this is by proactively engaging and interacting with citizens, recipients of public services and other stakeholders. Citizen participation represents a valuable resource as citizens and other stakeholders increasingly provide the information, knowledge and innovative ideas that contribute to the government of society, support transformation in society and help solve complicated problems (Roberts, 2015). The importance of such participation and involvement is reflected in central EU policies, such as the Tallinn Declaration (Council of the European Union, 2017) and more recently, the Berlin Declaration (European Commission, 2020).

Participants cannot contribute as long as public sector organisations and their processes are "closed" and claim to know what users need, design the services and procedures (Löffler, 2020), and decide on the public value that is to be achieved (Cordella et al., 2018). Direct citizen participation is thus a process by which public officials share power with members of society and during which citizens contribute their knowledge and expectations, making it on the one hand an integrative and legitimating tool (Edelmann & Parycek, 2009) and, on the other, one that can help resolve conflicts. Trischler and Scott (2015) describe this as the public sector organisations' move towards an open system, but it requires a huge change in the paradigm of the public administrations' culture, one that focuses on the inclusion of social practices such as openness, conversations, real-time feedback cycles, relationships, participation and collaboration. This kind of culture is one that focuses on partnerships in public sector organisations, partnerships that support participation and contribution by users and stakeholders, allowing their involvement in the design and provision of public service delivery (Osborne, 2018) and deciding on the outputs and outcomes to be obtained (Löfler, 2020). Public participation and co-production of public services require a change in interaction and cooperation between several actors, the re-organisation of the relationships, the exchange of information and open public processes in order to achieve outcomes such as increased legitimacy, more efficiency, effectiveness and accountability (Verschuere et al., 2012). New Internet-based technologies allow citizens to create, edit, evaluate, link to content or other creators of content as well as facilitate interactions between users (Burgess et al., 2017). At the same time, these technologies, the activities and the data they support are increasingly being recognised as transformational, influencing the way people, organisations and governments live, interact, work and produce (OECD, 2019). Digital technologies can contribute to the transformation of public sector organisations' culture towards being open and interactive, for example, by providing methods and tools that support co-production processes and participatory citizen–government relationships (Cordella & Bonina, 2012).

There are many ways that digital technologies support governance, for example, through e-participation and co-production, yet it may be that promises are made that cannot be fulfilled and may actually lead to more risks rather than promises (Nieuwenhuizen & Meijer, 2021). Co-production, with its aim of creating value, is often seen as positive and a beneficial value itself (Voorberg et al., 2015) as is the provision of frameworks for participation (Edelmann & Mergel, 2021). Citizens, though, have different and conflicting preferences about similar issues, they shift and change their preferences over time (Alford & Hughes, 2008), so participation and co-production are not always successful. Ostrom (2009) highlights the complexity in such participatory processes, she points out that their implementation and use require knowledge about the components and how these are related to each other. Thus, the transformation of the organisational culture in a public sector organisation means not only ensuring opportunities for participation and collaboration, supporting cooperation between stakeholders and integrating the resources available, but also the ability to learn from failures and mistakes that lead to a destruction of value.

A well-established domain that focuses on studying the issues and needs of public sector organisations is digital governance; it includes novel methods and frameworks for enhancing service quality through the use of ICT (Charalabidis & Lachana, 2020). This chapter aims to contribute to the research agenda of a Digital Governance Science Base (Charalabidis & Lachana, 2020) by focusing on the impact of digitalisation on the central elements of participatory organisational culture in public sector organisations. Although a participatory culture in the public sector is enshrined in national and EU policies and citizen participation and co-production is well researched, the first part of this chapter aims to provide a deeper understanding of the impact of digitalisation on public sector organisations' participatory culture by drawing on work by Jenkins et al. (2015). They point out that as participatory cultures have been transformed by digital, networked and mobile technologies, and technologies enable new forms of expression and engagement in public discourse, so a participatory culture is "*one in which members believe their contributions matter, and feel some degree of social connection with one another*" (2015, p. 4). Thus, this part of the chapter introduces the idea of a participatory culture as understood by Jenkins et al. (2015) and considers how digital technologies impact the participatory organisational culture in public sector organisations. The second part presents a review of scholarly literature on participation and co-production as central elements for achieving collaborative digital governance. But digital citizen activities may have limits (Clark et al., 2013), participation and co-production may not always be beneficial processes or necessarily lead to valuable outcomes, so the concept "co-destruction" is also explored in the context of public sector organisation's culture. Co-destruction may be due to several reasons, but rather than seeing co-destruction just as the destruction of value or a failure, it should be used as providing an opportunity for lessons learned and to support the further development of a participatory culture in public sector organisations. The chapter closes by considering the work on participation, co-production and co-destruction, and how these themes can contribute to the research agenda developed by Charalabidis and Lachana (2020).

2 Background

Public sector organisations are moving away from governance paradigms such as New Public Management towards management that involves stakeholders (e.g. the use of Freeman's principles for strategic management (1984, 2010), see Scholl (2001) or Flak and Rose (2005)). As digital technology changes the ways information and knowledge is created and distributed, so do the modes of involving those stakeholders in the production of this information and content.

2.1 A Participatory Culture in Public Sector Organisations

The term "participatory culture" drawn from Jenkins et al. (2015) is used here in order to understand how people are engaging, participating and contributing as a "*shared social practice and culture"* (p. 10). It contains *"a set of practices that have centered on accessible and communal forms of production and sharing",* and, at the same time *"it embodies a set of ideals for how these social practices can facilitate learning, empowerment, civic action, and capacity-building"* (Jenkins et al., 2015, p. 183). Participation is found in all types of social practices, and a participatory culture is "*one in which members believe their contributions matter, and feel some degree of social connection with one another (at least they care what other people think about what they have created)*" (Jenkins et al., 2015, p. 4).

The New Public Management paradigm found in public sector organisations is based on themes of disaggregation (splitting up public sector hierarchies), competition (ensuring multiple forms of provision), and the use of performance incentives, making it difficult for citizens to understand internal state arrangements, to represent their interests, and reducing their capabilities to understand and solve problems (Dunleavy et al., 2006). This traditional model of governance is slowly being abandoned, and instead, the notion of developing a participatory culture in public sector governance has become increasingly important. A participatory culture entails public participation, as it is a social, communicative and political process that requires public sector organisations to establish a range of processes, infrastructure and policies that ensure that stakeholders can participate. In the "Standards for Public Participation" (Dearing & Trattnigg, 2008), for example, participation is understood as the opportunity for all the affected and/or interested persons to represent or put forward their interests and concerns in the development of plans, programmes, policies or legal acts. It describes the involvement of the respective stakeholders through information, consultation or cooperation in the decision, design and implementation of public projects. By enhancing information flows and processes, stakeholders can participate in decision-making processes, contribute to the development of services and produce relevant information, knowledge and value. Some functions of participation are to provide information, other functions are representation and reconciliation of interests, leading to outcomes such as increasing the effectiveness of public sector organisations, ensuring the acceptance of decisions taken, but also enforcing legal protection and the democratic right to be heard (Fisahn, 2002). There is general agreement that citizens play an important role here as they are seen as contributors of skills and knowledge, as well as the beneficiaries, and finally, also the evaluators of the outcomes (Alford, 2016; Silvestre et al., 2016; Wamsler, 2016). Other stakeholders, in addition to citizens, can be interest groups such as the private sector, chambers of commerce, NGOs or other social organisations, involved through information, consultation or cooperation in the decision, design and implementation of public digital projects (Edelmann & Mergel, 2021; OECD, 2020).

2.2 The Impact of Digitalisation on Public Sector Organisational Culture

As digital technology changes the ways information is created and provided in society, so do the modes of involving members of society in the creation and provision of information. The digital-era governance model proposed by Dunleavy et al. (2006) emphasises the need to re-integrate functions into the governmental sphere, adopt holistic and needs-oriented structures and by drawing on the opportunities provided by the digitalisation of administrative processes. In Dunleavy et al.'s governance model, changes in the organisational culture are based on the adoption of IT that impacts management systems and the ways of interacting with, informing and involving citizens and other stakeholders. Digital technology is seen as central in order to integrate elements in the organisation, to develop a holistic reform that simplifies the relationships between organisation and user, and, at the same time, to increase productivity. But it also means that public sector organisations must be able to support participation and co-production processes so that external stakeholders are able to state what they need and be able to organise their interactions, "*leaving agencies to provide only a facilitating framework*" (Dunleavy et al., 2006, p. 487).

Internet-based technologies such as digital platforms, services and apps allow users to create, edit, evaluate, link to content or other creators of content (Kaplan & Haenlein, 2010), to facilitate interactions between users, provide opportunities to share information, opinions and interests (Khan et al., 2014), and "*are built around the convergence of content sharing, public communication, and interpersonal connection*" (Burgess et al., 2017, p. 1). Serrat (2017) argues that digital tools and social media should be used in the public sector as they offer opportunities to achieve user-oriented, transparent, accountable, participative, inclusive, responsive, joined-up, networked, and efficient government, but, as the public sector bears social responsibility for embracing change, also to meet people where they are, which increasingly, is online. The emergence and proliferation of digital tools and the digital transformation of organisations help the public sector find additional "*innovative new ways to deliver public value*" (Linders, 2012, p. 446), to respond rapidly to changes in the environment (Serrat, 2017), to develop new tasks and gain new capabilities (Lember, 2017) and to adopt reforms and new principles, such as Open Data and Open Governance (e.g. the Open Government Partnership, 2020). The use of digital tools to support value creation is expected to foster innovation in the public sector whilst overcoming problems that stem from a range of demands and limited resources, as citizens provide data and contribute to the creation of new products and services: "*Traditional views on public value creation focused on the public organisations as* *sole initiators of the value creation process. The increasing possibilities and the use of digital technologies have been challenging this understanding*" (Misuraca et al., 2019, p. 32). The use of digital tools is therefore understood as facilitating interactive administrative processes and thus challenges traditional patterns of participation, involvement, contribution and collaboration with public sector organisations (e.g. Bundeskanzleramt & Österreich, 2017; Pestoff, 2014; Wiewiora et al., 2016) and changes the way people, organisations and governments interact, work and produce (OECD, 2019).

Digital tools and the digital transformation of public sector organisations change the type and quality the services provided, the channels used for dissemination, the opportunities for collaboration and direct involvement, but at the same time, also the stakeholders' expectations about the public sector organisations' use of the tools available (Barbosa et al., 2013; Bolivar, 2018; Brandsen & Honingh, 2016; Granier & Hiroko, 2016; Moon, 2018). Achieving this is a complex, multi-dimensional process (Lindgren & van Veenstra, 2018), and public sector organisations cannot simply incorporate new digital tools into old administrative regimes. As suggested by Randma-Liiv and Vooglaid (2019), public administrations become responsible for organising the opportunities that involve and engage citizens and must be able to coordinate several dimensions, including organisational design, participatory process and management practices. A cultural shift, a new organisational culture is required that is able to integrate participatory elements such participation, production, collaborative governance, partnerships and collective action. The organisational and technical integration requires the development of an organisational culture that enables and supports participation, is collaborative and social, so as to be able to overcome the problems associated with hierarchies and bureaucracy (Criado & Rojas-Martín, 2016). The cultural change required is reflected in the Tallinn Declaration: "*digital progress is transforming our societies and economies to the core, challenging the effectiveness of previously developed policies in a broad range of areas as well as the role and function of the public administration overall. It is our duty to anticipate and manage these challenges to meet the needs and expectations of citizens and businesses*" (Council of the European Union, 2017, p. 2).

3 Literature Analysis: Digital Participation, Co-production and Co-destruction

The principle of participation requires that citizens are involved in order to represent the diversity of a community in a cooperative dialogue. This means that citizens are not just the "end-users", but partners and co-producers of information and services (Huijboom et al., 2009). Participation and co-production are seen as ways to achieve collaborative governance (Gawłowski, 2018; Greve, 2015; Nabatchi et al., 2017), they provide opportunities and are expected to be beneficial, whilst co-destruction represents the challenges or problems that act as barriers or even lead to value destruction, in some cases it is even seen as a public failure. Rarely addressed in research, so-destruction is often used as the excuse for not implementing digital participation or even starting co-production processes. If digital participation and co-production are the important topics that contribute to a research agenda on digital governance (Charalabidis & Lachana, 2020), then co-destruction must be included as a research theme.

3.1 Participation

Participation includes any form of involvement in the community that may impact the use of public resources or the way issues are resolved (Sharp, 2012) "*any form of involvement in community affairs that has the potential to shape the allocation of public resources or the resolution of community issues*" (Sharp, 2012). Roberts defines direct citizen participation as "*the process by which members of a society share power with public officials in making substantive decisions related to the community*". In contrast to indirect citizen participation (i.e. representation), direct citizen participation embraces increased cooperation between public administrators and actively involving citizens (Roberts, 2015), and its aim is to support civic engagement (Sharp, 2012). Public participation gives citizens the right to make comments and express opinions before decisions on laws, plans and programmes are taken, so that effective citizen participation is seen as being achieved when government decisions and government–citizen relationships are improved and the outcome of the public participation is duly taken into account (European Parliament, 2003). If all citizens are enabled to have a voice, there is a fundamental shift in governance, as well as a way to deal with multiplicity and diversity. The white paper on "E-Democracy & E-Participation in Austria" (2008) sees e-participation as complementing representative democracy and fostering civil society participation to achieve the ideal interactive state and public sector culture. Digital participation, especially where there is no legal obligation to participate, has numerous potentials, such as increasing the effectiveness, capacity and legitimacy of public decision-making processes, but also contributing to the modernisation of public service provision and greater acceptance by citizens (Parycek, 2019).

The use of certain digital tools themselves may be participatory and lead to greater acceptance: "*Technologies may be interactive in their design; they may facilitate many-to-many communications; they may be accessible and adaptable to multiple kinds of users; and they may encode certain values through their terms of use and through their interfaces. But, ultimately, those technologies get embraced and deployed by people who are operating in cultural contexts that may be more or less participatory*" (Jenkins et al., 2015, p. 12). A participatory culture does not begin or originate with the use of social media platforms or networks and not all technologies are participatory (Jenkins et al., 2015). Thus, as Jenkins et al. point out, Facebook, YouTube and other online platforms themselves should not be seen as participatory cultures but as tools "*that help maintain social contact or to share cultural productions*", where interactivity is a property of the technology that "*enable users to make meaningful choices*" and to "*contribute to a larger process of deliberation*" (p. 12). In a digital context, participation should be more than digitalised participation or the integration of offline methods into digital processes or the use of digital tools in offline participation and co-production frameworks. Designing offline or digital public spaces in participation means being able to integrate different processes, tools, methods and approaches, as suggested, for example, by McCarthy and Jinnett (2001):

1. Linking the activities of an organisation to build participation to its core values and purpose by selecting participation objectives that support this purpose;
2. Identifying clear target groups and focusing its tactics on good information about these groups;
3. Understanding the internal and external resources that can be used to build participation;

Roberts (2015) outlines several models of direct citizen participation, including co-production, in which citizens adopt the role of volunteer or co-producer. Online platforms are one of the most common and well-known ways of implementing digital participation (Aichholzer et al., 2015), examples such as "FixMyStreet" (mySociety, 2020) in the UK or the Austrian "Sag's Wien" (City of Vienna, 2020) are apps that allow citizens to be involved in those information flows that enable them to decide what is important to them, and informing the relevant public sector organisations or agencies of issues they think need to be resolved.

3.2 Co-production

Just like public participation, the implementation of co-production implies the need to promote citizens as central to the value chain, to ensure sustainable relations between government and citizens and the involvement of citizens in the process of public service delivery (Ryan, 2012). Co-production, originally defined as "*the process through which inputs used to produce a good or service are contributed by individuals who are not 'in' the same organization*" (Ostrom, 1996, p. 1073), are those organisational processes that enable public organisations and citizens to work together to "*make better use of each other's assets, resources and contributions*" and achieve valuable outcomes (Bovaird & Löfler, 2012, p. 27). Co-production rejects the idea of service delivery to passive users; instead, users are to be seen and treated as active participants in the production of outcomes (Osborne & Strokosch, 2013).

Co-production is generally understood as citizens' willingness to participate and to contribute to the common good (Meijer, 2014) and refers to the active involvement of end-users, such as citizens, as partners, in various stages of the production and delivery of services (Voorberg et al., 2015). In the co-production model, administrators are responsible for facilitating the joint provision of service design and delivery with citizens (Roberts, 2015). The idea was originally developed by Ostrom et al. (1978), who developed a model of public service production where the citizens influence public agency outputs and the objective community conditions, but the concept of co-production has moved from being a general process of external users providing inputs, to more specifically integrating citizens in the initiation (Bovaird, 2007), design (Nabatchi et al., 2017), implementation (Dunleavy et al., 2006) and assessment (Löfler, 2020) of public service processes.

Williams and Shearer (2011) point out that citizens are not just recipients and beneficiaries of public services, but responsible for identifying what is valuable to them and designing the service they need. Citizens have benefits and rights, but also obligations and responsibilities such as ensuring that they obtain enough and adequate information about the public services available (Breit & Salomon, 2015; Gawłowski, 2018). Co-production is seen as improving public value in several ways, such as leading to higher service quality, expanding opportunities for participation and engagement, enhancing the quality of information provided and helping citizens have greater satisfaction with public services (Brandsen & Pestoff, 2006; Cordella et al., 2018; Osborne et al., 2016; Radnor et al., 2013). The close collaboration with users is considered particularly important as it allows for organisational changes in public sector òrgaisations' culture through the integration of new roles and new ways of thinking, new capabilities for creating and realising value, implementing or supporting changes co-created by multiple stakeholders (Trischler et al., 2019). One way of supporting this change can also be achieved by adopting the reverse: instead of focusing on how customers can be engaged in the organisation, public sector organisations could focus on becoming involved in the customers' lives (Grönroos & Voima, 2013). Pestoff (2006) adds that co-production is "*an important means of enhancing both the quality and quantity of public services*" (p. 507), echoing previous work by Rich (1981) who argues that for citizens even small increases can contribute to significantly increasing the quality of life.

Digital tools and social media offer a number of ways to connect with citizens to help public administrations identify emerging issues and trends, to support digital mobilisation and engagement (Hermanns, 2017). Public sector organisations are adopting the new digital channels for several reasons, such as disseminating content and information, to broaden the range of services offered and to involve citizens, but also for internal reasons such as re-organising processes, and supporting collaborative forms of work. The new digital technologies have extended the applicability of co-production. As digital technology has enabled and initiated new partnerships, so it contributes to co-production relationships between citizens, stakeholders and government. Alford (2016) contends that recent technological advances may lead to an increased ability to perform co-production activities and enhance citizen engagement with local governments, and Meijer (2016) argues that the Internet can facilitate improvements in citizen relationships through the use of social media, online groups and networks. Breit and Salomon (2015) see the use of digital tools for the co-production first as leading to the transformation of citizens' role from sole recipients of public services to actively searching, handling and providing information to develop public services, and second, helping public administrations be efficient, increase the availability of services and provide personalised services.

Co-production can also be used to obtain political influence and access to resources by creating opportunities for citizen involvement in areas typically reserved for government and public sector organisations. Digital platforms for citizen involvement in decision-making processes are becoming increasingly popular, and several countries, cities and municipality, have, for example, co-produced digital agendas with their citizens (City of Vienna, 2016; Deutsche Bundesregierung, 2014; freie Hansestadt Bremen, 2014; Government Offices of Sweden, 2011). Whilst digital governance models and practices have been maturing and participation and co-production provide opportunities for developing solutions, the complexity of digital initiatives and processes increases, as do the levels of social expectations towards public sector organisations. Sometimes things do not go the way they are expected to.

3.3 Co-destruction

A participatory culture is "*a set of practices that have centered on accessible and communal forms of production and sharing*", and, at the same time "*it embodies a set of ideals for how these social practices can facilitate learning, empowerment, civic action, and capacity-building*" (Jenkins et al., 2015, p. 183). Jenkins et al. add that the way participatory culture is understood has been changed and transformed by new technologies that are digital, networked, mobile and social. Digital technologies allow for multiple forms of communication to replicate, remix and reproduce content, in ways that were not envisaged by the producers, merging the concepts original/copy and producer/consumer (Livingstone, 2004). Yet Jenkins et al. also point out the importance of not focusing solely on the impact digital tools, contexts and affordances have on people, organisations, culture and society but also considering how personal experiences impact participatory practices and norms. Collaborative innovation is a process of creative problem solving through which relevant and affected actors work together across formal institutional boundaries to develop and implement innovative solution. Barnes and Williams (2012) urge public sector organisations to embrace the new digital technologies in response to a changing society and citizenry, as a focus on the functional role technology will limit the value of digital participation and co-production. No matter what form and extent transformation in public sector organisations takes, the outcome involves a change of some nature. The positive vision of participatory culture in the public sector is one based on collaborative governance that supports the development, creates public value and achieves social relevance (Greve, 2013; Karo & Kattel, 2016; Sørensen & Torfing, 2018).

A participatory culture may not always have positive effects or be beneficial: there are barriers that need to be overcome, it can be disruptive, lead to abuse and mistakes (Jenkins et al., 2015). These are the cases where a participatory culture does not result in positive outcomes. There are several public projects and services characterised by failures, delays, political damage, as seen in debates in the media about wasting public money (Duijn et al., 2010) or the discussion about the ab/use of digital channels such as by former US President Donald Trump's use of Twitter.

This can occur in different ways—through conflict, marginalising some people and providing more dominant groups more visibility, through a shift of power or "*locus of control*" (Jenkins et al., 2015, p. 23), but also through misinformation that has gone unchecked and is widely disseminated, or manipulation. This is the opposite of participation and co-production: it represents the "*dark side*" (Williams et al., 2016, p. 692), "*co-contamination*" (Moon, 2018, p. 297), or when it goes "*horribly wrong*" (Brandsen et al., 2018, p. 284) and implies value destruction (Grönroos, 2011). This is the phenomenon seen as an undermining of public values, the misuse of available resources by providers and/or users such as "*dumping on service users, carers and other citizens some of the most difficult tasks of the state*" and "*punishing them where they do not perform as expected*" (Löffler & Bovaird, 2018, p. 275). Brandsen et al. (2018) argue that co-destruction can include several problems such as the deliberate rejection of responsibility, accountability, increased costs, loss of democracy, reinforced inequalities and implicit demands on those who have less and co-destruction of public value. The scarce adoption and the failure of public services' value creation initiatives has been mainly attributed to issues related to citizens and the users' limited experiences, skills and biases, a lack of necessary tools, processes and coordination, but also tendency to see it as requiring too much time and/or effort.

Barriers to a participatory culture may stem from the institution itself, as digitalisation and ensuring transparency is expensive, challenges the administrative culture and bears risks (Edelmann et al., 2018), and the organisation may not have the capacity to absorb and incorporate citizen feedback into its deliberations and policy-making processes (Bertot et al., 2016). Several have argued that the time and costs relating to planning and conducting co-design activities can increase considerably when users are not involved in the underlying topic or do not perceive themselves as suitable participants. The application of co-production is especially challenging in those projects which deal with sensitive or less engaging topics, need to engage marginalised groups or where users may be reluctant to participate or may not perceive themselves as suitable contributors (Grönroos & Voima, 2013). Thus, although citizens and other stakeholders are seen as having valuable experiences, ideas and resources that can help to spur innovation, motivating them to participate in collaborative projects can be challenging, there may be lack of internal approval or support for the implementation (Trischler et al., 2019) and participation is not always welcome.

Other barriers may be outside the organisation. This reflects the discrepancy between what public managers think service users need with what service users themselves state what they want (Willis et al., 2003). Public administrators' perceptions focus on citizens who lack the necessary competencies and experiences to co-produce public services or see transparency and allowing citizens' access to large amounts of data or information as problematic, and information overload is known to have detrimental effects. The format of the information, it is argued, as well as the timing of the accessibility to the information may represent transparency in some cases, but may be useless, obscure and even dangerous in other cases.

Åkesson and Edvardsson (2008), for example, found that public employees believe that not all users are able to access the appropriate information, and do not have the necessary competences. The generation of ideas, visions and decisions requires not only technical skills, but social and conceptual skills that are seen as being available to a certain extent in the users (Dickinson et al., 2015; Voorberg et al., 2015; Wherton et al., 2015). The efficiency and effectiveness of co-production depend on the ability of citizens to perform their roles in service delivery, but citizens may not have the ability to perform services that require specialised training, so that they cannot take advantage of co-production (Pestoff, 2006).

Digital and interactive technologies are designed to allow audiences to speak back to the producers of content, to search and query databases, and to hold powerful institutions to account. The rapid growth of social media (e.g. Twitter) suggests that many citizens believe that digital technology increases their ability to make a difference as it allows them to present their views, but it is clear that their use can also lead to misuse, failures and co-destruction. As public services consist of interactions between a range of human, organisational and technical elements and processes (Trischler & Scott, 2016), some argue that the role of digital technologies is over-emphasised, ignores the human and social aspects (Pestoff, 2014) and the users' needs regarding the services offered (Szkuta et al., 2014). Osborne et al. (2012) believe that, given the lack of the "*interpersonal immediacy of face-to-face contact*" (p. 146), digital services lead to passive interaction, lower or only minimal co-production of value. The use of digital technology can lead to an increase of the digital divide and limit particular groups' access, ability and opportunity to participate, e.g. older adults, those with low income, those who are unemployed or have less formal education but also race, ethnicity and gender are factors known to increase digital exclusion (Schradie, 2011). The digital divide describes the gap between those who have access to technology and those who do not, caused by the lack of computer access, Internet access and technological expertise. Marginalised groups are the ones most adversely affected by the digital divide, that is, those who are already disadvantaged by income or education are more likely to be excluded even more from digital citizenship. Because these groups are often in greatest need of government services, their exclusion from digitally based co-production may be especially problematic. Some groups therefore may need supplementary support or facilitation to participate in co-production (Needham, 2009), but it is often challenging to bring the relevant and affected actors together for different reasons such as power discrepancies, incompatible worldviews or conflicts of interest and ideas (Sørensen & Torfing, 2018).

Rupp (2017) argues that it may not just be a lack of awareness in users and employees, but, given the increasing use an reliance on digital tools, may be due, on the one hand, to a lack of digital literacy in the users in general, but, on the other hand, a lack of common technical standards, procedures and infrastructure between the public organisations. When digital tools are used in co-production, co-destruction may occur through security threats such as to user privacy, but they can also lead to dysfunctional exchanges and conflict through a misunderstanding of the way digital applications are to be used or the misinterpretation of the information available (Bolivar, 2018; Kumar et al., 2016; Meijer, 2016).

Whilst digital tools allow everyone to have their say and promote their thoughts, in practice, most do not. Thus, problems such as shifting norms, echo chambers, internet filters and bubbles and digital ghettos arise and may actually make it hard for the individual to be heard. Others argue that the use of technology, although seen as a way of increasing public participation may not be accepted, can lead to more exclusion, and that individually tailored solutions may reduce the open discussion of issues (Granier & Hiroko, 2016). They may also force the use of co-production when it is not wanted or suitable for the purpose or even diminish users' choices and opportunities for active participation (Lember, 2017; Linders, 2012; Moon, 2018).

4 Contributing to a Research Agenda

Digital governance has emerged as a research and practice domain that aims to exploit information and communication technologies (ICT) in the public sector in order to increase their effectiveness and efficiency (Charalabidis & Lachana, 2020). It is important to consider past research on relevant topics in order to suggest future areas of investigation and raise relevant research questions. In this chapter, it is argued that research should continue to focus on the public sector organisations' new participatory organisational culture and role in society, working with a range of opportunities provided by digitalisation, stakeholders and investigating the outcomes that can be achieved.

Digital governance can transform the ways in which public sector organisations produce and deliver services and interact with stakeholders, and these transformations can be mediated by organisational and cultural factors, and, increasingly, by digital technologies. Public management strategies need both the organisational capabilities and resources to fulfil social expectations regarding the promise of participation and co-production. The promise of participation and co-production is often seen as one of increased legitimacy, more efficiency and effectiveness of government and of more accountability, but it leads to structural transformation of the public sector (Meijer, 2016). Public participation and co-production of public services should not be seen only as an exchange of information, but the re-organisation of the relationships, the interaction and cooperation between several actors (Gawłowski, 2018; Mergel et al., 2019); it should represent open public processes and involve individuals from outside and inside the organisation (Boyle, 2009; Chatfield et al., 2013; Cordella et al., 2018; Duijn et al., 2010) in order to achieve the set outcomes. Citizen participation entails both democratic, societal fairness and individual benefits that are reflected in citizens' motivations to take part in such processes. This presents a considerable cultural and ideological change from the public sector's traditional role and further research is needed on this new role.

As participation and co-production increasingly become part of public sector management, it is necessary to ensure that the benefits of the digital technologies systems are fully realised, not just the citizens but by the other stakeholders and employees too. The focus of participation should not be participation per se or the participation instruments or the use of a digital tool in an analogue process or the inclusion of analogue elements in a digital process. Public sector organisations must develop an participatory culture that goes beyond simply posting documents on government Websites; there is a need to move towards an understanding of how the co-operation between those who know best can improve the services (Governance International, 2020), and this includes the proactive dissemination of information, government activities, deliberation and decision-making opportunities in multiple formats using different channels that ensure that citizens are aware of what public sector organisations are doing, providing and offering (Bertot et al., 2016). This not only highlights the need for public sector agencies to ensure that citizens and stakeholders are included, but to develop an organisational culture that allows to the design of such service systems, the implementation of knowledge systems able to analyse the input (Trischler & Scott, 2015) and ensuring that public sector employees have the necessary competences for using such systems (Bolivar, 2017).

The promise of participation and co-production is often seen in research as one of increased legitimacy, more efficiency and effectiveness of government and of more accountability (Verschuere et al., 2012). "*Traditional views on public value creation focused on the public organisations as sole initiators of the value creation process. The increasing possibilities and the use of digital technologies have been challenging this understanding*" (Misuraca et al., 2019, p. 32): the use of digital technologies supports citizens provide data and contribute to the creation of new products and services, leading to value creation that fosters innovation in the public sector, and helps overcome problems that stem from a broad range of demands and limited resources. Digital tools and social media enable more citizens to participate, but will also shape public sector organisations, their organisational culture and ways of working, and the way public services are delivered. They will also lead more inclusive policy making and increasing trust in society and public sector organisations (Meijer, 2016).

Research shows that whilst public sector organisations are strengthening participation and co-production relationships with citizens and stakeholders, less research focuses on the effects of digital technology on the provision of services (Clark et al., 2013) and co-production (Lember, 2018; Lember et al., 2019). It remains important to focus on whether the envisaged outcomes are actually being achieved through the use of digital technology and whether a real contribution and improvement for future users is being made. The overwhelming majority of research on public value has told a positive story of value creation, with only limited attention to the notion of public value destruction (O'Flynn, 2021) or "dis/value" that is, when "*the public value experience will not be positive, but could be limiting, frustrating, constraining, and struggled for*" (Cluley et al., 2020, p. 3). The use of digital tools and change may lead to problems such as complexity increasing by adding digital layer on top of the traditional human-centred processes or to unintended and negative outcomes, such as diminishing the opportunity to actively participate, disempowering citizens and increasing discriminatory practices or the digital divide. Co-destruction shows that increasing the level of participation and co-production is not always easy and may not lead to the outcomes desired. Value destruction can occur by misuse of a good or service by a user, but it is also necessary to consider the impact of the destruction of value has on the wider public service ecosystem too (Strokosch & Osborne, 2020). A research agenda must therefore avoid an over-optimistic vision and bias by addressing the problems and learning from mistakes made in the past.

5 Conclusion

Organisations across all sectors are developing digital agendas and strategies in order to exploit the benefits of new digital tools and opportunities, although the digital "*should be seen less as a thing and more a way of doing things*" (Dörner & Edelman, 2015). The "*shared vision of society is created by developing shared norms*" (Jenkins et al., 2015, p. 27), and the goal should be to create an organisational culture in the public sector that is able to provide more opportunities for meaningful participation (Jenkins et al., 2015). Innovative public sector organisations can develop a participatory culture by integrating and learning across contexts and locations, using digital tools, methods and data sources available, coordinating governance mechanisms and implementing constant evaluation (Bertot et al., 2016). A strategic framework for digital participation will combine the important strategic, organisational and environmental factors, coordinate the instruments by taking into account the strengths and weaknesses of each element so that these factors will complement each other (Wirtz & Langer, 2016; Wirtz et al., 2018) and support the social practices of the organisation's culture. A participatory organisational culture is one that is aware of societal trends and changes outside the organisation, and at the same time, of those factors that may impede the development of a participatory culture such as conflicting values among co-producers, institutional rigidity, risk aversion, lack of mechanisms that ensure accountability, shortage of capacity or incentives and conflicts that impact all processes in general. Research must be able to highlight the importance of investing time, resources and research into the recruitment, screening, selection, development and monitoring of co-production and participatory practices that support the transformation of the organisational culture of public sector organisations in a digital era.

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