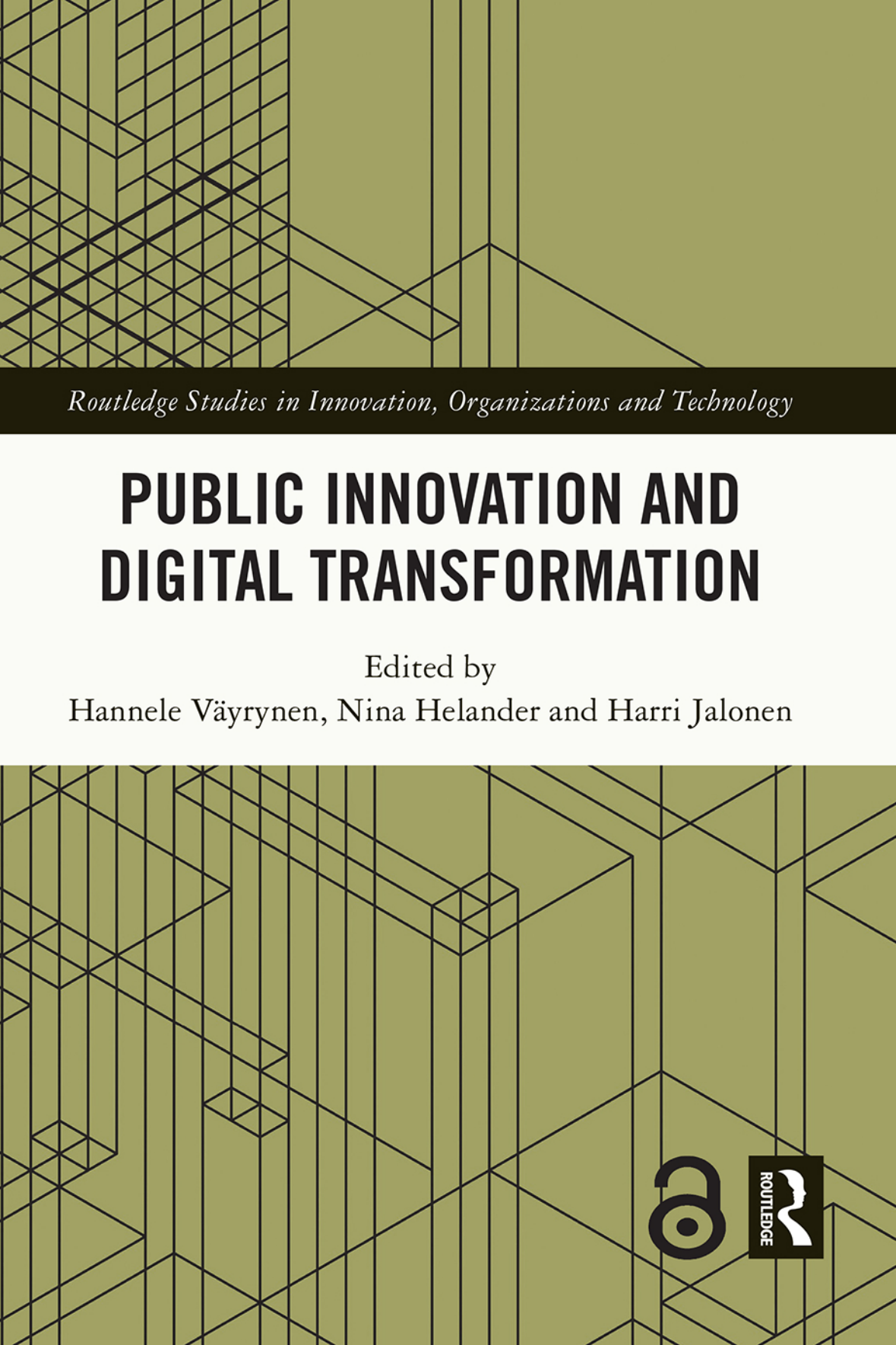
Routledge Studies in Innovation, Organizations and Technology
PUBLIC INNOVATION AND DIGITAL TRANSFORMATION
Edited by
Hannele Väyrynen, Nina Helander and Harri Jalonen
ROUTLEDGE

Public Innovation and Digital Transformation

Public innovation and digitalization are reshaping organizations and society in various ways and within multiple fields, as innovations are essential in transforming our world and addressing global sustainability and development challenges. This book addresses the fascinating relationship between these two contemporary topics and explores the role of digital transformation in promoting public innovation.

This edited collection includes examples of innovations that emerge suddenly, practices for processing innovations, and the requirements for transformation from innovation to the "new normal". Acknowledging that public innovation refers to the development and realization of new and creative ideas that challenge conventional wisdom and disrupt the established practices within a specific context, expert contributions from international scholars explore and illustrate the various activities that are happening in the world of multiple digitalization opportunities. The content covers public administration, technical and business management, human, social, and future sciences, paying attention to the interaction between public and private sectors to utilize digitalization in order to facilitate public innovation.

This timely book will be of interest to researchers, academics, and students in the fields of technology and innovation management, as well as knowledge management, public service management, and administration.

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Preface

A small group of enthusiastic innovation researchers were having a discussion about the kinds of innovations that were happening in the rapidly developing field of digitalization: what is more important, what kinds of innovations will survive? Consequently, this inspiring group of innovation intellect was invited to problematize the combination of public innovation and digitalization. As a result, this book was written. In this book we include examples of innovations that emerge suddenly, practices for processing innovations, and the requirements for transformation from innovation to the "new normal". Acknowledging that public innovation refers to an intended but inherently contingent process that involves the development and realization, and frequently also the spread, of new and creative ideas that challenge conventional wisdom and disrupt the established practices within a specific context, we explore and illustrate the various activities that are happening in the world of multiple digitalization opportunities.

The content structure of the present book was developed during spring and autumn 2020. Globally affecting pandemic forced the actors to find new solutions for the operations, products and services. This rapid transformation of digitalization convince us of the emphasis even more the importance of the consideration beside new technology, the social aspect (human beside technology with attitudes, learning and practices) as well as the more comprehensive picture around operations, namely economy, legal, human resources and networks. The content covers public administration, technical, business, management, human, social, and future sciences. It pays attention to the nexus between public and private sectors. The intention of these chapters is to offer new insight for academic discourse and, for students, to illustrate the system circle and the actors' roles in public innovation and digitalization. Furthermore, examples of concrete public innovation solutions and possibilities are provided for practitioners.

This book contributes to both the scientific discussion and the practices of public innovation management and innovation governance. The book also explores and identifies new avenues for future innovation research.

This book addresses the fascinating relationship of two contemporary topics – innovations and digitalization. Public innovations are reshaping organizations and society in various ways and within multiple fields, as innovations are essential in transforming our world and addressing global sustainability and development challenges. Simultaneously, digitalization is constantly shaping the way we interact,

carry out work and develop organizations, cities, and even societies. Digitalization changes many things, but at the same time many fundamental and human issues remain more or less the same. As far as public innovations are concerned, it seems that digitalization is a fuel for paradoxical development. The question is, how does digitalization change the logic of innovations and innovation management - or will it ultimately change it?

A review of the literature reveals that digitalization has been problematized surprisingly little from the public innovation viewpoint. In order to narrow this gap in the literature, this book, written by a wide collegial network representing different research traditions and points of view, will offer invigorating thoughts on digitalization and innovation combined. We approach innovations in the digitalizing era from three main perspectives, namely space, data, and nexus.

First, we offer **space** as an important perspective regarding public innovations in the digital era. As the world and ways of working are changing rapidly, there need to be new combinations of the more traditional and the new digital environments for innovation processes. Besides the physical environments, the new digital environments, such as digital platforms, offer new ways to operate. Chapters 3, 8, and 9 address this space perspective on innovations through fascinating empirical studies representing various sectors of industry.

Second, **data** is said to be the new gold. However, it cannot be said that a new gold rush is going on because practices in data sharing are as yet surprisingly undeveloped among the different actors in the public innovation ecosystems. Therefore, we discuss, on the one hand, how data is part of innovations and on the other hand, how data-dominant logic is seen in the public innovation process. Chapters 5, 6, and 7 deal with digital innovations from varying data perspectives.

Third, the **nexus** of interaction is an important perspective for digital innovations, as digital innovations at best are co-created and for example, occur both in public and private sectors, either together or in separate processes. Nevertheless, it requires co-operation between actors representing different sectors for innovations to succeed. It is assumed that co-creation occurs by nature in interactive and dynamic relationships where value emerges at the nexus of interaction between different actors in a particular context. Chapters 1, 2, and 4 will address this nexus of interaction perspective both through a literature review and an empirical case study.

On the whole, digital solutions tend to develop rapidly. However, data utilization and digitalization of processes may have unintended consequences or coincident effects, which it is important to problematize from the ethical perspective as well. This book will question these effects, too, from the various viewpoints of space, data and nexus of interaction, as briefly described in the following.

The first chapter sets up the scene for nexus of interaction and the public involvement in creating the best possible innovation environment for public and private innovators alike by considering: a) Through which interfaces and actor roles does public involvement in innovating and innovations happen? b) What means does a public actor have for creating and facilitating avenues for innovation? The chapter focuses on the concept of an innovation ecosystem – a network of public and/or private actors with an innovative mindset and resources such as

knowledge, competence, technologies, or physical materials – and shows the wide range of means and roles public actors have for promoting innovating.

Second chapter continues to deepen the nexus of interaction perspective by discussing the promises and pitfalls of digital co-creation. Drawing on the emerging literature on co-creation of public services the chapter seeks to identify the enabling factors helping bridge the gap between service providers and service users. Of particular interest is how digital means can be used for engaging vulnerable people. The chapter focuses on three technologies: open data, social media, and artificial intelligence. Pros and cons for each of them are discussed.

To accelerate public innovations also the perspective of space counts. The space perspective is discussed in the third chapter of the book, along with the chapters 8 and 9. Fourth chapter focuses on space perspective through a case study of a well-known and popular digital platform, namely Airbnb. The chapter uses a holistic approach to explore the social impacts of Airbnb from a hybridity and hybrid governance perspective and thus, take into account the that social impacts are influenced by interactions between public, private, and civil society actors, and activities. Through an inductive case study design, the hermeneutic analysis aims to illustrate how Airbnb's digital platform is currently part of hybrid governance.

Fourth chapter continues again the nexus of interaction discussion by taking a closer look to value creation logic in public innovation processes. There is a growing interest in academia to understand the logic of value creation. However, established views of value creation, namely goods-dominant (G-D) and service-dominant (S-D) logic ignore one important value creation ingredient. This important ingredient and driver of value creation is data. In fourth chapter the data-dominant (D-D) logic is introduced and a comparison between roles of goods, services and data in D-D and related G-D and S-D logics is provided. We then introduce several practical examples, how value creation following D-D logic impacts public service innovations.

Fifth chapter of the book takes a data perspective to public innovations and digitalization through an emphasis on Artificial intelligence (AI) and especially on machine learning. Using machine learning to exploit investment in information and communications technologies it potentially offers more personalized and appropriate services to citizens. AI is already featuring across the wide range of public services driving innovations in areas such as healthcare and traffic and could alter how public services are organized, how they interact with citizens and how they can be integrated. The fifth chapter has two objectives: 1) survey the AI-enabled innovations operating in the public sector and 2) explore the dynamics of AI-enabled innovation in public services. These discussions are structured by conceptualizing mutuality governance for analyzing and guiding the ethical and the problem-solving impact of AI. Research addresses the need for AI-enabled innovations to relate ethically to citizens, as many of the innovations originate or partner with AI-enabled capabilities in the private sector.

Data perspective continues in the sixth chapter of the book by taking a closer look to public organizations' data capabilities. In dynamic environments, public organizations have an opportunity to make innovations by applying innovative technologies, implementing big data, and enabling data analytics capabilities that

can create value. However, at the same time, evidence from the literature shows that public organizations need more comprehensive data analytics capabilities to achieve data-driven value creation. In the sixth chapter, based on a literature review and case example, the aim is to present the factors enabling public innovations from the big data analytics perspective; a theoretical framework for data-driven value creation in public innovation is proposed, incorporating the concepts of data and data analytics and different data-driven value propositions.

Data visualization can be one important tool in turning data to more usable form in public innovation processes. Engineering projects are getting more complex, both for the private and public sector, and many projects now require a systems thinking approach to deliver a successful project and outcome. The seventh chapter focuses on this challenge and hypothesizes that in complex projects digital knowledge through visualizations can be one means to encourage greater attention to systems thinking as one of the approaches to enhance knowledge within a project team – for both project managers and project team members.

The eighth chapter of the book turns the discussion again towards the space perspective as it deals with platforms and digital twins as a space and means to accelerate public innovations. Within a cities and public services context, digitalization has the inherent potential to drastically change procedural methods employed for city planning and public services offered to its citizens. In the not-too-distant future, applications of seamless public platforms, for instance with digital twins (DTs), will become commonplace in our daily interactions with public services. A digital twin is a replica of a real system realized through data generated by and collected from the real system. Throughout the life-cycle of a city's built environment the transition into a smart city is further fortified by digital twins that can improve information and performance management in the operational stages of a building. In a digitally twinned world, public services will increasingly rely upon platform innovation strategies to help enhance such services to the public. The eighth chapter will reveal a projection on how other governments can create new value with DTs in the digital built environment and uncover potential value for the public with examples of the visioning and business model structure of the e-construction platform as designed and developed by the Estonian Ministry of Economic Affairs.

Innovation labs are regarded as important spaces for creating public innovations. Innovation Labs can be seen as a valuable response to the needs of organizations in developing digital strategies and promoting digital adoption. Chapter nine draws on the findings of a literature review on Innovation Labs and digital transformation and an exploratory case study conducted in a Innovation Lab to gain new insights into the role of Innovation Labs as facilitators of organizational digital transformation. The chapter describes the key features and functions of Innovations Labs and shows how they promote digital capabilities and digital transformation processes and strategies in organizations.

The last chapter discusses future avenues of digital transformations. As public value-creation from data and digitalization becomes increasingly important for public innovation, the chapter suggests three complementary strategical directions for the public sector: Experimental government, inclusive government, and

anticipatory government. The directions could help governments induce innovation helping us create 'the future we want', as the declaration behind the Sustainable Development Goals puts it. The chapter discusses, among other things, the benefits from learning by doing, the emergence of public-private digital ecosystems and platforms, and the impact of new waves of artificial intelligence. The last chapter ties together the three main perspectives of this book, namely space, data and nexus of interaction, and the three potential future strategies for public innovations, namely the experimental government, inclusive government and anticipatory government. While experimental government builds especially on data perspective and inclusive government on nexus of interaction, anticipatory government integrates all these perspectives and creates a space e.g., for the usage of digital twins and AI as accelerators of public innovation.

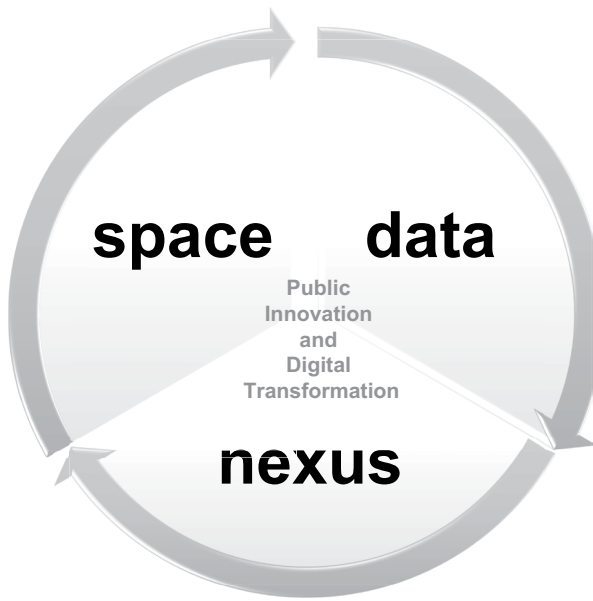

Figure 0.1 Innovations in the digitalizing era from three main perspectives.

1 Avenues for public actors to enable and promote innovating and innovation

Hannele Väyrynen and Jarmo Uusikartano

Introduction

The ways and means for public actors to promote innovation and innovating remain uncharted. This concerns issues such as the actual capability of public organizations to promote innovations, the utilization of external knowledge in public actions, and the means to co-create with private actors (e.g., Bason 2018; Clausen et al. 2020). Therefore, in this chapter, we set up the scene for public involvement and avenues to create the best possible innovation environment for public and private innovators alike. For this purpose, we present four interfaces through which public involvement in innovating can happen, six roles representing the different means for public actors to support innovations, and some future, yet easy, avenues to improve public support for innovating.

As both societal and economic activities affect innovation actions and the perceived value of innovations (Russo-Spena et al. 2017), it is crucial for private and public actors to consider how they can shape, change, and adapt to the innovation environment. In this chapter, *innovation* refers to a new idea, process, or practice and an object that the actors identify as new (Rogers 1995, p. 11). In turn, *innovating* concerns development functions and innovation actions, i.e., practice-based learning and co-creation between the actors of an innovation ecosystem (e.g., Russo-Spena et al. 2016). When creating a favourable environment for innovation, public actors can participate with administrative or executive instruments. As the instruments are versatile, public actors can also be represented by various entities such as a municipality or city, public officer, public corporation, or public development company.

Innovating is rarely the act of just one private or public actor. Therefore, in this chapter, the focus is on an innovation ecosystem that is a network of actors (public and/or private) with an innovative mindset and resources (such as knowledge, competences, technologies, or physical materials) that enable a favourable environment for innovations to emerge. An innovation ecosystem as such is a multifaceted concept that can refer to "collaborative arrangements" (Adner 2006) or integrating mechanisms (Valkokari 2015), multi-level knowledge sharing clusters (Carayannis & Campbell 2009; Valkokari 2015), or new value creation through innovation (Autio & Llewellyn 2016; Yin et al. 2020). Moreover, Granstrand and Holgersson (2020) define the innovation ecosystem as "the evolving set of actors, activities,

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and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors". This kind of innovation ecosystem is intended to function through "a multilevel structure of interdependent organizations from different industries that trade several resources in an 'energetic flow' from an organization to another, through symbiotic and dynamic relationships" (Ferasso et al. 2018). In innovation ecosystems, the network of different actors is centred around value creation and characterized by social aspects (Russo-Spena et al. 2017) as the ecosystems are all about interconnected actors (e.g., Valkokari 2015).

From the public governance and policy development perspective, the "national innovation systems" create frames for social interaction related to innovation activities. As Lundvall (1985) stated, "[R]egional innovation systems are formed by key organizations intensive in research and development like universities, research centers, financial systems, supported by a governance structure". For now, the public and private sectors need to collaborate due to the scarce resources they have if operating alone. Public actors especially can open up their processes and practices to the private sector, which can offer new technologies, solutions, and information that creates new value for the public sector (e.g., in terms of enhanced products or optimized public services that ultimately benefit the citizens and customers). However, public–private co-creation, promoting innovation, and facilitating new innovative openings demand an active innovative attitude and practices from public actors. This means the public actors need to recognize, define, and possibly even redesign their approach to promoting innovations and innovating. Therefore, it is relevant to consider the best practices for public actors to enable and promote innovating. This chapter, therefore, considers the following questions: (a) *Through which interfaces and actor roles do public involvement in innovating and innovations happen? (b) What means does a public actor have/use for creating and facilitating avenues for innovation?*

Roles of public actors in promoting innovating

For now, the array of public actors and their means to promote innovating are unclear and uncharted (e.g., Bason 2018; Clausen et al. 2020). However, public actors have earlier been recognized as adopting different roles and means when participating in promoting sustainability. For this purpose, Uusikartano et al. (2020) presented six public actor roles – namely organizer, operator, financer, policymaker, regulator, and supporter. These roles represent the means that public actors have for influencing the actions of a certain industrial ecosystem covering a wide range of different areas of business, from organizational to managerial and financial issues. To shed light on the public involvement in innovations, the aforementioned roles are adapted in the following sections to the context of publicly supported innovating.

Interfaces for public involvement in innovating

The public actor roles mentioned by Uusikartano et al. (2021) can be applied to the context of publicly supported innovations and innovating that take place in the interface with private organizations and are executed by, e.g., public development

companies, policy programmes, projects, eco-industrial parks, publicly facilitated networks, workshops, regulation, and research collaboration. The six roles presented next represent financial, organizational, political, and legal means that are utilized through four different interfaces named as follows:

- *Ownership* – services provided or offered by different public organizations, ranging from management practices to public premises, innovation education, and regulation
- *Financing* – actions that are publicly funded or indirectly financially supported through, e.g., collaboration platforms, public innovation funders, publicly financed projects, and taxation
- *Authority* – means based on the authoritative power a public actor has, e.g. creating a demand or need for new innovations through public policies, laws, incentives, or marketing
- *R&D support* – actions creating prospects for innovations, including innovating by public organizations, investments in new technologies, and legal assistance.

Roles of public actors for involvement in innovating

Through these four interfaces, public actors can influence and be involved in innovating. Based on the public actor roles introduced by Uusikartano et al. (2020, 2021), the means of public involvement in innovating are presented as six roles, representing a set of innovation-related actions and means.

- The *organizer* supports innovating through different organizing actions aimed at creating an innovative setting, i.e., favourable conditions for innovations to happen. This can include bringing together facilities, know-how, and the expertise of diverse actors for new experiments. Moreover, the public actor can innovate by itself (such as public research institutes (co-)developing new solutions) or offer tools for other actors (private R&D actions financed by public institutes).
- The *operator* manages innovation practices such as research collaboration. The means include publicly provided sharing and collaboration platforms, as well as workshops and training sessions arranged for developers and innovators. Also, the operator may create demand for innovations through policies calling for new solutions for a specific need.
- The *financer* supports the innovation process actions with public funds. Direct funding instruments include publicly financed research projects and innovation institutes, investments in new technologies, and themed incentives for pilots in new specific areas. Indirect financial support can take place in the form of free-of-charge services for R&D (e.g., publicly owned testing equipment).
- The *policymaker* works through policies and political programmes that support, steer, or initiate innovative experiments. This may include public research institutes guided by a publicly set agenda, innovation funding based on certain thematic policies, or programmes and road maps pushing actors in new directions.

- The *regulator* is responsible for guidelines, standards, laws, and other guiding or coercive imperatives that affect innovations or related practices. This encompasses the limits set for innovation actions by legislation, taxation steering the actions performed by innovators, as well as legal help and support such as patenting procedures.
- The *supporter* promotes innovators in a consultative or collaborative manner with various services and support for innovation practices. This includes research collaboration, educating a new workforce, opening public data and infrastructure up for innovators, and marketing and promoting new innovative openings nationally and internationally.

The aforementioned roles, interfaces, and their linkages are presented in detail in Table 1.1.

Table 1.1 Public actor roles for enhancing innovations and interfaces for public involvement in innovating in the 2020s

Interface	*Role*	*Description*	*Examples*
Ownership	**Organizer**	Organizational structures for innovating	*Arranging opportunities for R&D such as bringing different types of know-how together*
	Operator	Innovation management	*Facilitating and managing collaboration on innovating*
	Financer	Free-of-charge services for R&D	*Publicly owned equipment and know-how available free of charge*
	Policymaker	Operational programmes including R&D	*Public organizations guided by political programmes and control*
	Regulator	Regulation guiding the innovation actions	*Public organizations operating within the legislative limits*
	Supporter	Education and training regarding innovation practices	*Educating new workforce, research collaboration with public institutes*
Financing	**Organizer**	Public innovation funders	*Public institutes financing R&D actions*
	Operator	Publicly funded platforms for innovating	*Publicly provided sharing and collaboration platforms*
	Financer	Publicly financed projects/ pilots/ organizations	*Publicly financed or supported development projects/ organizations*
	Policymaker	Political programmes for innovation funding	*Political agendas and thematic programmes for innovation funding*
	Regulator	Taxation	*Tightening taxation pushing the boundaries, eased taxation for new openings*
	Supporter	Indirect subsidies for innovating	*Public data, services, and goods available for innovators*

(*Continued*)

Table 1.1 (Continued)

Interface	*Role*	*Description*	*Examples*
Authority	**Organizer**	Vision and goals for new solutions	*Strategic visions and goals set for / by public organizations*
	Operator	Demand for innovations	*Public organizations searching for new innovative solutions*
	Financer	Incentives for new openings	*Themed, public financial instruments for new trials*
	Policymaker	Steering demand for innovations	*Political programmes pushing operations and businesses in a new direction*
	Regulator	Legal rights and responsibilities for innovation practices	*Laws and law proposals supporting/restricting innovation practices*
	Supporter	Marketing, communication	*Services for branding, export promotion, media*
R&D support	**Organizer**	Public research institutes	*Public research institutes innovating and co-developing with companies*
	Operator	Means for innovation processes	*Workshops, training*
	Financer	Investments in new technologies	*Public procurement directed toward innovative solutions*
	Policymaker	Creating strategy-based prospects for innovations	*Road maps and future visions that anticipate the future*
	Regulator	Legal help, patenting procedures	*Patenting services*
	Supporter	Support functions for innovating	*Public infrastructure as a test bed for piloting and building partnerships*

Public involvement in innovating in practice

To illustrate how the indicated interfaces and public actor roles occur in a real-life setting, we present a case study based on empirical findings. The case is based on the combined results of longitudinal studies (taking place from 2018 to 2020) and qualitative analysis of primary and secondary data sources on four Finnish circular economy centres. These centres represent ecosystems where a variety of private and public actors collaborate with each other in order to gain economic, social, and environmental welfare by utilizing methods with the aim of closed resource loops. Therefore, a circular economy centre can be seen as a practical manifestation of an innovation ecosystem where public and private actors together aim for more sustainable practices through new ways, practices, processes, products, etc., i.e., innovations. Hence, the case is referred to later on as an innovation ecosystem.

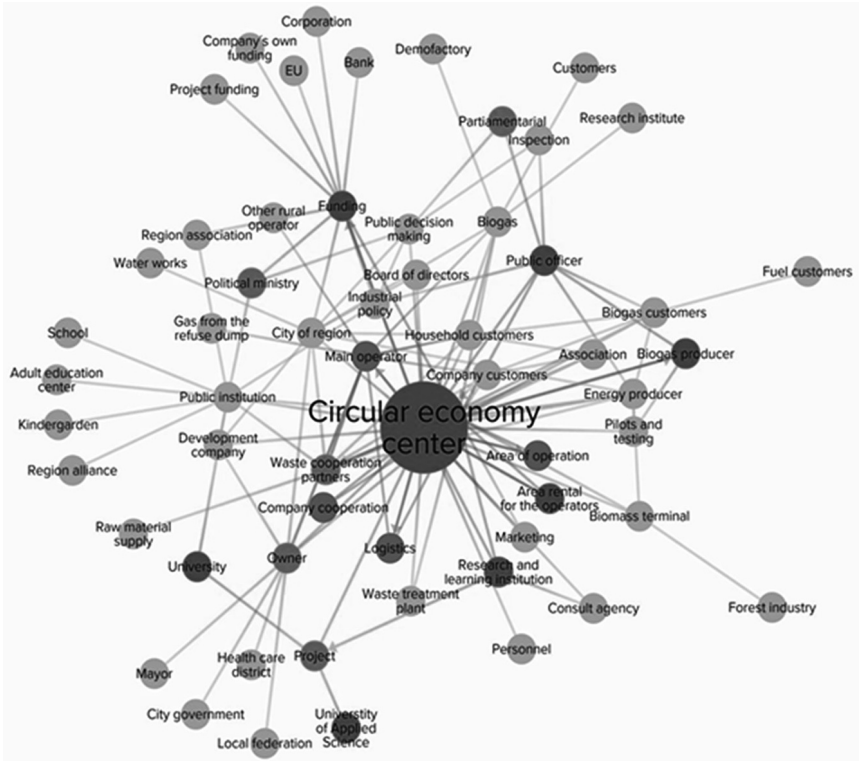

Figure 1.1 Illustration of the actor structure of the innovation ecosystem case. The most prevalent relationships and actors are shown in dark gray.

First, an ecosystem mapping of all recognized actors involved in an innovation ecosystem is presented in Figure 1.1, combining four subcases. The figure shows what types of public actors take part in the innovation ecosystems and which of them are the most prevalent (the dark gray links in Figure 1.1) in terms of public involvement in innovating. Second, to examine how public involvement occurs within the actor structure of the innovation ecosystem, the case is examined against the presented four interfaces and six public actor roles.

In the studied case, the innovation ecosystem is represented by a circular economy centre, a hub for the regional management of waste material flows operated by a public waste management company (hereinafter referred to as the central organization) accompanied by private companies. The central organization of the innovation ecosystem is responsible for the overall development of the ecosystem, giving it diverse roles ranging from organizational to managerial and financial business issues. The main resources of the central organization are allocated to waste management, which can leave the resources reserved for R&D rather scarce. Moreover, the tightening waste management regulation and increasing understanding of the extended possibilities of materials once considered waste call for new technologies and innovative solutions, which underlines the importance of

public and private partners in the innovation ecosystem. Regarding these partners, local city representatives are the ultimate decision-makers as owners of the innovation ecosystem area and central organization. In this respect, they also provide the necessary funding for the main operations of the central organization. Research institutes co-create new knowledge and offer development resources in the innovation ecosystem. Moreover, R&D actions can be funded and executed through externally funded projects that include several public and private sector partners. Companies join the innovation ecosystem if they see that membership in the ecosystem would provide them with economic benefits (e.g., new customers through the ecosystem members or decreased production costs through joint practices). The public actors of the innovation ecosystem interact with other organizations through the interfaces of ownership, financing, authority, and R&D support (as can also be seen in Figure 1.1). Next, a detailed consideration of the public actor roles and interfaces occurring in the case is presented.

Ownership relates to public involvement in innovating that happens through publicly owned resources. The *operator* comprises the central organization, the operation partners (e.g., transportation companies or waste treatment companies), the area rental unit, and other operators in the innovation ecosystem area (e.g., biogas producer, part of the waste flow operations). The *organizer* of the innovation ecosystem is a local public development company that offers a network, new knowledge sharing, or cooperation possibilities for the innovators. Research institutions and universities may also have overlapping roles. They can be *organizer*s (e.g., via projects) but *supporter*s as well. Therefore, the research and learning institutions may offer means for cooperative innovating and knowledge creation. *Policymaker and regulator* are the roles that make the framework for the waste management operation. On the other hand, the parliamentary actors formulate the legislation as the national framework, and the local public officers and municipalities (as the owners of the innovation ecosystem) supplement the area regulation and official development programmes for the operators, organizers, and supporters of the central organization. Politicians and ministries direct funding for the research and innovation instruments through various development programmes. In the innovation process, the policymaker and regulator define what the role of the public actor in the innovation process can be. So, the *financer* role affects simultaneously the other five identified roles: it enables the operator to operate and the organizer and supporter to create and modify innovation networks or development actions in the innovation ecosystem; furthermore, it enables the policymaker and regulator to direct funding for the innovation ecosystem.

Financing directs public resources to different innovation practices and development phases through different funding instruments. In our case, public financing concerns the *organizer*, *financer*, *policymaker*, and *regulator*, represented by politicians, ministries, and public officers who design the regional innovation programmes affecting the innovation ecosystem; the innovation actions or projects are dependent on external funding instruments. The *operator* offers the companies a physical platform for piloting and testing innovations but not direct financial support. The *supporter* of the innovation ecosystem (e.g., a public development

company or university) helps in contacting and facilitating information flows between the ecosystem members, and arranges various joint events.

Authority occurs on an individual, organizational, and/or institutional level. The *organizer* is represented by the central organization, local city government, and their personnel with whom the municipalities as owners formulate the strategic vision and goals for development. Public decision-making and public officers as *policymakers* are the ones who steer and promote sustainable innovations. Similarly, the public actors operating as *regulators* can restrict or support innovation pilots and processes with legislation. The central organization actors, individuals, and company staff are *operators* responsible for the practices and technology solutions in the physical area of the innovation ecosystem. The *financer* may be a personal contact of a member of the innovation ecosystem from a European Union institution or from the banking sector who informs the central organization's actors about the innovation funding instruments or programmes. Active individuals in the development company, associations, funding bodies, research and learning institutions, or even public officers can be significant *supporters* of marketing and communication in order to receive visibility for the innovation pilots and realize results in the ecosystem.

R&D support concerns the network of cooperative actors related to companies' innovation practices. Publicly funded universities and research and learning institutes are *organizers* that challenge and invite industries and companies to solve problems and create innovative solutions in cooperation with them. The central organization – namely, the *operator* – can identify the needs and offer means for innovations. The *financer* may be determined by the subject area of the innovation. For example, technology investments of an innovation ecosystem company can originate from a local bank while more general production or organization practices can be developed with external project funding. *Policymaker* and *regulator* are roles adopted by the politicians, ministries, public officers, and funders whose actions affect the innovation environment on the national level. The *supporter* role can be represented by actors who are part of the central organization's innovation practices through supporting, co-creating, or co-operating with the central actor.

Future avenues for public support for innovating

After presenting the recognized interfaces and roles for public involvement in innovating in theory and practice, we will now describe some concrete future avenues for public actors to support innovations even better. Each of the presented avenues can be applied through any of the indicated four interfaces (ownership, financing, authority, R&D support), offering therefore a wide range of options to support innovating in new ways. Moreover, the offered avenues are meant to be easy to implement. In other words, when public actors are looking for new avenues to support innovating, the authors suggest building on the existing competence and resources the public sector already possesses.

Opening up and offering the *public data sources* that various public organizations collect and produce can offer crucial information for other actors to develop

and create innovations. Moreover, it increases the transparency of public decision-making and reporting. Offering public data sources for companies to utilize may even encourage private actors to develop new products or services for the public sector. However, quite often private sector actors are not aware of the existence of open public data sources. So, more active and visible promoting of the existing available open public data sources is required.

Public procurements and calls for tender can guide the direction of innovating and facilitate the emergence of innovations. Namely, pursuing certain themes or presenting requirements for new kinds of innovations also steers the direction of innovating. This is something currently seen in societies aiming for more sustainable development as their local, regional, or national governments call for new solutions regarding, e.g., smart city design, electric mobility (both vehicles and public transport), or public-sector e-services (i.e., technology-based services).

Cross-operational collaboration between public and private companies with their practices and technological solutions can offer new insights into established industry practices. Furthermore, new solutions for totally new industries can be found. As an example, Sulapac Ltd. (see Sulapac 2020) manufactures packaging for the cosmetics, candy, and jewellery industries that are made of a combination of biomaterials and wood fibre. The process is scalable to other industries and accessories as well and the products are plastic-free and recyclable. Another example is the signal and sensor industry that can offer know-how and technology solutions, e.g., for the space industry (components or sensors) or for the health industry (measurement tools for self-monitoring, patient data analysis by artificial intelligence, picture-based machine learning for disease identification).

The existing *public resources and platforms* can offer new openings for public and private innovating if they were only made explicitly available to the actors. In general, public actors have a wide range of resources that could be opened up, offered, shared, or rented for innovators. These include the following. *Data* on the mechanisms and protocols of public decision-making, public financial statements and budgets, and the research results of public research institutes to support the development and commercialization of innovations. *Infrastructure* that includes public buildings that are underutilized or even totally empty, publicly owned land areas, and public research or processing facilities and equipment to be used in the piloting, testing, and production of innovations. *By-products* such as waste streams collected by municipal waste management to be used as inputs or raw material for new products. *Know-how and services* that public-sector personnel working in different fields have, including policies, legislation, research, administration, healthcare, governance, defence, security, and taxation to support and assist the private actors along the different phases of innovating. The tacit and explicit, location-specific *knowledge* that public actors have regarding business life, the age structure of a certain area, the workforce of an area, local natural resources, and regional development differences help to determine the needs and potential of a certain population. The aforementioned resources can be made available through public platforms, including publicly organized workshops and seminars, city districts, public organizations such as waste management organizations, research institutes, education providers, city governments, and public places such as cultural facilities,

libraries, sports venues, and parks. All the above-mentioned resources and platforms for activities are such that public actors already possess in some form. Now they should be made available for private and public innovators so that these public assets are not underutilized, i.e., it is a question of seeing public resources as elements of a possible and controlled test environment for innovations and innovating.

Public administration in principle affects all the entities and activities located within the borders of a country and therefore is a direct way to enable innovating. Here, public actors can *facilitate*, *create*, or even *push* public and private innovators. As a *facilitator*, public actors can offer and organize different forums for inter-organizational collaboration such as seminars, workshops, face-to-face discussions, web platforms, and competitions centred around distinct thematic issues. It is worth noting that public actors can facilitate public–public, public–private, and private–private cooperation (e.g., Meissner 2019; Brogaard 2021). In other words, instead of innovating everything by themselves, public actors should also *create* conditions for serendipity occurring among or through inter-firm cooperation. The means include at least financial, regulative, and administrative instruments. When public actors open up their resources and flows for companies, the administrative entities can *push* companies toward innovative openings, e.g., through public procurements that call for not-seen-before solutions. As an example, the current general global call for more sustainable societies is often initiated and pushed forward locally by public actors. The means here include financial incentives, national and regional targets for CO_2 emission reductions, and regional urban development planning.

Regulation is one of the most prevalent ways for public actors to affect the societal environment in which all innovating takes place. Regulative means can both cause intentional *push toward, demand for, or facilitation of* innovative openings or, in the worst case, *limit* the emergence of potential innovations. To create demand for innovative openings and to avoid the regulation from being too limiting on society for new pilots and tests, public actors need to reconsider their role in terms of public–private collaboration and innovating, which means considering what kinds of partners public actors want to be. Through their regulative actions, the public actors also control how promoting and flexible the existing societal environment is for the new tests and pilots that precede innovations. Especially during times of crises such as a pandemic or cataclysm (e.g., environmental or political cataclysm), the ability of the existing regulation to allow quick pilots and implementation of innovations is tested. This often requires close collaboration between public and private actors (as an example, the fast development of vaccines can be seen as a result of innovations created by private medical companies and strongly supported by public resources). The authors would like to see public actors participating even deeper in collaborative endeavours with companies, e.g., in the form of joint ventures. In this regard, the public actors should actively consider and decide on their role and act accordingly. Most importantly, it is worth reflecting on whether public actors have utilized their available opportunities to the full extent and created the best possibilities for involvement instead of unintentionally restricting their opportunities for supporting innovating. For example, the authors have witnessed a

situation where, related to possibilities for public–private collaboration, the same regulation on the duties of public waste management has been interpreted as limiting in one municipality and enabling in another. In another example, one city was reluctant to operate with private companies, as it wanted to avoid any possibility of being accused of favouring a particular industry or company.

Discussion and conclusions

To summarize the main takeaways regarding public involvement in innovating, we can highlight the following three perspectives. First, it is essential for public actors to fully acknowledge the wide range of means and roles they have for promoting innovating. In order to promote positive conditions for innovations to emerge, public actors do not usually lack the necessary resources but are underutilizing or even ignoring their existing ones. Therefore, it is a question of recognizing the possible roles (organizer, operator, financer, policymaker, regulator, supporter) a public actor can have for supporting innovation and utilizing a balanced mix of different means.

Second, there are tools such as the presented ecosystem mapping and visualization that help to recognize and make visible the existing actors, resources, and relations within the innovation ecosystem and to further harness the underlying potential within the ecosystem. From a visual ecosystem mapping, possible unused resources, opportunities for collaboration, and even new business potential can be identified. However, ecosystem mapping and visualization are just one tool for examining innovation ecosystems and their resource reserves. There are many tools for recognizing the critical relations and functions of the ecosystem.

Finally, it is important to acknowledge that public involvement in innovating can happen through several avenues. In other words, public support can be targeted for public and private innovating and innovations that are a result of public–public, public–private, or private–private co-creation. Moreover, even if the public actor is not itself interested in innovating, the private organizations located within its sphere of influence always operate within the boundaries and limits set by the society and public actors. Therefore, public involvement, at least indirectly, in innovating is inevitable.

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2 Digital co-creation

Mission (im)possible?

Hanna Kirjavainen and Harri Jalonen

Introduction

Co-creation of public services assumes collaboration between a range of parties. That is particularly evident in the involvement of users in the implementation of services, involvement that spans the ideation and design to the implementation and evaluation stages of such services. Ideally, the service end user has a say in the content, quality, and availability of the service under development. Co-creation is commonly seen as a response to the needs of service users (the quality argument), citizen engagement (the democracy argument), resource efficiency (the productivity argument), production of new and creative ideas (the innovation argument), and the general acceptability of services (the legitimacy argument; see, e.g., Brandsen & Honingh 2018). While well-intentioned, the extant research offers relatively little evidence of co-creation being a notable success (e.g., Voorberg et al. 2015). Some research even indicates co-creation can have negative consequences, including the deliberative rejection of responsibility, reduced accountability, rising transaction costs, weakening of democracy, reinforced inequalities, implicit demands, and value co-destruction (e.g., Wu 2017; Steen et al. 2018). The picture becomes gloomier when clients who are expected to contribute to co-creating services lack the ability or the willingness to do so. Extant research identifies several issues: participation may be organized in a way unfamiliar to key parties; there might be difficulties integrating personal experiences and professional knowledge; stakeholders' lived experiences might reflect that little has come of the input provided by vulnerable citizens (Bonevski et al. 2014; Brandsen 2021).

One problem is providing only traditional forms of co-creation methods to citizens that emphasize the ability to form and voice opinions and preferences (Brandsen 2021). Those forms disadvantage people with mental or physical disabilities and those with social problems. Moreover, the different groups framed as *vulnerable* are not as internally homogeneous as is usually portrayed in public discussion, something particularly evident in any discussion on young people who are not in education, employment, or training (NEET). That category of young people (here referred to as NEET youths) includes myriad sub-groups, such as drug users, those with different aspects of mental illness, first- or second-generation migrants, and the socially withdrawn. Naturally, these rough categorizations overlap and intertwine at different points and could be divided into smaller, more

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accurate sub-groups. These issues of categorization and inclusion are the starting point of this chapter, advancing Brandsen's (2021) idea of more individual co-creation approaches that are tailor-made to match the target groups.

The rapid penetration of digital technologies has ushered in new opportunities for co-creation But unfortunately, the promise has not been fully realized (e.g., Lember et al. 2019) and the question of the directions in which digitalization will direct co-creation remains open (Lember 2018). This chapter provides some examples of how digital opportunities may be exploited in co-creational settings, deriving examples from an international research project targeting NEET youths, who are usually capable of and interested in using digital means, such as smartphones and social media. Many vulnerable youths are impossible to reach through traditional means, and some, such as the socially withdrawn, can be extremely difficult to find, let alone connect with. Our individual-based approach also addresses the common criticism that digital means are not equally useful for those who are digitally incapable (Clark et al. 2013), as one size is not even meant to fit all.

This chapter discusses the pros and cons of digital technologies in general and specifically from the perspective of vulnerable groups. The chapter begins with a brief introduction to vulnerability. Then having reviewed the literature, the chapter presents the promise and pitfalls of open data, social media, and artificial intelligence (AI). The chapter also showcases some digital initiatives conducted in the research project. The chapter ends with a discussion and conclusion section that calls for conceptual understanding and presents some managerial implications.

Many faces of vulnerability

It is not easy to comprehensively define the concept of vulnerability, as the meanings attributed to it depend on the disciplinary approach adopted. This chapter leans on the sociological perspective, linking vulnerability to social exclusion, admittedly a broad term too. Brandsen (2021) explains social exclusion by reference to a lack of resources and opportunities that people generally possess. It is important to remember that vulnerability as a concept is normative and deficit-based, implying some kind of situation or behaviour that is problematic for society (Brown 2011). The term may exacerbate exclusion and reinforce stigmatization. The reasons for people being in vulnerable positions should not be seen as mainly intrinsic because issues such as globalization, natural disasters, shocks to the world economy, and existing societal structures are responsible for a significant proportion of citizen vulnerability globally (Brown 2011; Brandsen 2021).

Vulnerable populations often either use public services excessively or shy away from them. Both cases would encapsulate many dissimilar groups with little in common but the mismatch between existing services and the needs of individuals. However, most public services do at least target vulnerable groups, so including them is not only about making the services more efficient but also more legitimate too in the eyes of the users (Verschuere et al. 2018). Governments have tried different approaches with citizens, but well-off people tend to participate more eagerly than the marginalized. Consequently, even governments have been

known to filter potential participants when selecting people for co-creation activities (van Eijk & Steen 2014; Steen 2021). It is particularly challenging to engage with groups who are outside the service system, as the motivation to engage is heavily linked with whether how people assess the applicability of the service (Steen 2021).

The reasons behind the underrepresentation of vulnerable and disadvantaged populations vary, including their difficult conditions or circumstances such as health problems or economic situation (Corus & Saatcioglu 2015), lack of skills (Van Eijk & Steen 2014), or poor perception of their own competence to engage, or mistrust of government or fellow citizens (Steen 2021). Mulvale et al. (2019) summarize the most common problems as issues with initial recruitment, repeated engagement, and power differentials, as well as challenges with ethical considerations, context, and communication. The quality of relationships is crucial, and the need for professionals to exhibit flexibility, responsiveness, and a deep understanding is fundamental. In the worst-case scenario, any reckless engagement with power-related issues and relations in co-creation could nudge the process to producing harmful results (Osborne et al. 2016). Nevertheless, exclusion probably leads to the preservation of existing structures, ongoing inequity, and the continuance of a mismatch between available services and needs (de Freitas & Martin 2015).

The current imbalanced involvement produces a constant bias. The core of this problem probably lies with the methods traditionally used to garner involvement, which might be effective but are by no means inclusive (Brandsen 2021). Brandsen (2021, 530–532) differentiates five main factors contributing to the limited involvement of vulnerable groups in the participation process, with those being excessive time demands, intimidating formats, mismatched expectations, fundamentally different perspectives, and perceived absence of added value. Taking part is also usually based on verbal communication, favouring those who are able to voice their opinions and are used to doing so. In addition, professionals may not appreciate personal experience, perhaps being more used to relying on research-based knowledge. Citizens also often expect more influence than is afforded them and then feel disappointed when their contribution does not lead to significant change. Many of these reasons discourage participation in general: however, the lack of social skills and self-confidence common in vulnerable groups causes an overlap, which magnifies the destructive effects because people's experiences are multidimensional and intersectional (Tsatsou 2020). Co-creation often relies on models from the private sector (Brandsen & Honingh 2018), but the pace and intensity common to commercial environments might be overwhelming for people in vulnerable positions, as they would usually have less agency and fewer capabilities than others (Fox et al. 2020). Moreover, the public sector differs from the private sector in its users being unwilling or coerced customers and in usually aiming for its service users to become more or totally self-reliant, to the point that they are no longer customers (Fox et al. 2020).

Accordingly, public-sector initiatives to implement co-creation demand completely new methods. Determining those methods requires redefining the purpose of the services to be constructed and expectations of what service users will bring

to the process (Fox et al. 2020). Too often, public services concentrate on fixing single issues (usually the most pressing one) instead of viewing service users holistically. Another common defect is concentrating on problems rather than strengths. The current approach tends to be to fit the person to the service and not the other way around (Wilson et al. 2018). True co-creation, in contrast, would be based on intrinsically utilizing the asset-based and bottom-up approach (Fox et al. 2020). Besides this, successful co-creation requires both formal and informal ways of ensuring the division of power, giving precedence to the voices of vulnerable groups, and also for the process to embody reflectivity, accountability, and transparency (Mulvale et al. 2019).

Digital technologies: Open data, social media, and AI

The literature indicates advances in digital technology are enabling factors helping bridge the gap between service providers and service users. It seems that proponents of the open data movement are re-articulating notions of democracy and participation (Jalonen & Helo 2020) and presage innovation, but only if private and public databases are made available to application developers. Similarly, social media encourages citizens to share their knowledge and expertise, which would enhance collaboration and innovation. Open data and social media resonate with the idea of open innovation (Chesbrough 2006) and democratizing innovation (von Hippel 2005), which both emphasize how interactions between different stakeholders are productive sources of innovation. AI, in turn, promises to support the delivery of efficient, responsive, and effective services based on the use of data (e.g., Berryhill et al. 2019).

Open Data promises benefits but also presents several barriers

Open data refers to information that anyone can access, use, and share. Open data can be used when it is made available in a common, machine-readable format. Typically, open data is licensed, permitting people to use those data however they wish, including transforming, combining, and sharing it with others, even commercially (European Data Portal 2021). Open data initiatives are expected to bring many societal, economic, and operational benefits. In the public sector, open data can be used internally (e.g., improving processes) or externally (e.g., creating new services; Mergel et al. 2018).

The literature reports four particular key promises: innovation, efficiency, democracy, and transparency (e.g., Janssen et al. 2012; Safarov et al. 2017; Zuiderwijk et al. 2019). First, open data helps to instigate new services and discover new solutions to address societal challenges, such as economic growth, environmental sustainability, and social resilience. Second, open data improves the efficiency of operations related to information processing and reduces the costs of searching for, producing, and sharing data. Offering the ability to access data over the internet reduces transaction costs, administrative burden, and the need to reproduce data (Jetzek et al. 2013). Third, open data fosters citizen participation and engagement in political and democratic processes by providing motivation and

lowering the threshold for participation. Easily accessible and usable data may engage and empower citizens. Fourth, open data increases governmental transparency in terms of how much information government shares with its citizens. Transparency requires honesty and openness and also improves accountability. Open data plays a key role in promoting transparency, as it can facilitate exposing government processes (e.g., bidding, contracting, and purchasing documentation; agendas, minutes, and final protocols; statistics and customer feedback) to public scrutiny. Greater transparency leads to more effective public control over the data underpinning policymaking (Lember et al. 2019).

Open data brings not only opportunities but also some major challenges. Sieber and Johnson (2015), for example, positioned open data at a crossroads. That research highlights significant concerns regarding the fragile nature of open data within the government space and the need to negotiate the ethical-economic tension between governments as open data providers and the citizenry and the private sector as users of open data. Janssen et al. (2012) warn of the myth of open data: While there appears to be broad policy and academic research support for the open data approach, Janssen et al. conclude that there is not enough evidence on how open data policies are put into practice. Jamieson et al. (2019) take a step further by claiming that it is impossible to have a more transparent and efficient public service, to have a more informed citizenry, or to promote innovation through open data. They argue that open data can contribute to neither political and social nor operational and economic benefits. In addition to policy-level challenges, there are several technical issues to be addressed. Beno et al. (2017) studied obstacles to using and publishing open data in various types of agencies including academia, government, the public sector, private sector, and non-governmental organizations (NGOs). The study reports that the barriers related to data users can complicate or inhibit the consumption and reuse of published open datasets. The barriers related to the data providers can lead to them declining to publish open data. There are also barriers relevant to both providers and users in the form of a lack of knowledge or experience. The study also implies that the severity of obstacles varies internationally and between agency types.

High expectations are associated with open government data yet promises to increase transparency, participation, collaboration, and co-creation remain largely unfulfilled (Jamieson et al. 2019; Lember et al. 2019). Access to open data per se does not engage citizens and other stakeholders in co-creating services, nor does it spur innovation.

Social media enables interaction but can lead to disconnection

Social media is a constellation of shared technologies that derive value from allowing the creation and exchange of user-generated content. The early days of social media saw it depicted as an innocent arena for sharing information and interacting socially. The assumption was that social media would empower citizens and customers to express their activity in unforeseen ways; however, as social media matured and became ubiquitous, its value as an empowering technology came to be questioned.

Social media has transformed our communication habits in many ways. It has provided us with an open environment in which to connect and publish all kinds of content. The absence of gatekeepers empowers people to express their voices, meaning social media has not only facilitated exploring new ideas but also offered a context for collaboration between government and citizens in a way that increases government responsiveness (Bertot et al. 2012; Loukis et al. 2017; Eom et al. 2018). In addition, studies show that social media improves innovation processes in public-sector organizations (e.g., Mergel 2016). Social media can also be a useful context for co-creation, and Driss et al. (2019) suggest that social media's capacity to enable citizens to create, share, and comment on issues in an uncontrollable way could accelerate citizens becoming policymakers. Similarly, Jalonen et al. (2021) found that social media can enrich the knowledge base relating to the initiation phase of the co-creation of public services. The last study advises that social media discussion dealing with the availability, access, and quality of public services – even if acrimonious – can be testimonials that enable a public organization to identify bottlenecks in the service delivery process.

Social media has not only increased the amount of shared information, such as opinions and facts, but has also inspired people to share their feelings about topics encompassing products and services and societal issues. In the early days of social media, there was an optimistic view that it could strengthen the societal consensus through discussions hosted on its platforms. While that is still possible, there is now a greater awareness that social media can also be used for malicious purposes. Commentators have raised concerns over issues including social polarization, the speedy diffusion of misinformation and disinformation, breaches of privacy, and data surveillance (e.g., Zuboff 2019). Instead of fostering open discussions, social media has sometimes created echo chambers of like-minded people that inhibit understanding different perspectives. Deliberately promulgating disinformation has been used to damage the reputations of organizations and individuals and to influence public opinion and the democratic process (McKay & Tenove 2021). Simply put, what was anticipated would be a remedy has become a disease.

The paradox of social media is tangible (e.g., Jalonen 2014). Social media sites allow citizens to fulfil many of the tasks online that are important to them offline: staying connected with friends and family, making new friends, creating, and expressing identities, sharing and exchanging ideas, and offering and receiving emotional and informational support. Nevertheless, social media carries new risks, such as peer-to-peer bad behaviour; inappropriate and insulting content; lack of self-confidence, self-respect, and self-esteem; and data and privacy leakages.

AI is stupid without ethical consideration

The use of AI in the public sector involves the transfer of personal data between users of public services, an AI network, and public authorities. A number of governments in the Organisation for Economic Co-operation and Development (OECD) have developed AI-focused strategies, and others are in the process of doing so. Systems utilizing AI computer systems are expected to offer cost savings,

more responsive, and better integrated and coordinated services for businesses and citizens (Berryhill et al. 2019). An AI system is an appropriate technology wherever there are large and coherent datasets. One of the most promising areas is healthcare, where AI can identify disease symptoms at an early stage (Noorbakhsh-Sabet et al. 2019). Utilizing AI has helped diagnose cancers, predict vulnerability to cardiac arrest, and detect Alzheimer's. A strong AI system can thus prevent misdiagnosis and improve opportunities available to public authorities and health professionals to tackle issues and adjust the services offered. The more time information service providers have, and the more accurate that information, the more they will be able to create efficient and effective services. An AI-oriented system can also improve the efficiency of administrative tasks and customer service. Advances in speech-recognition technology enable the deployment of automated online assistants and chatbots in multiple domains, from childcare and education to services for the elderly to respond to simple information requests. In addition to the various efficiency gains available (Wirtz & Müller 2019), AI provides opportunities to improve public services, for example, sentiment analysis (Liu 2012) allows municipalities to explore service-related sentiments and emotions in social media content. Sentiment analysis enables the analysis of unstructured, human-generated texts, which can help public organizations understand their operational environment and improve their detection of the symptoms of collective emotions and attitudes in a way that should flow through to enhance service-user experiences.

Similarly, AI can help detect anomalies, regularities, and trends in service usage, thus revealing niche needs to public organization planners. Service design can also benefit from AI, which can illuminate where services could be more user-focused and better tailored to changing circumstances. A public organization that has a strong understanding of the topics discussed and shared on social media will be more prepared to address threats and exploit opportunities. An example would be a public organization harvesting data on anti-vaccination campaigns from social media to prepare strategies and tactics to equip its public health staff to address the arguments.

Despite the many possible benefits, there is a lack of ethical principles and standards regarding AI applications, giving rise to concerns about accountability and the transparency of AI systems (Scherer 2016; Casares 2018; Wirtz & Müller 2019). Machines outperform humans in many planning and controlling tasks. The legitimation of their position rests more on their success in making responsible and ethical judgments, engaging clients, and employees, and identifying and executing new opportunities. The main ingredient of AI-assisted governance is personal data that public authorities and AI-mediated actors collect before or during the service delivery process. This poses a risk related to the privacy of the public's data, exclusion from social and economic opportunities, due process, the quality of algorithmic decision-making, distributive justice, and the overall regulation and governance of AI (Yeung 2018). Governing and regulating AI is particularly relevant for the public sector, which holds large datasets that help make decisions on behalf of a large number of people. Various possible regulatory problems are apparent in the context of AI (Scherer 2016: 359): the discreetness problem (AI applications may be developed outside of an integrated institutional environment), the diffuseness

problem (AI may be developed by diffuse actors operating in different locations and jurisdictions), the discreteness problem (AI can use different sets of technologies, making it challenging to assess the potential of each before they are combined in one systemic framework), the opacity problem (AI technologies can be opaque and unintelligible to potential regulators), the foreseeability problem (AI can be autonomous and work in ways that may be hard for its developers to foresee), the narrow control problem (AI may be beyond the control of responsible actors), and the general control problem (AI could be beyond the control of any human agent). These problems give rise to ethical dilemmas concerning the type, form, and extent of public decision-making to which AI technologies should be applied.

AI will not replace human work in public services in the near future. However, it may benefit strategies emphasizing the effectiveness and quality of public services, for example, through its ability to detect conformity and anomaly in service usage. An AI system is able to process huge amounts of data, identify patterns, and therefore guide public organizations to make data-driven decisions. With new technologies also come new threats. In the case of AI, the most fundamental threat arises from machine-made judgments on ethical issues or situations where AI imposes externalities on other stakeholders.

Digital co-creation with vulnerable groups

The digital divide is a worldwide issue today and one that encompasses access to the internet and the skills required to use it effectively, how it is used, and the outcomes of that use (Scheerder et al. 2017). How people utilize the internet and with what consequences has grown more salient as in the developed world, almost everyone has access to the internet: in the European Union, over 90 per cent of households in 2019 had internet access (Eurostat 2021). However, thus far, research has focused more on internet use and to some extent internet-oriented skills, instead of the so-called third-level digital divide concerning the benefits of internet use (Scheerder et al. 2017). Age, educational level, and employment status account for a large proportion of the differences in internet-oriented skills and the use of the internet (Blank & Groselj 2014), whereas differences in outcomes seem to relate to other digital divide determinants, such as being unemployed and having a lower education level. People in the last two groups seem to scarcely engage in the social and political dimension, which leads to sub-optimal outcomes. Overall, the benefits of internet use correlate with education levels and income – that is, people with higher education and levels of income utilize the internet more profitably than those with a more basic level of education and lower income. That profitable usage might include accessing online courses, employment, e-health services, and social and political participation, whereas those with weaker resources spend more time engaged in unproductive surfing (van Deursen & van Dijk 2014; van Deursen & van Dijk 2015; van Deursen et al. 2017). This pattern of behaviour might be explained less by skills and more by personal resources, such as interest and socialization patterns (van Deursen et al. 2017) leading to digital exclusion. The situation is a consequence of the complex

reality of people's access and use of technology and their capability and willingness to utilize different forms of technology (Borg et al. 2019).

Nevertheless, ongoing digital development has benefited vulnerable people in many ways, such as helping them save time and money, offering them flexible options in both spatial and temporal terms, enhancing independence and supporting networking and participation, and instilling confidence to communicate owing to the anonymity of online interactions. However, some vulnerable groups may not be fully capable of utilizing digital means, and some may be exposed to abuse via social media (Tsatsou 2020). Social media can both mitigate loneliness (Kivijärvi et al. 2019) and cause or increase psychological problems (Keles et al. 2020) or even reinforce participants' status as social outcasts (Vainikka 2020).

The internet has also provided a new context for professionals to support those in need. The internet-mediated means available include online counselling (Richards & Viganó 2013), healthcare services (Halford et al. 2009), and social work (Chan & Holosko 2016). Brandsen (2021) states that digitalization reduces the reliance on physical meetings, thus enabling people to participate from their homes. That facility might significantly lower the threshold to join in for elderly people, people from rural areas, the socially withdrawn, and other groups with disabilities or social problems, such as debilitating insecurity. Digitalization also facilitates adopting a visuals-based approach, which can help those unable or unused to reading long texts or participating in voice-based mediation. Participatory access can be further enhanced through simple smartphone apps (Clark et al. 2013), available irrespective of location and perhaps not even constrained by time of day (Lember 2018). The counterpoint to the advantage conferred by online anonymity mentioned earlier (primarily encouraging participation) is that those citizens who join in may be unknown (Lember 2018).

Lember (2018) emphasizes that digital technologies never have a neutral impact on society, and the codes behind digital solutions always include values and norms. The digital progression may lead to greater pressure to censor content and manipulate algorithms, leaving vulnerable groups in an even weaker position than currently (Brandsen 2021). Van Deursen et al. (2017) fear that digitalization threatens to create a vicious cycle where vulnerable groups are marginalized by technology, as increases in digital skills do not mean internet usage leading to beneficial outcomes for everyone, as the correlation depends heavily on sociocultural, socioeconomic, and personal factors. These drawbacks take time to become visible (Lember 2018), which makes them more difficult to point out. The crucial question is who controls the form of digital technologies in public service delivery (Lember et al. 2019).

The debate about whether participation in the offline and online world follow similar patterns and whether the internet amplifies, or even accelerates, inequality remains open. Borg et al. (2019) summarize that social support, education via collaborative learning or experience, and inclusive design are required to enable digital inclusion. As the evidence points to those with higher levels of education and good incomes currently being more likely to benefit from institutional outcomes (van Deursen & van Dijk 2014), it is important to discover new digital approaches, particularly those aiming to engage vulnerable people.

Deploying digital technology in practice

Co-creating Service Innovation in Europe (CoSIE) was a research project conducted from 2017 to 2021 and funded under the Horizon 2020 programme of the European Commission. The project aimed to engage citizens, especially groups often labelled "hard to reach", in the collaborative design of public services. During the implementation of the project, the collaborative partners developed diverse methods of co-creation in the field of public services. Of particular interest was the utilization of digital technologies to facilitate the co-creation aspect of the service design (CoSIE 2021).

Here we report insights from the pilot conducted in Finland. The Finnish pilot "Youth Co-empowerment" focused on NEET youths. The rationale behind the pilot was to harvest more data about the situation of NEET youths to understand the many shades of marginalization and to pilot new ways to involve them in society. The project extended the project team's understanding of the multifaceted nature of the target group, and it was clear that several approaches had to be piloted to engage NEET youth and ensure their voices were heard (see Brandsen 2021). Furthermore, it became apparent that many youths are willing and able to participate in shaping new digital public services that suit them (see Lember et al. 2019). The ideas garnered from the youths involved used elements familiar and interesting to their generation, such as social media, videos, AI, and gamification. With those two viewpoints as a premise, several digital initiatives were introduced in the Finnish pilot.

The Finnish municipalities follow their key performance indicators regarding the health and well-being of their citizens. The Finnish Institute for Health and Welfare maintains several open databases, which provide information about general well-being from different perspectives. These databases illustrate the overall situation; however, their data is in one way or another converted. The data only provide average findings from the municipality or age group. Therefore, they must be connected to user-level data if they are to contribute to making services more user-centric and impactful. Currently, however, the necessary data do not exist as an official open data source. To that end, the Finnish CoSIE pilot team connected open data harvested from social media and other sources. The team developed several prototypes of digital applications such as those they labelled "*Here I am*", "*Tukemon Go*", and "*Luuppi*". In addition, the team made use of AI. *Here I am* and *Tukemon Go* were ideated in social hackathons, in which youths in vulnerable positions and professionals worked side by side in small teams, developing new ideas to tackle youth marginalization in Finland. In line with Lember (2018), social hackathons represented both a method of co-creation and a source of co-creation initiatives.

Here I am is an application that seeks to find and activate young people: especially those at risk of being marginalized or excluded from society. The project team noticed that loneliness is a big problem for most young people outside the school system and employment, which is why young people need to find other youths in their area easily and informally. It was also clear that young people do not necessarily know the service system well or may not even know what services

might benefit them. The project team agreed that a current lack of engagement and knowledge should not be an obstacle to identifying and obtaining suitable services. The app was designed to help the user to find formal and informal events nearby. Formal events include, for example, sports activities or concerts and events organized by the city or an NGO, whether specifically youth-oriented or otherwise. Informal events include those based on a common hobby or interest, for example, people playing football together. Through this app, young people were able to find both kinds of activities and participate in them. The app includes a chat function to address the issue of attending events being daunting to the marginalized. The chat function offered a source of support to start a new hobby or simply just to get out and about. The app provides services both to anonymous and logged-in users. It provides more services to the latter group, but to lower the threshold, it was important that young people could also approach and use the app anonymously.

Tukemon Go is an application that maps youth services in a visually enticing way, utilizing gamification elements and artificial reality in a manner similar to Pokemon Go. Its popularity attests to gamification being an attractive co-creation option (e.g., Lember 2018). *Tukemon Go* consists of a digital platform showcasing local services. By clicking on a service, for example, a youth centre, the user accesses a visual and textual presentation of the place and videos of the staff from the centre. *Tukemon Go* is intended to lower the threshold for youths to visit new services, as they have already seen and heard the professionals involved. Ideally, the user will even be able to choose who to deal with from the centre involved. The app would also have a feature that enables users to send their contact information to a youth worker, who could help them find a way forward. The idea also contained some options for the user to suggest developments such as other functions and services that might be incorporated into the app to smooth participation.

The internet activity of vulnerable youths may not be productive in some terms (e.g., van Deursen & van Dijk 2014), but many do use social media extensively (e.g., Vainikka 2020). *Luuppi* is a digital application that helps professionals understand those who do not want to participate or are not even reached by traditional services. The typical user of the app is a service designer in a municipality undertaking development work. The app enables the real-time retrieval of social media data and the visual and interactive presentation of the results of its subsequent analysis. *Luuppi* helps explore what is happening, know how something is happening, and influence the course of its happening. The main operational logic of the app is as follows: First, the user can define a search that retrieves messages in real-time from a selected data source. The messages will be saved into the app's database. Second, the user can create dimensions and classes to classify messages into different categories. The user attaches keywords to those classes to label the messages based on them. For example, the user can create a dimension such as *obstacle*, attach classes such as *time*, *price*, *distance*, *professional's behaviour* and so on, and attach keywords to those classes such as *rude*, *arrogant*, *incompetent*, or *mocking* to the class *professional's behaviour*. Those labels will not be saved in the database, but the messages will be dynamically labelled on their way from the database to the user interface. That dimension can be used in the user's various projects in the application and

could potentially be shared with other users of the application. Third, the user can create visualizations and listings based on the dimensions and classes created; so the user might design an interactive line diagram to present how the number of mentions of different classes in the dimension *obstacle* has developed over the last year (assuming that the user has collected the messages for that long). Clicking the line *professional's behaviour* will generate a chronological listing of messages in that class.

AI was used to analyze messages published on *Hikikomero*, an anonymous chat room that is part of a discussion forum (see more Jalonen et al. 2021). The forum covers topics from all walks of life, including users' assessments of the quality or lack of public services. The forum's administrator defines the chat room as a peer group for depressed and socially withdrawn people. It is meant to cater to people who find everyday social interaction difficult. While not all users in the forum are *hikikomoris* who withdraw from society and seek extreme degrees of isolation and confinement (Furlong 2008), the assumption is that the young people who voice their opinions on *Hikikomero* do not participate in conventional co-creation activities, such as workshops and citizens' juries. Using performed topic modelling (Blei et al. 2003), a technique based on unsupervised machine learning (Shalev-Shwartz & Ben-David 2014), the Finnish CoSIE pilot team was able to analyze texts and identify themes and structures of discourses. Topic modelling uses messages and words (particularly nouns and verbs in this study) as units of analysis. The method assumes that each document is a collection of topics and that each word has a certain likelihood of featuring in the topic (Puschmann & Scheffer 2016). Subsequently, with the help of a machine learning algorithm, the team analyzed the discourses and the sentiments (Liu 2012) expressed in all messages. The four discourses identified represented different rhetorical appeals and linguistic features.

Among the main learnings from the *Hikikomero* case was the importance of acquiring different perspectives when setting the objectives for public service systems. Politically relevant discourses may be very different when viewed from the perspective of marginalized groups. These viewpoints may easily be overlooked if the knowledge base for decision-making is based merely on the opinions of the active and participatory elite. Using unsupervised machine learning to make sense of social media discourses is consistent with calls for the increased use of AI in the public sector (e.g., OECD 2019). Digital technologies can be used to capture large datasets, creating the big picture and framing the data in a meaningful way. The use of social media discussions in the co-creation of public services is also in line with the OECD's Office of Public Sector Innovation policy recommendations, which emphasize, among other aspects, dialogue between government and citizens and the active collection of civic feedback.

Brandsen (2021) states the main barriers to participation by vulnerable groups are scarcity of time, skills, and cultural capital, and also insecurity and a perceived lack of conviction on the part of professionals. The CoSIE Finnish pilot initiatives responded by offering an option to participate from home and by utilizing visuals. The project also encouraged professionals to rely not only on research knowledge by combining large datasets and open data with anonymous uncensored quotes from social media, which offered an effective combination of generalizability and personal information.

Discussion and conclusions

Digitally enabled co-creation can be understood as a process consisting of three consecutive phases: sensing, sensemaking, and seizing (Figure 2.1; for more on the three s's, see, e.g., Teece et al. 2016). *Sensing* refers to collecting and organizing data from social media and other sources. Mapping the context of co-creation helps a public service organization understand *what is happening* in the environment. Typical probing questions asked to garner input into co-creation would seek to isolate needs and expectations. *Sensemaking* aims to add value to the data extracted in the sensing phase. Sensemaking links causes to consequences by providing answers to questions of *how and why something is happening*. The output of sensemaking is service designers having access to an enhanced knowledge base related to the challenges young people face. *Seizing* focuses on the change and creating new actionable solutions and opportunities. The outcome of seizing is learning from the data in a way that enables to *influence events as they happen*.

Prior research showcases the lack of evidence on how the vulnerable can be integrated into co-creation activities for public services, yet still little is known of how digital technologies can be used to improve the level of participation of citizens, whether vulnerable or not. The current research addresses the challenges of making youths in a vulnerable position real contributors to the co-creation of public services by calling for a conceptual understanding with managerial implications. The chapter concludes with four propositions.

First, every technology has its advantages and disadvantages. In addition to intended and desirable outcomes, there is a risk of unintended and undesirable consequences. That being so, we favour the analysis of socio-technological factors and the dynamics within complex systems that lead to failures. Jalonen et al. (2021) have suggested that optimal value co-creation builds on a dynamic balance between exploitation and exploration activities. Exploitation is characterized as refining, selecting, implementing, and executing operations, whereas exploration is an organizational activity based on searching, risk-taking, playing, experimenting, discovering, and innovating (March 1991). The key question, therefore, is to what extent digital technologies distort the co-creation process. Where exploration dominates and exploitation is subservient, the result is a kind of pop-up participation. The opposite, participative diversion, may emerge when exploration activities decrease while exploitation remains at a high level. Where digital technologies support neither exploration nor exploitation, there is a risk of co-destruction powered by systemic distortion (Jalonen et al. 2020).

Second, co-creation should not be assumed to be a process where the value of public service is something that can be delivered by a public service organization to the citizen. Instead, value is something that emerges from interaction and is defined by the citizen. Public service organizations can facilitate, but not dictate, the value creation process (e.g., Osborne 2018; Grönroos 2019). Reaping the benefits of co-creation requires a focus on the justifications through which citizens make services relevant to them. As the same service can be justified on many different grounds (e.g., Boltanski & Thévenot 2006) and, correspondingly, the acquisition of very different services can be justified for similar reasons, services must be

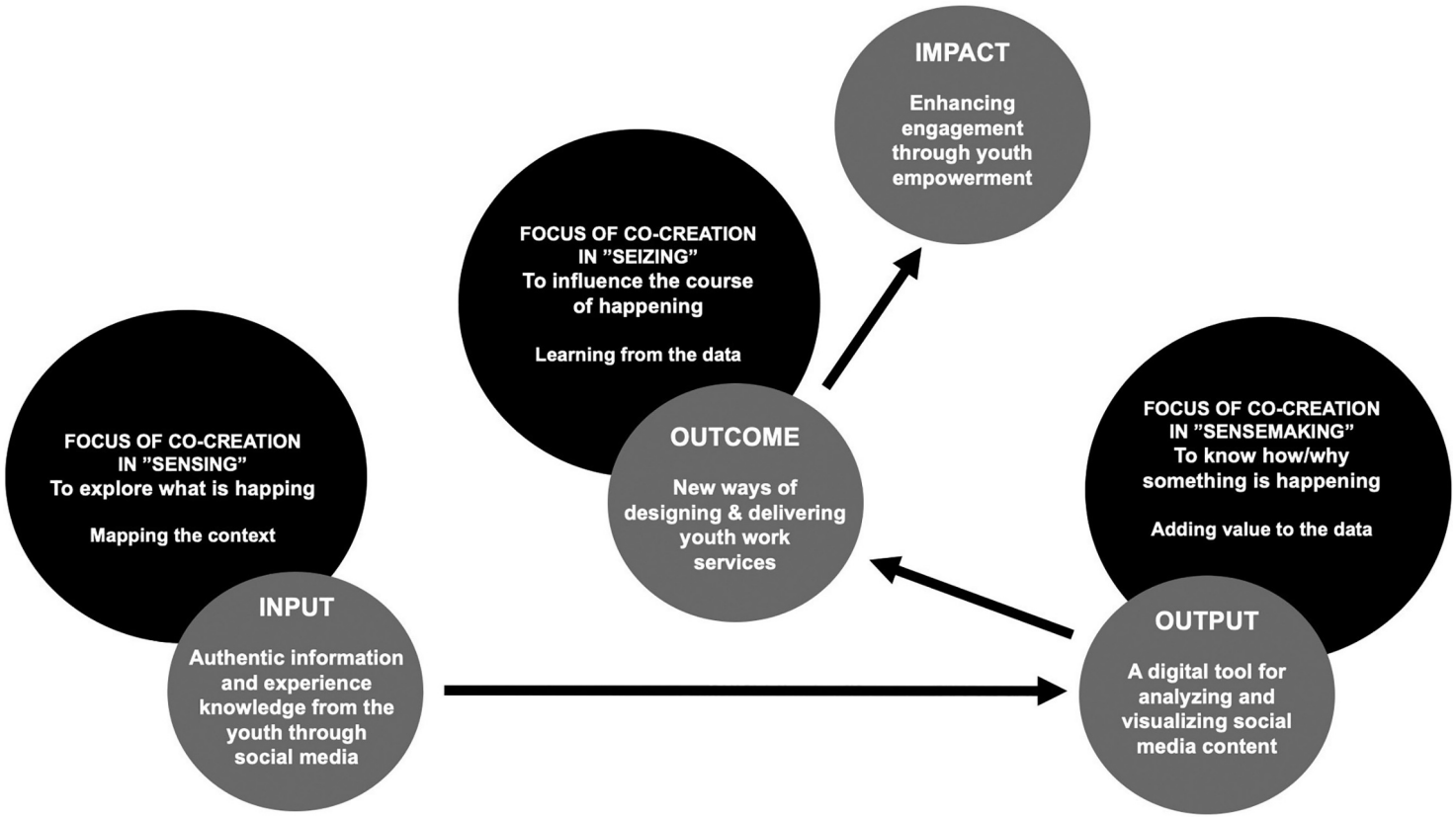

Figure 2.1 Sensing, sensemaking, and seizing in co-creating public services.

assessed based on users' needs and expectations rather than on the attributes of the services. This is particularly important for marginalized young people, as, for some, marginalization is a badge of their struggle against the values of society that they perceive to be alien to their own. Building on Jamieson et al. (2019), we propose that the needs, requirements, and interpretations of young people should be considered in a co-creative manner.

Third, a public sector that makes an effort to be digital (Negroponte 1995) and employs social media improves its chances of reaching the once unreachable. Doing so, however, requires a great deal of both the public service system and individual officials. Many managerial tasks must be prioritized to harness the full potential of digitalization, which includes, but is not limited to, acquiring technological expertise, creating a dynamic and agile organizational culture, encouraging public organization personnel to experiment, and boldly applying innovative approaches to reach the unreachable. When the risk of failure is obvious, the odds are that users will not be considered experts but troublemakers. This thought is in line, for example, with Meriluoto's (2018) findings related to the configuration of expertise as a prerequisite of participation. As Meriluoto describes it, the epistemic threshold enables a public-sector organization to choose participants according to its predefined and conscious or unconscious objectives. Instead of seeking experiences that can challenge the status quo, public service organizations are often biased towards knowledge production, thus reaffirming the status quo.

Fourth, studies have pointed out that while open data and social media have the potential to extend government services and engage citizens through innovation processes, that same social media has simultaneously introduced new challenges related to accessibility and social inclusion (Bertot et al. 2012; Lassinantti et al. 2019). Of particular interest has been whether opportunities for co-creation through digital technologies "will exist for all, or only a select few" (Lember et al. 2019). Social media may offer new possibilities for those who are already in control and able to navigate co-creative processes but exclude people with disabilities and other forms of vulnerability. Therefore, we propose that the aim of using digital technologies in co-creation processes should be to move beyond standard practice, not only by increasing engagement but also by broadening its scope. More specifically, the inclusion of vulnerable groups in co-creation processes requires a focus on the barriers that prevent such people from participating and translating that knowledge into actionable guidelines and practical tools.

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3 Social impacts of digital platforms

A can of worms in governing the hybridity of Airbnb

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Introduction

Digital platforms come with the promise of a brighter future. For private companies, the brighter future means reduced costs and more income (Kerravala 2004), sustained competitive advantage (Stanko & Calantone 2011), and product and service innovations (Bharadwaj et al. 2013). Improved accessibility (McCosker 2018), better quality communication, and enhanced value creation (Parker et al. 2016) are typical gains that digital platforms promise to households. Governments can achieve better transparency, more active citizen participation (De Blasio & Selva 2019), and co-creation of public value by applying digital platforms (Meijer & Boon 2021). However, some digital platforms may benefit and harm households, companies, governments, and the voluntary sector simultaneously (Frenken & Schor 2019).

Although the benefits and disadvantages of digital platforms impact different sectors, scholars tend to approach their social impacts from an organizational (e.g., Dogru et al. 2017; Mody et al. 2017; Richards et al. 2019) or platform perspective (Parker & Van Alstyne 2005; Frenken & Schor 2019). Applying this type of analytical approach to the social impacts of digital platforms is limited because these impacts are influenced by interactions between public, private, and civil society actors and their activities. Previous literature called these interactions hybridity and attributed them to hybrid forms of governance. If these social impacts relate to more hybridity than to any particular organization or platform operating in the economy, it is peculiar that we keep analyzing such impacts through organizational or platform-centric frameworks. This chapter argues that the reasons for the limited analytic perspectives on social impacts are threefold.

First, societies cannot see the hybrid nature of digital platforms because organizational and platform narratives are more dominant and awareness about hybridity thinking remains low. Second, how public-, private-, and voluntary-sector organizations contribute to hybrid governance and hybridity in societies is rarely addressed in academic literature or the practical world. Third, hybridity in mechanisms leading to social impacts is underestimated and mostly unidentified.

To help societies understand digital platforms as hybrids, we will take one such platform as a case context and qualitatively describe the hybrid nature of this platform. We purposefully chose to use the Airbnb platform to inductively prove our

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point that digital platforms can manifest hybridity and hybrid governance. In addition, we shall show how Airbnb currently influences hybrid governance and why it would make sense to analyze social impacts from the perspective of hybrid governance. Our hermeneutic approach (Gadamer 2004) aims to establish an antithesis for the reasons justifying organizational and platform hegemony in analytical frameworks used to assess social impacts. The exploration based on document data looks back in order to look forward, and it reviews and reshapes our current knowledge about digital platforms.

Digital platforms and social impacts: The curious case of Airbnb

Airbnb is a global actor and digital platform that provides accommodations and experiences to its customers. In its 2019 business update, Airbnb (2019a) stated that its "mission is to create a world where anyone can belong anywhere," and they want to establish "an end-to-end travel platform that will handle every part of your trip". Airbnb is the world's largest accommodation provider, although it does not own the properties used in its accommodation business. In addition to places to stay, Airbnb has introduced two new service categories, experiences and, in the midst of COVID-19, online experiences. Examples of these include activities such as cooking classes, mountain biking, and planning future trips online during the current pandemic.

Following the ethos of the sharing economy, the providers of these accommodation and experience services are mostly average citizens, although companies also provide some of these services. From an economic perspective, Airbnb offers ordinary citizens an opportunity to earn additional income by allowing them to list their properties or service offerings. As providers of accommodations or services, households become entrepreneurs and hosts for tourists and temporary residents. In the Airbnb platform, companies operate through professional hosts who are property managers from the hospitality business. Compared to households that rent their properties, professional hosts offer accommodation services at resorts, nature lodges, hostel and boutique hotel rooms, serviced apartments, and traditional bed and breakfasts.

The vast majority of Airbnb users are travellers who use the Airbnb website (airbnbn.com) to search for a suitable accommodation listing. For travellers and others in need of a place to stay, Airbnb provides an authentic experience that is often more affordable than hotels and other professionally run accommodation providers. Over 500 million travellers have used Airbnb since its inception in 2008.

Airbnb started as a two-sided market (Caillaud & Jullien 2003; Rochet & Tirole 2003) that connected hosts and guests through a digital platform. With the introduction of experiences, Airbnb moved from a two-sided buyer and seller market to a multisided market (Hagiu & Wright 2015) where service and accommodation providers support each other in providing local authenticity for guests (see Guttentag et al. 2017). In a multisided transaction market, the digital platform's key role is to provide the infrastructure that connects providers of goods and services with final customers and facilitate value exchange transactions among them (e.g., Rochet & Tirole 2003).

Airbnb is a transaction facilitator between service providers and users: the guest pays with their credit card, and Airbnb holds the money until the accommodation begins. In addition to managing transactions, Airbnb provides the core infrastructure for the digital market and offers the hosts an opportunity to create value for customers. Here, providing infrastructure management means that Airbnb takes the primary responsibility and control for developing technical features of the platform and integrations with other products and services. Lowering transaction costs and building trust between service providers and users are other important activities of Airbnb. To build trust, Airbnb has established user profiles and a review system. The user reviews and profiles of service users and providers are intended to promote trust among service sellers and marketplace buyers. The given reviews accumulate a reputation score that is the single most important factor for success on the platform (see Taeuscher 2019). The user and service provider profiles show this reputation score.

In technology strategy language, Airbnb operates as a digital platform, that is, a sociotechnical assemblage that is composed of the technical elements (including software and hardware) and related organizational processes and standards (Tilson et al. 2010; De Reuver et al. 2018). In general, digital platforms provide a set of boundary resources, such as technological artifacts and regulations that "serve as the interface for the arm's-length relationship between the platform owner" and complementary service developers (Ghazawneh & Henfridsson 2013, p. 174). The main boundary resource for Airbnb is the contract mechanism that enables hosts to list their offerings. Moreover, Airbnb provides an application programming interface (API) for third-party integration and the development of listing, pricing, and guest management services. However, at the time of writing this chapter, Airbnb was not accepting new API access requests, indicating their strong control of partner selection. That is, although digital platforms are also usually generative (i.e., they enable continuous evolution of uses and functionalities; see Yoo et al. 2010), Airbnb provides limited opportunities for this.

According to previous research, three key types of digital platforms exist: multisided transaction, complementary innovation, and information platforms (Cennamo 2021). Airbnb is a prime example of a digital platform that enables multisided transactions between different stakeholders. This means that experience and accommodation hosts can simultaneously sell their services to possible service users. Compared with complementary innovation platforms such as Android (i.e., the operating system), Airbnb provides limited ability to develop completely new services. At the same time, it is more than a simple information platform, such as Google Search.

Airbnb functions not only as a digital platform but also as a broader platform economy (Parker et al. 2016), where a digital platform facilitates the development of a new type of digital marketplace (Cennamo 2021). In the platform economy, the focus in competition moves from controlling the value chain to attracting generative activities to a platform (Cennamo 2021). As a platform economy, Airbnb attempts to attract new experiences as services to the platform. Operating as a platform ecosystem is the final important function of Airbnb. Adner (2017, p. 40) defined ecosystem as "the alignment structure of the multilateral set of partners

that need to interact in order for a focal value proposition to materialize". A platform ecosystem is a type of business ecosystem that is the organizational form of a platform economy. In business and platform ecosystems, the main competition takes place not between individual companies but between ecosystems as actors seek to "enlarge the pie for everyone" (Cennamo 2021, p. 266; see also Panico & Cennamo 2020). For Airbnb, this means that it must manage its business ecosystem to increase its competitiveness. To enhance its business ecosystem, Airbnb has engaged in useful collaborations outside the digital platform where guests and hosts operate. The Airbnb business ecosystem includes insurance companies as core partners and various companies that provide cleaning, property management, software, and analytics services to enable running and improving their operations (Shipilov & Burelli 2021). Observing Airbnb as a digital platform, platform economy, or business ecosystem points out that the societal scope of the tasks conducted by Airbnb varies if one moves from a digital platform perspective to business ecosystem thinking.

A range of actors competes with Airbnb. Airbnb's competitors include Expedia, Booking Holdings, hotel chains, and other established accommodation providers. From these competitors, Expedia and Booking Holdings are also major short-term rental platforms. To generate profits, Airbnb collects commissions from two sources: from the guests and the hosts providing services and accommodations. Airbnb charges a service fee for every successful transaction. For accommodation hosts, the service fee is usually 3 per cent of the amount of money transferred in the transaction. For experience providers, the same percentage is 20 per cent. Service users typically pay fees of less than 14.2 per cent of the transferred money. Airbnb gets most of its income from transactions relating to accommodations. In 2017, Airbnb generated USD$93 million in profit from $2.6 billion of revenue.

Currently, it is estimated that there are globally over 2.9 million hosts on Airbnb, and 14,000 new hosts join the platform monthly. There are now approximately seven million listings on Airbnb worldwide. A total of 100,000 cities and 220 countries have active Airbnb listings. Founded in 2008, Airbnb has raised a total of $6 billion through 29 funding rounds. Its present market capitalization is estimated at $100 billion. Airbnb has made 17 investments in start-ups and acquired 24 companies. In 2020, Airbnb (NASDAQ: ABNB) launched its initial public offering and became a company in which anyone can invest. After the first week, Airbnb was valuated at $75 billion, more than Marriot and Hilton hotels combined (Forbes 2020).

The success of Airbnb is driven by a few key factors. First, Airbnb reduces friction in the booking process by providing a standardized set of information on the listings. Second, Airbnb provides a reputation system for both guests and hosts, supporting the formation of trust between the contract parties. Other motivations for using Airbnb include the ability to interact with hosts, "locals" in the area, access to home amenities and extra space, the novelty and authenticity of the experience, and the sharing economy ethos (Guttentag et al. 2017). Lastly, the experimental nature of the Airbnb platform separates it from its main competitors, such as Booking Holdings and Expedia.

The commercial growth of Airbnb has resulted in both positive and negative social impacts. Generating revenue for hosts, enabling travelling for less wealthy people, and boosting the sharing economy and tourism in underexplored geographical locations are typical examples of the positive impacts of Airbnb (Balampanidis et al. 2021). As examples of negative social impacts, Airbnb has created unequal income distributions and illegal markets enabling tax avoidance, and it has induced higher property prices and rents, thus enforcing social segregation by driving the less wealthy people out of neighbourhoods attracting Airbnb guests (e.g., see Corporate Europe Observatory 2018; Barns 2020). Considering the social impacts of Airbnb, it is not surprising that governments and voluntary-sector organizations have begun to pay attention to Airbnb and its activities. Slowly, governments have started to intervene in the activities of Airbnb, and we are seeing an increasing number of statements about Airbnb coming from voluntary-sector actors, such as Inside Airbnb, an activist group collecting Airbnb data to support debate around the platform. Thus, recently, the hybridity of Airbnb has become more visible. However, few have acknowledged the hybrid nature of Airbnb and the meaning of this hybridity in respect to the positive and negative social impacts that have been associated with Airbnb. For this reason, this chapter argues the following:

1) Airbnb is poorly understood as a hybrid.
2) The knowledge about the role of Airbnb in hybrid governance is in a nascent state.
3) As a consequence, the hybridity in the mechanisms leading to Airbnb's social impacts has been largely neglected.

To advance our current understanding, this chapter aims to clarify how exactly Airbnb is a hybrid and why it is, therefore, part of hybrid governance. After explaining the hybrid nature of Airbnb, the chapter goes on to show that the hybridity in mechanisms leading to the social impacts of Airbnb has been largely neglected because it is difficult to capture through our current measurement systems. This chapter applies a hybrid governance view to the analysis and measurement of the social impact of Airbnb as a digital platform. Our thesis is that although there is existing literature that analyzes the impact and externalities of the likes of Airbnb broadly and at the societal level, the majority of digital platform literature focuses on the platform and actors that are near the platform core (e.g., Järvi & Kortelainen 2017). This situation makes it difficult to understand how governments should intervene in the operations of digital platforms and how digital platforms can have more influence on social impacts that they are accused or credited with causing.

Airbnb as a manifestation of hybridity

Airbnb has been analyzed as a two- (or multi-)sided market arrangement, platform economy, business ecosystem, and platform ecosystem that aims to ultimately create market value (Meyer & Cennamo 2018; Cennamo 2021; Shipilov & Burelli 2021). However, due to the pervasive impacts of Airbnb-type digitalized platforms

on societal activities, it is a limited approach to understanding the value of Airbnb to societies. With that approach to Airbnb, the analysis omits the interconnectedness of the economy, polity, and civil society, as well as value conceptualizations that those societal systems aim to serve. This omission appears to include deep ontological assumptions that treat Airbnb as a digital platform that is a closed system by nature. As such, the closed system excludes the external world from its operations and cannot, therefore, see the hybridity of Airbnb to its full extent. Complementary approaches, including platform society (Van Dijck et al. 2018) and platform urbanism (Barns 2020), place digital platforms in a larger society and theorize and investigate their impacts predominantly through a critical lens. However, this critical approach to platforms does not address the topic from the perspective of societal hybridity. What we argue here is that Airbnb is hybrid in many ways, and it can be analyzed as a hybrid constellation that aims to contribute not only to the creation of market value but also to the value creation mechanisms of public and social value (Stark 2009). To understand Airbnb as hybrid, let us examine how it contributes to public and social value creation.

While market value refers to the monetized and quantified form of worth that manifests itself in the transactional systems of societies (Arena & Gloria-Palermo 2008), the notion of public value has been conceived as something that cannot be merely encapsulated through market transactions or their residuals (Meynhardt 2009; Bozeman 2020). Benington (2011, p. 42) defined public value as first "what the public values; second, what adds value to the public sphere". Negotiations between different stakeholders and interest groups define and redefine what counts as public value (Sørensen et al. 2021). These negotiations focus on finding cognitive, goal, and practice alignment among citizens, community leaders, public authorities, scientists, experts, professionals, non-governmental organizations, and businesses (Kane et al. 2009). Usually, the results of these negotiations can be seen in the strategic goals and programmes of the governments, but there are also other venues displaying what constitutes public value. Airbnb can contribute to governments' goals to produce public value, and it can conduct practices generating public value. If Airbnb's sharing economy saves natural resources, it contributes to the United Nations and national governments' strategic goals relating to the preservation of nature. Moreover, the economic transactions on the digital platform of Airbnb are valued practices among national and global governments that emphasize economic activity, prosperity, and growth.

Constructs of social value are emblematic of the criticism toward the omnipotence of market value dominance, yet with a distinct emphasis on communities and civic action that are instrumental in facilitating social capital in societies. In the literature, social value concerns the bricolage of service impacts on different stakeholders, communities, and constituencies within society (Domenico et al. 2010). Airbnb considers itself a community of hosts and guests, and it claims to be "committed to serving all stakeholders in the Airbnb community" (Airbnb 2019b). To serve communities in travel destinations, Airbnb has provided support for rural revitalization programmes and sustainable development by partnering with local governments and organizations. Thus, it seems that Airbnb aims to produce social value and, in some cases, has provided it.

From the aforementioned, it follows that Airbnb is becoming an important actor in the networks of complex policy processes that do not follow the definitions of sectoral or organizational mandates in which individual concerns are linked to specific policy problems and where the respective accountabilities are easily demonstrated through the performance of the individual policies (Mazzucato 2021). The activities of Airbnb have important impacts on, for instance, the policy processes of alleviating social exclusion and segregation or, more generally, in developing more sustainable and socially fair cities. Consequently, Airbnb can be seen as part of the collaborative exercise between public policies and agencies, private businesses, economic institutions, and civic activities. In this chapter, such interplay is referred to as hybridity, which we apply to digitally organized platforms and ecosystems. In respect to hybridity, the prior literature refers to it as the interaction between public, private, and civil society actors and their activities involving the following four characteristics: mixed ownership, contrasting institutional logics and incongruent goals, the multiplicity of funding arrangements, and diversity of financial and social control forms (Billis 2010; Johanson & Vakkuri 2017; Vakkuri & Johanson 2020; Vakkuri et al. 2021a, 2021b). Next, we show how Airbnb reflects hybridity through these four characteristics.

Mixed ownership in Airbnb

In the hybridity literature, mixed ownership is mostly related to the pursuit of politically driven goals while exploiting private ownership and business logics and operating in global financial markets (Thynne 2011). Compared to traditional accommodation providers, Airbnb has a novel approach to ownership. The mixed ownership model of Airbnb utilizes households' and associations' ownership to get new properties listed on the digital platform. The expansion of supply is based on households', companies', and associations' capital, not Airbnb's capital. Airbnb owns the digital platform, not the rented apartments. Without the platform owned by Airbnb, households, hospitality companies, and associations cannot rent their properties for short-term use. However, there is no rental business on Airbnb if there are no households, hospitality companies, or associations renting their properties for short-term use. Because households and associations are key actors on the digital platform, mixed ownership is at the very core of Airbnb's business model.

The ownership of data is a key distinctive feature of digital platforms. Airbnb owns the data that accumulates on the platform, analyzes the data to continuously improve the platform, and serves it back to hosts to prompt and support them in helping the platform grow. Moreover, civil society organizations, data analytics firms, and researchers seek to collect this publicly accessible data for their use (Scassa 2019), and some actors, such as Inside Airbnb,[1] offer processed data packages under a Creative Commons licence that, despite its limitations (Alsudais 2021), is used frequently in business intelligence and academic research. Although this data has been collected from Airbnb's publicly available sites, it is a bit uncertain who owns the data, although Inside Airbnb claims ownership for the data collected from the sites of Airbnb.

Airbnb also encourages households to mix homeownership and business ownership. While Airbnb basically can be seen as any ordinary business firm producing value for its owners and shareholders, it utilizes, shapes, and redefines the nature of homeownership in its business processes. Traditionally, the nature of the property as a commodity has included financial aspects in the sense that it is an investment commodity with a long-term perspective. The sharing economy changes this by making it a more short-term consumer good that can be exchanged in the housing and accommodation markets. In a sense, Airbnb changes the division of labour between the economy and civil society by transforming homeowners into entrepreneurs. As a result, owning a home is no longer just owning a home: it is owning a home and a business property at the same time. Simultaneously, homeowners become proprietors of more liquid assets that can easily be exchanged for cash.

Competing and sometimes contrasting institutional logics and incongruent goals in Airbnb

In the literature, contrasting institutional logics and incongruent goals are manifested, for instance, through the logic of profit-seeking vis-à-vis the logic of effectiveness and social value (Kreps & Monin 2011; Besharov & Smith 2014). In the context of Airbnb, the institutional logics relating to neighbourhoods and buildings of residence differ from the institutional logics of the accommodation business. Homes and neighbourhoods are not developed for voluminous profit-maximizing tourist business that generates disturbances in local communities. By joining together tourism and residence mentalities in business operations, Airbnb has introduced a collision of institutional logics. One example of this is the disputes in condominiums caused by short-term renting. Airbnb guests are typically unaware of the condominium's rules and regulations, or they ignore them. Unauthorized parking, improper trash disposal, inappropriate use of the facilities, or excessive noise are typical examples of guest misconduct. Airbnb guests can also present a security risk to the condominium's community. While the logics of the accommodation business consider the dark side of tourism, the logics of neighbourhoods and residents have difficulties dealing with the adverse effects of tourist visits. As a consequence, difficult questions arise, such as who is responsible and in what way when a resident's visitors damage shared facilities or cause security threats in local communities.

From the institutional logic perspective, the collaboration of Airbnb and local governments is not unproblematic either. The growing importance of Airbnb in the urban setting may facilitate the importation of the sharing economy and an influx of visitors and increase accommodation capacity, which usually aligns well with the goals for local economic revitalization and financial sustainability of cities. At the same time, however, short-term renting services sold via Airbnb have adversely affected the housing markets by making it more difficult to find accommodations for the local population. Such negative developments make it more difficult for local governments to fight against segregation of neighbourhoods because properties listed on Airbnb pump up housing prices in popular areas and

these prices start to dictate who lives and where they live in the city. The previous examples show how the institutional business logic of Airbnb contradicts the local government policy of enabling affordable housing. The compartmentalization within the public-sector systems and decision-making means that contradictions between different logics can occur between Airbnb and particular local government departments (Karppi & Vakkuri 2020). Moreover, complex task structures in local governments increase the likelihood that some departmental policies in the local government are in contradiction with the activities of Airbnb.

Multiplicity of funding arrangements in Airbnb

In the hybridity literature, the multiplicity of funding sources and resource bases is frequently associated with the increasingly important relationships between public and private actors, namely, the relationships involving taxpayers, investors, and financiers. This applies, for instance, to public–private partnership arrangements in service delivery and large infrastructure projects (Hodge & Greve 2009). In the context of Airbnb, let us consider three important perspectives. First, households, associations, governments, and private investors provide funding for Airbnb's business operations. Airbnb utilizes funding from households, private entrepreneurs, and associations to get new properties listed on its platform. If supply increases, it is the households, private entrepreneurs, or associations that have funded this increasement, not Airbnb. Airbnb concentrates on finding the funds for the development of the digital platform. Without the funding collected by Airbnb, there is no digital platform of Airbnb on which households can offer their apartments for rent. Airbnb exists only because there is funding from investors for the business operations of Airbnb and funding from the households, private entrepreneurs, and associations securing the supply.

Second, the emergence of a home as a consumer good has an influence on the financing of dwelling houses. Buying property becomes an attractive investment opportunity for citizens because it can be rented via Airbnb. The Airbnb platform allows easy, short-term rental, which in turn promises better yield for the investment. This being the case, homeowners can finance their homes through bank loans, household capital, and/or money gained from renting on Airbnb's platform. Here, hybridity is strongly present because financing the supply side in Airbnb can combine different forms of funding.

Third, funding of the apartment is linked to the funding of the neighbourhood or city districts where the accommodation is located. Apartments renovated for the purposes of Airbnb enhance the housing conditions in the area, whereas occupancy taxes paid from the accommodation service provide funds for keeping the technical infrastructures up to date in local communities. As Airbnb is not only about the accommodation but also about the milieu where the listed property is positioned, the general housing conditions and the comfort of the living environment play a part in generating revenues for business. This has encouraged Airbnb to take part in local government development projects. As a result, we have seen public–private mixes of funding and investments in the urban development of some city districts where Airbnb operates. In this type of case, the funding of the

local government infrastructure projects becomes more hybrid. Funding of these infrastructure projects has the potential to enhance Airbnb business operations in those funded locations because improvements in living conditions have the tendency to increase locational attractiveness. Lists of the most visited tourist attractions reveal that developed nations and destinations attract tourists.

Diversity of financial and social control forms in Airbnb

In the hybridity literature, diversity of social control relates, for instance, to regulatory control of the markets, laws of government, or professional self-control (Noordegraaf 2007; Gritsenko & Wood 2020). One aspect of Airbnb is that it allows rating of the accommodation, which serves as information for quantifying and standardizing the reliability of the host who owns the rental property. It controls the minute details of their home, such as tidiness, functioning of appliances, and the availability of hot water. These are important aspects that orient customer choice, but they introduce a form of social control over these households. At the same time, the households renting the properties must adhere to the rules and regulations set by the local and central governments. Respecting domestic privacy, paying occupancy taxes, and taking care of appropriate waste disposal are typical examples of governmental means that control Airbnb hosts. In addition to the government and Airbnb, the host on Airbnb must consider the rules of the local communities. Let us consider one example. If a host constantly ignores the rules of condominiums in Finland, the condominiums can take the rented apartments under their control. Besides condominiums, the local neighbourhoods as communities have incentives to control the developments in their local surroundings. On some occasions, local communities have become active in supervising the behaviour of the visitors and in intervening in the disturbances. Local communities often exercise their control by sending complaints to the public authorities. Here, disobeying the local rules can lead to time-consuming processes where hosts have to address and settle complaints.

Governing the hybridity within Airbnb

To understand Airbnb as part of hybrid governance, we will review how the digital platform is currently governed by Airbnb, households, citizens, associations, and the government. After a brief review of the governance of the platform, we shall illustrate what implications the controls used by each actor have for the other actors exercising governance. In constructing our argument about the hybrid nature of governance, we shall use Ouchi's (1979, 1980) model of control to demonstrate hybridity. Therefore, we focus on market controls, bureaucratic controls, and clan controls. Moreover, we note that shared norms, values, and beliefs of the platform signify clan controls (Leoni & Parker 2019). Market control is based on price information mediated by efficient market mechanisms (Ouchi 1979, 1980), whereas bureaucratic controls are incentives, personnel capability controls, action controls, results controls, and job design. Here, personnel capability controls refer to personnel selection and training, action controls are decision rights and pre-action

reviews, and results controls point to performance measurement tracking the goal achievement (Rajala & Laihonen 2020). We use both formal and informal controls in our illustrations (e.g., Berry et al. 2009).

Airbnb, as a company, has corporate governance procedures that guide its activities. It governs its activities through its board of directors, management, internal auditors, external auditors, and stakeholder engagement. Airbnb also governs the digital platform in various ways. As a form of formal bureaucratic control, it verifies the identification of each service provider and user who wants to create an account for the Airbnb platform. Confirming the identification is a decision right and action control utilized by Airbnb. Confirming the identification of service providers is also personnel selection in some sense, as it controls who gets to provide services through the platform. To control the collaborators, Airbnb allows only a few actors to access their API and only after reviewing the possible collaborator carefully.

As a bureaucratic control, Airbnb uses results controls when it conducts account reviews. Account reviews are used in the processes in which Airbnb can deactivate or suspend the hosts or users' accounts. Account reviews ensure that service users and providers are behaving and performing according to the rules of the digital platform. The *super host* status is somewhat similar to what promotions are in conventional organizations. The super hosts show up earlier in the search results and get more reservations, which results in (Zhao & Rahman 2019) the super hosts getting more income. To be a super host, the service provider needs to achieve a certain level of performance. The performance is measured through customer reviews, response rate, cancellations, trips hosted, and trips reviewed. As such, the super host status acts as formal results control – that is, a form of bureaucratic control. Host and user dashboards revealing key performance indicators and benchmark information are informal results controls, providing ideas on how to improve user behaviour in the digital platform for increased profit. These dashboards compare the user with other users operating on the platform. For example, the dashboards reveal whether a service user or service provider has been reviewed as being below average in the reviews.

The service fees of Airbnb represent price as a formal market control. Based on the service fees, Airbnb takes smaller proportions from the accommodation services compared with experience services. This pricing policy makes accommodation services seem more profitable. The smart-pricing option in the Airbnb platform utilizes market control by automatically changing the price of accommodation to match the demand in the area. Smart pricing acts as control only if hosts allow the smart-pricing algorithm to take over their accommodation pricing. Also, by using tax planning, Airbnb can control corporate taxes paid to governments. In this way, Airbnb exercises control over government funding.

Airbnb attempts to create shared beliefs and norms by providing best practices and general tips. As an example, Airbnb provided tips for dealing with the COVID-19 pandemic in rented properties and travelling in general. These tips form a view of what to expect as a traveller and a host in terms of proper COVID-19 procedures. In the customer and service provider reviews, it is possible to exercise clan control and state in the answers to open-ended feedback

questions that COVID-19 procedures were not in line with the guidelines of Airbnb. In this manner, Airbnb can support clan control in the community.

It is not only Airbnb that controls the entrance of service providers to the digital platform. In fact, local governments in many cities require that providers register, get a permit, or obtain a licence before listing their property or accepting guests. This type of demand provides decision rights to local governments, indicating that bureaucratic controls are used to control city residents attempting to rent their places to tourists. To govern Airbnb by using decision rights, some local governments have either prohibited short-term rentals altogether or restricted the time periods that the property can be available for rent on the Airbnb platform (Corporate Europe Observatory 2018). Both of these actions have restricted Airbnb's ability to facilitate transactions relating to certain locations. Local and central governments influence the accommodation services offered on Airbnb in many ways. Public ordinance orders and local government ordinances typically at least partly control the house rules that Airbnb hosts determine. Housing regulations are known to affect the service level in accommodations. Overall, as physical spaces in cities are organized and regulated by the public sector, the bureaucratic controls of governments can enter the world of Airbnb that rents apartments in city environments.

As a formal market control, governments use income and capital income taxes, which affect the pricing of listings on Airbnb. These taxes also control the profit making of hosts and service providers. Airbnb as a company must pay corporate taxes, for example, to Ireland. In addition, some local governments collect occupancy tax that is paid by the guest. Also, fining hosts who have illegal listings has been used by the public sector. As the previous examples demonstrate, market controls of the government are deeply embedded in the transactions of Airbnb and affect the behaviour of the actors who use the digital platform. In terms of clan control, governments operate in a more indirect manner. For example, the European Union as an intergovernmental organization has supported the values and beliefs of Airbnb and its collaborators on the platform by claiming that "home-sharing represents an excellent use of resources and under-used space" (Corporate Europe Observatory 2018, p. 25). In this way, political support for the cultural values of Airbnb and its hosts and guests provides legitimation for the culture.

Service providers (i.e., hosts who can be households, associations, or private entrepreneurs) can use the Airbnb Resolution Center to send monetary requests for reimbursement or to cover damages. These requests are delivered to the guest by Airbnb, or they are addressed directly by Airbnb. The Resolution Center also operates as an arena in which monetary requests related to reimbursement, damages, or cancellations are resolved. The guests or Airbnb can make payments to the host to resolve the situation. Money requests are essentially based on prices, and as such, they are market controls. The service providers can also apply bureaucratic controls by modifying the listing availability. Managing the availability of the listing controls Airbnb's possibilities to create transactions concerning the listed property. Removing listings from the services and exiting the platform entirely by deactivating the account are informal ways to control the service offerings of Airbnb. The ability to choose the guests who can rent the apartment manifests another decision

right of the host. By controlling who rents the accommodation, hosts can exercise control over guests. As a results control, the guest ratings offer another bureaucratic control that the service provider can apply to control the behaviour of the guests. The house rules that the host can determine operate more as shared norms and clan control exercised toward guests whenever breaking the rules does not allow a claim for financial compensation. Although monetary requests could not be made, the host can always give lower ratings to users violating the house rules, which enforces clan control through bureaucratic control.

Also, guests can use the Resolution Center to send monetary requests for reimbursement or damages. The monetary requests are delivered to the hosts by Airbnb if they are not dealt with directly by the company itself. These money requests are market controls by nature. The Resolution Center can resolve the monetary requests related to reimbursement, damages, or cancellations. In practice, the hosts or Airbnb can pay the guest to resolve the situation. As a results control, the host ratings offer bureaucratic control that the guests can use to control the behaviour of the hosts. By using search filters in the Airbnb listing search, the service users signal preferences to the hosts. This signalling sets norms for renting and creates shared beliefs about the accommodation between guests and hosts. If the host cannot fulfil the promised preferences, guests can, in some cases, send a money request or a travel issue relating to crucial deficiencies. However, not all unmatched guest preferences justify reporting a travel issue or sending a money request. Through customer reviews, unmatched preferences that do not justify reimbursements function as cultural control.

Governing the hybridity of Airbnb impacts

To understand the hybridity of social impacts, it is helpful to look at a couple of examples of such impacts. The business operations of Airbnb have been associated with unequal distribution of income as a negative social impact (Schor 2017). This means that Airbnb enforces what Barabási and Albert (1999) called *preferential attachment*, also known as the rich-get-richer effect or the Matthew effect. The sharing economy in Airbnb's platform has led to developments in which successful hosts reap the most benefits from the platform in the form of gained incomes (Picascia et al. 2017).

Income inequality is a social impact within the digital platform of Airbnb. However, the income inequality within the platform also has a social impact on society, as hosts on digital platforms are also citizens of different nations. Thus, income inequality is a national and global government problem. Some of the developments on the Airbnb platform are in contradiction with the United Nations' sustainable development goals, which have many targets relating to the achievement of a fairer distribution of income, such as "progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average", or "[a]dopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality" (United Nations 2020, p. 11). As 193 countries officially adopted sustainable development goals, the income inequality generated within the platform of Airbnb

(see Mashhadi & Chapman 2018) is a problem for many countries. From the perspective of households and associations, more equal income distribution would benefit most of the Airbnb hosts, as relatively few are among those superstars who reap the most benefits from the platform (see Brynjolfsson et al. 2010). It is important to understand the relevance of Airbnb's social impacts on government, households, and associations as non-governmental and non-profit organizations, and why and how these impacts are related to hybrid governance. Moreover, comprehending how government, citizens, households, and associations contribute to these social impacts of Airbnb makes hybridity in the mechanisms leading to Airbnb's social impacts visible.

With regulation, taxation, and other policy solutions, the government can make the income distribution more equal among the actors operating on the Airbnb platform. In other words, the bureaucratic and market controls of the government matter. Amsterdam provides a good example of how superstars can be controlled via regulation (i.e., bureaucratic control). In 2017, Amsterdam required that all hosts have to register with the authorities, and in January 2018, the period allowed for renting activities was halved from two to one month per year (Corporate Europe Observatory 2018). If one can rent their property for only one month, it is difficult to become a superstar because the number of booked nights is limited by the government. In the Finnish context, the important question relating to taxation is whether flat rate or progressive taxation should be used to tax the hosts' incomes generated through Airbnb's platform. Currently in Finland, Airbnb incomes are considered capital income, and the taxation of capital income is based on flat rates. However, flat rates have been associated with higher income inequalities in many past studies (Efremidze & Salayeva 2021), whereas progressive taxation relates to lower income inequalities (Joumard et al. 2012). To lower income inequality, the government could adopt progressive instead of flat rate taxation.

If income inequality is a problem on the Airbnb platform, Airbnb itself is not by any means innocent. The super host status as a bureaucratic control created by Airbnb generates more visitors to these actors (Han et al. 2019), as does the high reputation score on the digital platform (Zhao & Rahman 2019). Because consumers have reputation signals such as customer reviews and ratings (Dellarocas 2005; Moreno & Terwiesch 2014), they recognize and choose the most popular options on platforms (Brynjolfsson et al. 2010). Getting more visitors concentrates the revenue streams to these dominant actors operating as super hosts. Besides the super host status, performance measures as informal results controls contribute to the Matthew effect. For example, measures, such as customer reviews, lead to customer concentration on Airbnb because customers make their decisions based on these reviews (Zhao & Rahman 2019).

Guests as tourists make reservation choices, contributing to revenue concentration that leads to income inequality. This relates to the old economic thinking claiming that consumers are kings, and they have market power (Von Mises & Greaves 2007). Thus, the decision rights given to guests have an impact on income inequality. Because reputation and trust matter for guests (Zhao & Rahman 2019), it is understandable why super hosts with good reputation scores and quality services are favoured over unrated hosts on Airbnb's platform. At the same time, there

are hosts that are super hosts or pursue super host status, indicating that chances to increase incomes for households are of interest. Airbnb hosts have a strong economic incentive driving participation on the platform, whereas achieving income equality is not the main motivation for households to register as hosts on the platform (Leoni & Parker 2019).

Similarly, improving the sharing economy is not just the result of Airbnb's work. Some governments support the progress of the sharing economy by allowing Airbnb to operate in their area, while others make active efforts to prevent short-term rentals in at least some parts of the city. In 2014, Barcelona decided to suspend the issuance of permits to use apartments for short-term rental in central Barcelona, and a similar decision was made by Berlin in 2016 to limit Airbnb's sharing economy in the city (Corporate Europe Observatory 2018). Compared with Berlin or Barcelona, Finnish cities allow Airbnb hosts to operate more freely (Vuokranantajat 2019). Thus, bureaucratic controls of the government can either enable or create barriers for the sharing economy. Regulating Airbnb and its activities also influences how straightforward it is for households and companies to become part of the sharing economy movement.

By providing a digital platform for households, companies, and associations to share their properties in over 220 countries, Airbnb contributes to promoting the sharing economy (Airbnb n.d.). Ensuring smooth transactions and building trust between hosts and guests with bureaucratic controls are other means through which Airbnb promotes the development of the sharing economy. As the sharing economy is at the centre stage in the business model of Airbnb, many other examples of activities boosting the sharing economy can be found in the documents of Airbnb, and we used only a few examples here.

Households, companies, and associations operating as hosts promote the sharing economy by listing their apartments on the Airbnb platform. Currently, there are over 5.6 million listings on Airbnb worldwide, indicating that hosts want to promote the sharing economy (Airbnb, n.d.). The hosts also advance sharing by providing details about their listing and their environment so that guests can choose suitable accommodations. Without these apartments and information about the accommodation services, Airbnb would not have any supply on its platform, and it would not be possible to promote the sharing economy in its current form. Thus, the hosts are focal actors in the sharing economy of Airbnb.

The guests show their support for the sharing economy by reserving accommodations, using the booked facilities, and inviting their own connections to the platform. Guests as tourists have made over one billion visits by using Airbnb (Airbnb 2019b). The behaviour of the guests in the accommodations also influences the success of the sharing economy, as misconduct has a negative impact on it in the eyes of the local communities and the public in general.

To conclude, the previous illustrations show that the negative and positive social impacts of Airbnb arise from the actions of governments, citizens, companies, and associations. For this reason, approaching these social impacts from the perspective of hybrid governance would provide a more comprehensive and systemic option compared with any compartmentalized approaches focusing on either the solutions of Airbnb, citizens, companies, governments, or associations. What we argue

here is that controlling the hybridity in the mechanisms leading to Airbnb's social impacts requires coordination and boundary-crossing collaboration in hybrid governance.

Measuring social impacts of Airbnb – A can of worms in hybrid governance

Understanding the hybridity in the mechanisms leading to Airbnb's social impacts is a prerequisite for measuring it. This means that the conceptual prisons that force practitioners and academics to divide the units of analysis into citizens and public-, private-, and third-sector actors promote more measurement practices focusing on these actors while ignoring hybrids (Vakkuri et al. 2021a, 2021b). Such a division, in a sense, denies the hybrid nature of organizational life (Johanson & Vakkuri 2017). In the context of Airbnb, this denial explains why we are talking about the social impacts of Airbnb, not the social impacts of hybrid governance revolving around the digital platform of Airbnb. This chapter is an attempt to make the hybridity relating to Airbnb visible so that we can proceed to measure its influence on Airbnb's social impacts.

The leap to the kind of thinking proposed in this chapter is significant because people have a long tradition of thinking and operating within public-, private-, or third-sector organizations. Each of these organizations has its own performance culture conceptualizing performance differently, which makes it difficult to proceed to hybrid governance and performance (Rajala 2020; Vakkuri & Johanson 2020). Due to the different performance cultures, performance information in the public sector usually differs from the performance information of private and third sectors. This creates data integration problems (Rajala et al. 2020). The information needs of individuals and organizations in the public sector are also dissimilar (e.g., Bouckaert & Halligan 2007) to the information needs in the private sector (e.g., Fitzgerald et al. 1991; Lynch & Cross 1991; Kaplan & Norton 1992; Barnabè 2011) and the third sector. Concerning the public sector's information needs, Bouckaert and Halligan (2007) talked measured information about needs, objectives, input, activity, output, effect/outcome, and trust. In the private sector, the information needs usually focus on the following nine key performance areas: personnel, leadership, learning, stakeholders, processes, products/services, financial performance, competitiveness, and value creation (Vakkuri et al. 2021a, 2021b). The third sector is typically interested in goal achievement, the system of resources contributing to survival, reputational matters, or multidimensional performances utilizing a combination of different approaches to performance (Lecy et al. 2012; Moxham 2014).

While not understanding Airbnb as a hybrid contributes to measurement problems relating to its social impacts, there are a plethora of other reasons explaining such problems. The common problem in measuring the social impacts of hybrid governance is the lack of shared information systems (Kurunmäki & Miller 2006). Creating a shared information system is far from easy due to data protection issues in the public sector (Rajala et al. 2018), and commercial confidentiality in the private sector prevents the distribution of performance information between

public and private partners (Coghill & Woodward 2005). As the information needs of the third sector can be quite different depending on the organization (e.g., Lecy et al. 2012), mixing information systems of third-sector organizations with public- or private-sector systems poses integration challenges. Without social pressure from the public, the incentives to conduct complex information system integration processes are not evident.

In the context of Airbnb, measuring the impact of Airbnb is only possible if one has access to a representative describing the platform and its social impacts. Getting data from Airbnb has been difficult for researchers (Schor 2017; Scassa 2019). Inside Airbnb presents a partial solution to the problem. Inside Airbnb is a mission-driven activist project that seeks to provide data that quantifies the impact of short-term rentals on housing and residential communities; it also provides a platform to support advocacy for policies to protect our cities from the impacts of short-term rentals. Inside Airbnb collects Airbnb data through a process of web crawling and scraping – that is, by emulating the browser of a regular Airbnb user; downloading each listing as a web page; extracting the listing metadata, reviews, and other details; and providing the result dataset in downloadable and machine-readable format. The rather peculiar and complicated way to collect the data from Airbnb results from the transparency and data sharing policies of Airbnb. Instead of Airbnb providing an API through which such data can be collected, the citizen society must rely on developing digital workarounds to be able to measure the platform.

There are several issues in using this kind of data in research or policy analysis. The data collection process is not available and therefore not observable to the user of the data. All the inherent problems of web crawling and scraping are present here, including ethics, copyright, the lability of the access mechanism, possible issues with sampling, the possibility for Airbnb to block data collection, and the low refinement level of the collected data. Once the source data is collected, a major effort is necessary to refine or "clean" the data to enable its analysis. Here, part of the cleaning is done behind the scenes by Inside Airbnb, adding to the limitations on reproducibility of the data collection and analysis process.

If one can compile a representative and credible dataset on Airbnb, it becomes possible to analyze many of the mechanisms internal to the Airbnb digital platform. One can, for example, estimate the impact of trust (reputation) in the value (asking price) of the listing or analyze whether preferential attachment drives the formation of connections on the platform, giving rise to superstars and rich-get-richer dynamics. However, turning our attention from mechanisms generating changes within the platform to the externalities of Airbnb as a digital platform is much more complicated, and it requires databases about the world surrounding the digital platform.

Discussion and conclusions

The global scaling of the sharing economy has brought about some fundamental changes to modern society, which highlight various aspects of hybridity. What we are currently seeing are changes in the interactions between government, private

sector, and civil society. Co-production, co-design, and collaborative governance movements all hybridize societal actors. Airbnb hybridizes many things in our societies as well. In Airbnb's sharing economy, every property owner becomes a potential landlord. The cultural aspect is that the idea of home transforms into a business opportunity. This is not to belittle the nature of property as an asset, but the change alters the property as a long-term investment good into a short-term consumer good. At the same time, it transforms the government–citizen relationship into a relationship between the government and an entrepreneur. To put it otherwise, home has become a subject for business transactions and government business policies, and it is no longer only a sanctuary for the family within civil society which the governments protect with public ordinance orders.

The second aspect of hybridity relates to the regulations governing hybrids. The point here is that, in many cases, public authority is unprepared to keep up with the pace of technological developments introducing new forms of hybrids that endanger safety, justice, and order in societies. Airbnb is one prime example of these types of developments. This is a governance problem, as governments have to produce innovative solutions to secure safety, justice, and order in societies. The sharing economy challenges the existing regulatory framework by extending the borders of the hospitability business to the domestic lives of households. The obvious concern from a government point of view is the possible losses in tax revenue, as it is difficult to monitor how homeowners are making money on Airbnb's digital platform. Also, the responsibility issues relating to health and safety can be problematic when tourists cause problems in facilities and neighbourhoods designed for permanent residency. The responsibilities between tourists and homeowners are unclear when tourists damage the facilities of condominiums. Is the responsibility shared, which makes the responsibility hybrid by nature, or does one party take responsibility for the damages? The governments also might have difficulties in supervising who is unemployed and who is not if Airbnb hosts do not register their status in any governmental system. Households can have hybrid identities: a host on Airbnb and unemployed in government systems.

Third, the sharing economy hybridizes urban and rural communities. The attractive neighbourhoods can become areas where tourists blend with local communities. This hybridizes the community identity. The results of the blending can be controversial, as the travellers' genuinely good intention to blend in with the local population can end up with local residents being strangers within their own communities. In terms of hybridity, these developments tend to integrate civil society and business together in a new way. Some of the developments are positive and some are negative, but local governments face a situation in which there are no easy solutions.

Overall, the hybridization poses governance challenges, as the developments seem to highlight the need to move from corporate governance to hybrid governance. Prior research on hybridity and hybrid governance has extensively and, to some extent, excessively emphasized the primacy of organizational reasoning in the governance of performance. With the emphasis on the analysis of hybrid organizations, the research has provided rich and already fairly nuanced accounts of hybridity in organizational spheres, including, for instance, the

institutional logics describing valuable activities of state-owned enterprises, non-profit organizations, social enterprises, and municipally owned corporations (Billis & Rochester 2020; Besharov & Mitzinneck 2021; Vakkuri et al. 2021a, 2021b). The research tradition reflects a sequential, linear process of evaluating complicated societal activities because performance measurement has usually focused on the rationality of mechanisms through which "organizational" goods are transformed into "public" or "common" goods (Vakkuri & Johanson 2020). The research foci in previous studies have mostly excluded the more difficult performance measurement and management topic: the social impacts of hybridity. The analysis of digital platforms and ecosystems as hybrid entities, including public–private–civil society links, clearly suffers from such a caveat in research tradition. Therefore, we have in this chapter argued that research should also be able to more fully understand the governance and management of institutional hybridity and its social impacts. This type of understanding necessitates that we start to examine the complicated inter-sectoral and inter-organizational interactions of micro-, meso- and macro-level activities and impacts (Dopfer et al. 2004). In this chapter, we analyzed Airbnb as an ecosystem transcending both the levels of societal governance and traditional sectors of public, private, and civil society. The chapter shows that social impacts associated with Airbnb actually are not just based on Airbnb's actions and inactions but also on the conduct of other actors.

The attempt to discuss hybridity through activities seen in hybrid governance is closely intertwined with the lack of proper data. In terms of data, current statistics often delegate the representation of economic activities to either organizations (micro) or to nation-states (macro), or, respectively, to either the public or private realm. Therefore, in the context of platforms and ecosystems with hybridity characteristics, we have only a rudimentary understanding of the processes, outputs, and outcomes of ecosystems in general (Johanson & Vakkuri 2017), let alone ecosystems that are cross-sectoral and transcending the boundaries between government, business, and civic activities. Simply put, we lack proper data, applicable conceptualizations, and methodological tools to assess the extent and intensity of hybridity among ecosystems. These shortfalls have their roots in disintegrated information systems operating within sectoral boundaries, organization-centric thinking, and different performance cultures of the public, private, and third sectors. Social pressures to measure the effects of hybridity are also largely missing.

For a more detailed account of hybridity in platforms and social impacts, our chapter has introduced three important agendas for future research:

1 Studies should aim for more sophisticated identification of the forms of hybridity in the contexts of digital platforms.
2 Mapping out the relationships between organizations, digital platforms, and hybrid governance is of importance to research and practice.
3 Explaining the impacts of hybridity on the conceptualization, measurement, and governance of the social impacts of digital platforms is a priority for future investigations.

Although our results offer valuable contributions to research on hybridity in digital platforms, our analysis should not be considered exhaustive. More research is required to provide even more elaborate accounts of the complicated and multifaceted links between hybridity and digital platforms in society.

Note

1 About Inside Airbnb: http://insideairbnb.com/about.html

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4 Data-driven logic transforming public innovations

Jari Jussila and Heli Aramo-Immonen

Introduction

In recent decades, there has been a growing interest in academia to understand the logic of value creation. The traditional way of looking at markets has been from the company perspective, where the role of the customers has been viewed as passive actors participating in transactions with the company. The company produces goods that are supplied to customers in exchange for money. Simply put, companies create value in terms of products that the customers buy. This has been referred to as goods-dominant (G-D) logic of value creation. The introduction of service-dominant (S-D) logic shifted the perspective on how and where value creation takes place and what is the role of supplier and customer. In S-D logic, customers are perceived not only as "destroyers" of value but also co-producers of value with the supplier, and both value-in-exchange and value-in-use are acknowledged as important.

However, both G-D and S-D logic ignore one important information age value creation driver in the market, which is embedded in most of the products and services exchanged in the private and public sectors. This missing ingredient is data. Consider, for instance, the ratio of data-intensive companies in the fastest-growing companies in the world. Even today, many consumers fail to understand that at the core of value creation for tech companies is the data they collect from consumers and their actions, and not the products or services they provide. This phenomenon has not gone unnoticed by governments, and several initiatives have been taken to protect the privacy of consumers and ownership of data – for example, General Data Protection Regulation in Europe and multiple regional legislation in the United States. Nevertheless, many public-sector organizations have failed to recognize the importance of data and given ownership of critical data to tech companies. This has led, for example, to severe interoperability issues and lock-ins to specific companies providing the software-intensive products or software services needed by the public sector. New legislation created to address these data ownership and privacy issues have increased awareness of the importance of data. However, a comprehensive understanding of data-driven (D-D) logic is missing.

How is value created, captured, co-created, co-produced, and destroyed in data-driven logic? What does it imply to the private sector, public sector, and

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consumers while exchanging and making use of data-intensive public products and services? How can D-D logic be involved in public innovation and digital transformation? These questions guide in answering what is D-D logic and how it can be used to support public innovation and digital transformation.

Background and key concepts

In the traditional value creation model, value is formed by the firms or manufacturers as a product or service, which is then distributed to consumers through suppliers for exchange based on monetary compensation (Helander et al. 2020). This notion of companies as value creators and customers as value users has been around since the industrial revolution in the 18th and 19th centuries. Past and present business models have been designed from the viewpoint of these significantly production-oriented companies (Ketonen-Oksi et al. 2016). Analogously, the public sector has been viewed as a producer of public goods and services that are consumed by citizens. Thus, citizens can be perceived as wasting public goods and passively receiving the services provided by governments and cities. This traditional view has been criticized in several academic disciplines, such as management, marketing, and public administration.

Research in administrative sciences has recognized the importance of two-sided and multi-sided interaction between government and citizens (Jørgensen & Bozeman 2007; Scholl et al. 2009). For instance, many government-provided services, also referred to as E-government, do not involve only Government-to-Citizen informational and transactional relationships, but they are also often mediated by information systems developed in Business-to-Government relationships. To distinguish this is especially important in countries which have a long tradition of public service governance and therefore heavy infrastructure supporting service production. Paradoxically this may be a burden to societies' development towards D-D logic. On the contrary, novel governance systems such as highly digitalized systems in Estonia or E-government system build up from "tabula rasa" such as in Rwanda, may be very well functioning and from the beginning build according to D-D logic (Twizeyimana et al. 2018).

To give a practical example, when you log in to an E-government service the authentication may be via a bank service. Thus, each time a citizen logs in to an E-government service, a transaction cost occurs between the bank and the government. For example, the average fee of bank authentication for using E-government service in Finland was 50 cents, before the legislation enforced a maximum fee of 10 cents (Parviala 2017). As another example, consider Cloudpermit, an e-permitting software for local government building departments that allows citizens to apply for building permits (for construction) only. In this case, the citizen applies for a building permit and provides all the necessary documentation to the E-government service that is hosted by the Cloudpermit company. The benefit of using such an E-government service is that everywhere in the country the application process and services are the same, and there are no municipality- or city-related differences related to e.g., professionalism, equality, responsiveness, etc., or need to physically visit city building departments. These examples highlight that

the government is not the sole producer, and the citizens are not the sole users of government goods and services. Two-sided interactions between government and citizens have been recognized in E-democracy models (e.g., Päivärinta & Sæbø 2006) and open innovation literature (e.g., Chesbrough 2003), for instance. E-democracy enables citizens to participate in government opinion forming or decision-making (Päivärinta & Sæbø 2006), voicing and deciding what is valuable for them, e.g., what investments in public goods are included and what are excluded based on limited resources. Open innovation, on the other hand, enables citizens to participate in co-creation of public services and innovation of new services and public goods.

Whereas firms focus implicitly or explicitly on transaction costs (Coase 1937; Williamson 1979; Williamson 1996), profit maximization (Alchian 1950; Winter 1964), shareholder value (Day & Fahey 1988), ecosystem value (Moore 1993; Jacobides et al. 2018) or some other mainly monetary based conceptualization of value, in the public sector there are a broader set of values governing operations. One such framework is "value for money" often referred to as "Three Es" (Holtham & Stewart 1981; Power 1997; Grönlund et al. 2011). The "Three Es" represent audits consisting of three types: economy audit, efficiency audit, and effectiveness audit (Midwinter 1994; Power 1997; Pollitt et al. 1999; Dittenhofer 2001; Grönlund et al. 2011). Economy audit deals with how well the costs of resources are minimized (Midwinter 1994; Grönlund et al. 2011). Efficiency audit relates to the relationship between output and input used to produce the public service (Midwinter 1994; Grönlund et al. 2011). In practical terms providing a specified volume and quality of service with the lowest level of resources capable of meeting that specification. Efficiency can be further divided into resource efficiency and administrative process efficiency (or flow efficiency), where the latter focuses on the government's efficiency in executing its routine operations (Srivastava & Teo 2007; Modig & Åhlström 2012; Jussila et al. 2017). Effectiveness audit focuses on the extent to which the organization is able to implement policies and achieve its objectives (Midwinter 1994; Grönlund et al. 2011).

The "Four Es" approach adds the concept of equity to the "Three Es" approach and considers for whom an organization is economical, efficient, and effective (Bailey 2004; Frederickson 2010; Santandrea et al. 2016). Bailey's (2004) concept of horizontal equity refers to treating equally people, households, or groups in equal circumstances (Sá et al. 2015). Hence, the "Four Es" is about finding a balance, where people are a part of the equation and not only how economically, efficiently, and effectively public goods and services are provided.

In marketing literature, a fundamental shift in worldview took place with the introduction of service-dominant (S-D) logic (Vargo & Lusch 2004). In its original conception, the differences between goods-dominant (G-D) logic and S-D logic were contrasted on the primary unit of exchange, role of goods, role of customer, determination and meaning of value, firm-customer interaction, source of economic growth (Vargo & Lusch 2004). In fact, this is a very old idea. The French classical liberal economist Frédéric Bastiat (1801–1850) was impressed by the relative order which prevailed in the early days of the February Revolution in Paris in 1848. From his legacy is drawn the foundational proposition of S-D logic that

organizations, markets, and society are fundamentally concerned with the exchange of service—the applications of competences (knowledge and skills) for the benefit of a party. That is, service is exchanged for service; all firms are service firms; all markets are centred on the exchange of service; all economies and societies are service based.

At the core of S-D logic is the idea that all exchanges can be viewed in terms of service-for-service exchange, the reciprocal application of resources for others' benefit (Vargo & Lusch 2004). Vargo and Lusch formulated the core ideas of S-D logic into 11 foundational premises (FP) as follows:

FP1 Service is the fundamental basis of exchange; FP2 Indirect exchange masks the fundamental basis of exchange; FP3 Goods are a distribution mechanism for service provision; FP4 Operant resources are the fundamental source of strategic benefit; FP5 All economies are service economies; FP6 Value is co-created by multiple actors, always including the beneficiary; FP7 Actors cannot deliver value but can participate in the creation and offering of value propositions; FP8 A service-centred view is inherently customer oriented and relational; FP9 All social and economic actors are resource integrators; FP10 Value is always uniquely and phenomenologically determined by the beneficiary; FP11 Value co-creation is coordinated through actor-generated institutions and institutional arrangements.

Goods versus services versus data: Rethinking the orientation

Viewed in the production-centred and service-centred approach, the production-centred focuses mainly on goods as the unit of exchange and the service-centred approach focuses on knowledge and skills, i.e., services as the unit of exchange. Both ignore an important element in exchange, which is data.

The data-centred approach is an extension of the goods-centred and service-centred approaches. The nature of G-D logic is in contrast to S-D logic is elaborated in detail, for instance, in the works of Vargo and Lusch (2004), Lusch et al. (2007), Vargo and Lusch (2008), and Vargo and Lusch (2014). For introducing the data-dominant (D-D) logic a comparison of the roles of goods, services, and data in G-D, S-D, and D-D views are first outlined in Table 4.1.

In D-D logic, in agreement with Vargo and Lusch (2004), people exchange to acquire benefits from something. The benefits provided by the public sector can originate from enjoying a relaxing walk in the park, commuting on public transportation to work, reading books loaned from the public library, receiving public medical care from a doctor, and attending public university education, to give a few examples. Naturally, there are differences between nations, what public goods and services are available or to the degree that the exchanges are subsidized or reimbursed. Similarly, there are differences between taxation in each country, state, or city that a citizen exchanges to benefit from public goods and services. Common to different nations is that in order to be able to receive public goods or services there is an exchange of data involved. For instance, receiving public medical care from a doctor typically requires a social security number that must be given in order to book a time with the doctor. The booking of the time online requires digital authentication, and in the hospital, the person must register with his or her

Table 4.1 Comparison of roles of goods, services, and data in G-D, S-D, and D-D logic

	Goods-Centred Dominant Logic	*Service-Centred Dominant Logic*	*Data-Centred Dominant Logic*
Role of goods	Goods are transferable items that satisfy human needs.	Goods are transmitters of embedded knowledge that are used by customers in value creation processes.	Transfer of goods is based on data or data is the good. Goods are to a varying degree data-intensive.
Role of service	Services are acts or performances that a service provider produces to create value for the customer.	Services are acts or performances where value is co-created in interaction with supplier and customer sphere and created in use in the customer sphere.	Data from supplier and customer spheres are used to provision acts or performances that co-create value for supplier and customer and possibly third parties in the ecosystem.
Role of data	Data is an intangible good and different from tangible goods due to the impossibility of a person to physically hold it.	Data is embedded knowledge that is transmitted by goods.	Data is embedded knowledge that is experienced via private or public goods and used to personalize and tailor services.

credentials in order to get to the service. Furthermore, the quality of medical care is often dependent on data of the patient, e.g., previous medical records of the patient. In order to prescribe suitable medicine, the allergies or other medical conditions of the patient must be known. The quality of service, in this instance, is not dependent solely on the specialized skills and knowledge of the doctor, but also on the data about the patient and knowledge that is embedded in the information systems used by the doctor.

Borrowing a book from a library typically begins by searching from which library the book is available. If it is an electronic book, it can be accessed directly for the duration of the loan period. If it is a physical book, it can be reserved online and picked up on-site. Here again, the citizen must present his or her library card or some other credentials that verify that the loan can be authorized. If the credentials are missing, a new library card or similar must be first registered before the citizen has access to the library services. Or if the citizen has unpaid overdue charges, they must be taken care of before new loans can be activated. Thus, the use and exchange of this public good are dependent on data.

Attending a public university also requires valid credentials. In many countries, there are limited public university admissions. Admission is often based on data from previous performance in studies or results of entrance exams. Individual performance can be evaluated in terms of other applicants, and based on the data, the most successful students or applicants are selected. After being selected, the

performance is continuously monitored and in case of weak performance, it may lead to dropping out of school. Hence, public university attendance and completion are dependent on data.

What about taking a walk in the park or commuting on public transportation? The data as a central facilitator in benefitting from the built environment is less obvious than in previous examples. However, when commuting on public transportation, you need to know the schedules, the places the buses or trains stop, and the available seats for the transport mode. Access to public transportation may also require credentials and reserving seats beforehand in order to use it. In some countries, public transportation is a public good, and in others, it is a private good. In the case of private good public transportation, travelling is not even possible without paying a ticket, and not having a ticket while travelling will result in a fine. No data, no ride. Furthermore, cities use the information collected from the passengers and public transportation in urban planning to design and redesign the routes, schedules, etc. It can be argued that what you get in this sense is the result of data-driven urban planning. A walk in the park is not always a walk in the park either. First of all, unless the citizen is already familiar with the park and the location, he or she needs to find it and get there first. Information about the park can be found on a paper map or mobile app, for instance. For a tourist who is visiting a new city and would like to visit a park or some kind of recreation area, such public goods are as good as non-existent if their information is not easily available. Even in this specific example, data can have an important role as the enabler of the exchange.

Returning back to the medical care example, the importance of understanding D-D logic can be highlighted by two extreme scenarios. The first, a sub-optimal scenario in terms of patient care and government healthcare spending relates to the unorchestrated jungle of information systems acquired and used by the hospitals. For example, some cities and municipalities have historically made decisions independently on what information systems to acquire with no national standards or interoperability requirements for information system providers. As a consequence, the information systems of different hospitals do not communicate with each other, and if a patient, for instance, visits different hospitals, his or her patient information and previous medical history have not been by default available. Additionally, there are cases where the provider of the hospital information system has closed down and prevented any third-party innovations by restricting access to data and interfaces under the company's control. The failure to understand D-D logic in this sense can be a significant barrier to public innovation. A more optimal scenario is where the government has understood the importance of data and interfaces and enforced standards which commercial enterprises need to comply with in order to offer services to the public sector. A good example is the real-time platform for urgent care called ***NHSquicker***, which has been developed by Professor Navonil Mustafee from the University of Exeter, in collaboration with the local UK National Health Service (NHS) Trusts (Mustafee et al., 2018). In the United Kingdom, there are services where a patient can go if she/he has an urgent care problem – for example, Minor Injury Units (MIUs), Urgent Care Centres (UCCs), NHS Walk-in Centres. These services are for patients with conditions

that are not very serious but are urgent in nature (thus the need for an non-appointment-based service). The NHS Trusts also operate 24/7 Accident & Emergency (A&E) departments for patients who need critical care. The A&E departments are located in major hospitals, and together with the urgent care facilities, they define the overarching Urgent Care Network for a particular geographical area (also referred to as the catchment area for a local NHS Trust). Mustafee's project developed a real-time A&E/MIU/UCC wait-time platform and a front-end mobile application. The app uses the data received from the real-time platform to nudge patients that require urgent care to visit centres that are appropriate for their care level and where they could be seen quicker. The objective is to use the real-time information on wait times and travel time and offer choices to the patients for them to decide the most appropriate service points to visit; for example, are they prepared to travel further to be seen quicker? NHSquicker receives real-time information from over 25 centres of urgent and emergency care located in the south-west of England. This is possible as the data from the different Trusts, which operate a multitude of A&E Patient Flow Systems like *Symphony(™)*, *PatientFirst(™),* and *EPIC(™)*, is sent in a standard format that has been co-developed with the NHS Trusts (Mustafee and Powell, 2021). NHSquicker also provides information on local services such as dentists, sexual health clinics, and pharmacies. The data comes from the NHS Directory of Services, which is maintained by the UK NHS. The information is available based on users' GPS location or the postcode that they have entered.

Drawing on the presented examples, we next present seven FPs to present emerging data-dominant (D-D) logic.

FP1 Data is a central facilitator of exchange of goods and services

Data is needed to exchange goods and services. This applies equally to the private and public sectors. In the private sector, goods and services can be exchanged after an order or purchase has been completed between firm and customer. In the public sector, exchanges of public goods or services typically involve either verifying identity (Blakemore et al. 2010) or information seeking and actions by citizens, e.g., reserving, filling out an application, that generate data before the exchange can take place.

FP2 Data is a fundamental driver of value for money

Data enables economical, efficient, and effective planning, design, and delivery of public goods and services. For instance, making use of patient medical history and diagnostic tools available for doctors enables more efficient and economical, and more safe treatment of patients. Barriers or missing access to patient medical history, on the other hand, can lead to ineffective or in some instances even dangerous treatment for the patient. Information system providers of hospitals can hoard data and limit data flow to external systems and to reject third-party application access to data with the intent of protecting from the threat of new entrants and the

threat of substitute products or services (Porter 2008). Data generated by patients, e.g., patient flows, and data about hospital resource efficiency enables hospitals to further develop their services and operations leading optimally to balanced "Four Es" when they have control of their own data.

FP3 Customer is a co-producer of data

The use of public goods and services generates data. Public organizations are among the largest creators and collectors of data that is valuable to citizens, organizations, and businesses for participation, decision-making, and creating innovative products and services (Janssen, 2011). Citizens should not be considered merely as users but also as stakeholders having an active role as participants, collaborators, developers, and co-producers of data in the city's activities (Kunttu 2019). Data that is shared in an effective and open way offers increased possibilities for different stakeholders to innovate together toward shared goals (Jussila et al. 2019). Customer coproduces data anytime a public service is used, e.g., record of a book loan, patient record of a visit to the hospital, public university degrees completed and thesis work published, commuting on public transport, or taking a walk in the park. In some cases, the data is generated by the customer during the exchange, e.g., the record of a book loan, be it physical or digital, and in other cases, the smart city has a more active role in data collection, e.g., measuring how many people enter and leave a park or a physical building. Even in that scenario, a citizen is needed in order for the data to be collected.

FP4 Data resources are a source of innovation

Open data on public goods and services are a source of innovation for governments, firms, and third parties alike (Jussila et al. 2019). Ojo et al. (2015) point out that there are initiatives like "Apps for Amsterdam" and "Helsinki Loves Developers", which enable the co-creation of services addressing the needs of citizens and businesses based on the availability of open data built applications. A smart city can benefit also by expanding on existing open source projects not only inside the city (Ojasalo & Kauppinen, 2018 but also between cities. By releasing the developed software code in the smart city as open source, several cities can take advantage of solutions built for the needs of one city and thus use resources more smartly and sustainably (Jussila et al. 2019).

FP5 Data-centred view is most beneficial when it is oriented towards ecosystems

The data-centred view in smart cities is founded on the premise that all data is valuable, whether it is produced internally or externally. This leads to ecosystem thinking, where ecosystem parties mutually coevolve and develop using data resources available to them. The beneficiary of smart city open data can be in some cases, for instance, an individual citizen entrepreneur that has developed an application, a firm that has developed a commercial service, another city that develops

a new service or improves an existing one, or the government that gains important national data and metrics by collecting data produced by smart cities. D-D logic is most beneficial to various stakeholders when it is ecosystem oriented and not closed or restricted to dyadic relationships between smart cities or government and citizens. For instance, jointly developed open data ecosystems improve the commitment of different stakeholders and ensure that the created solutions are based on real needs (Tarkkala et al. 2020).

FP6 Data is a key enabler for digital single market ecosystems

Data markets are enabling data-driven businesses. Open data is necessary for digital single market (DSM) ecosystems (Demchenko et al. 2018). Data as a driver of new economic value is evolving. Open data is available from sources such as social media, smart city data, and government data for example. However, the major potential is remaining in private custody such as customer data, patient data, personal data, and operational data for example. Opening towards shared big data is essential for the DSM ecosystem.

FP7 Data is moving towards commoditized economic goods

The data has to be commoditized (sovereign, trusted, reusable, exchangeable, actionable, and measurable) in order to enable data-driven business. Defining workable business and operational models benefit from the non-rival nature of data, data ownership, data quality, value, privacy, integrity, and provenance (Demchenko et al. 2018). In D-D logic internet of things (IoT) sensor networks and farms continuously produce data that could be used by different organizations and produce secondary data that may have added value. Furthermore, personal data is used for advanced market research and services development. This development is transforming data towards commoditized economic goods.

Discussion and conclusion

Both the traditional G-D view and S-D logic view ignore one important information age value creation driver in the market, which is embedded in most of the products and services exchanged in the private and public sector. This missing ingredient is data. Therefore we introduce in this chapter a novel view – namely, D-D logic. The core ideas of D-D logic are now formulated into seven FPS. Contemporary data-centred business ecosystems are constantly evolving around blended data sources like IoT data and open data. New data analytics opportunities, platform economy, and open source software development generate an endless stream of data-driven business opportunities. Therefore, there is also space for co-creation of new insights between academics and practitioners. In this chapter, we introduced D-D logic that has three major implications for public innovation. First, a superficial understanding of data as a central driver for value creation and capture can lead the public sector into unfavourable partnerships with the private sector, and, e.g., create unnecessary and expensive lock-ins (Zott & Amit 2017) to

certain information system provider(s) that limit interoperability and third-party innovation of public-sector services. Understanding D-D logic is especially critical in development and acquisition of new information systems and services for the public sector. Secondly, data is a critical resource in building ecosystems and nurturing innovation in smart city and national-level "smart country" ecosystems (Angelidou 2014). As the *NHSquicker* example demonstrates, data can enable more citizen friendly, efficient, effective, and economic public-sector services if the public sector has understood the important role that standard format of data and information system interfaces play as enablers of data resource use. Third, people responsible for public-sector legislation and contracts are the gatekeepers of data-driven innovation and value creation and have a significant impact on future public-sector services and goods. Increasing gatekeepers' understanding of D-D logic is proposed to have a direct and long-term impact on public innovations in the information age.

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5 Artificial intelligence and public innovations

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Introduction

As artificial intelligence (AI) technology becomes more complex and far-reaching in its implications, we are in danger of education losing the race with technology: our understanding, organizations, policies, and ethics could be buried under an avalanche of technology diffusion and adaptation (Goldin & Katz 2008). A danger is that the pace and direction of AI innovation are dictated by the tech giant's pursuit of profit rather than clear public service strategies meeting citizens' needs. "Break first, think later" – the mentality of commercial AI innovation – may deliver financial and technical success, but meeting social needs is another matter if trust is endangered and social consternation rises (Leslie 2020).

One danger is trying to pursue more from less, with the cost reductions resulting from AI innovation becoming inevitable even if opaque technology is applied to socially intractable problems. Equally dangerous is neglecting technological advances that offer new service solutions simply because the technology is advancing too fast. Avoiding AI is impossible: instead, agents in public services need to grapple with new knowledge flows and the new roles, relationships, and responsibilities posed for citizens, public service providers, and private organizations. This is especially challenging since most public agencies have little in-house AI capacity or AI research capability, meaning that many AI projects are necessarily public–private partnerships (PPPs), which introduces an additional set of complexities for public agencies that perhaps prefer bottom-up modes of innovation (Mikhaylov et al. 2018; Wirtz et al. 2019). Balancing fast-paced technology and slow-moving social and ethical values challenges public service agents to think, plan, and act critically and systematically.

In support of a critical approach to AI innovation, we consider the meaning and practical implementation of mutuality at the city level since mutuality is essential at every stage of design and implementation if AI-enabled new service solutions are to reflect user needs and meet public service standards such as equity, consent, privacy, and transparency. Our research question: Is AI altering mutuality governance in innovations between the private and public sectors?

We consider what mutuality means as a form of governance in the relations between the public and private sectors around AI given the need to blend

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institutional drivers and overcome the uneven distribution of expert knowledge. This is done by drawing on the experiences of the City of Oulu and the City of Tampere in innovating AI.

The chapter begins by conceptualizing AI as a general-purpose technology and then critically assesses previous research on AI innovation, highlighting the challenges posed for public agencies and the case for mutuality in AI innovation. Building an analytical framework on these discussions, we apply it to experiences of AI innovation in Oulu and Tampere, focusing in particular on how mutuality shapes service innovations. After discussing these results, we propose theoretical conclusions and carefully outline generalizable lessons for public agencies implementing AI-enabled service solutions.

Conceptualizing AI in the public sector

AI capability builds upon data digitalization and big data analysis evolving from human-computer interaction (Papert 1993) and decision theory (Minsky 1986). Singularity, i.e., computers imitating human emotional-cognitive ability, has often been predicted (Newell & Simon 1972; Kurzweil 2005), as have artificial superintelligence computers *significantly more intelligent than humans in all respects* (Barrett & Baum 2017). However, this remains to be achieved (Russell 2019), though general intelligence is perhaps close to today's advanced machine learning (Searle 1980). However, most AI operates in closed fields as narrow intelligence, such as in the games of chess and Go. AI is good at searching massive databases and arriving at decisions from patterns, giving rise to capability-based classifications of AI (Dwivedi et al. 2019) revolving around AI doing things that humans are not good at (decisions from masses of data), while humans remain better at evaluative judgements and exercising wisdom, which AI, in turn, is not good at. In terms of technological conceptualization, AI is an umbrella term for a diverse range of computational techniques and technologies – ranging from rule-based systems to deep learning systems – and functionalities – ranging from machine learning to robotics and decision-support to facial recognition (Stone et al. 2016). The European Commission (AI HLEG 2019) describes AI as either software and hardware systems that through data acquisition reason and process information to decide the most suitable action for achieving a given goal or (in robotics) undertaking programmed actions.

Narrow AI offers four functionalities relevant to the public sector: (1) support for decision-making processes, (2) integrated data governance, (3) interaction and virtual agents, and (4) the automation of administration (see Table 5.1). To solve a specific problem, AI might use one or more technologies (if interoperable and integrated) from the wide domain of AI technologies, such as natural language processing, computer vision, neural networks, robotic process automation, and many more. AI technologies in these areas can provide *descriptive, predictive*, *explorative*, *prescriptive*, or *automated decision-making* (Watson 2014).

Local authorities have adapted successful AI-enabled decision systems (Spieth et al. 2014; Ross 2016) and successfully increased decision speed and accuracy

Table 5.1 AI application areas in public services

Application area in public sector	*Purpose and AI functionality*	*Data reference*
Decision-making support	• Augmenting civil servants • Knowledge management systems: codification • Knowledge flows with neural networks • Predictive and prescriptive analytics	Wirtz and Müller (2019) Gupta (2019) Ross (2016) Spieth et al. (2014)
Interaction / virtual agents	• Computer-based interaction with user • Communication: citizen experience, user involvement in service design • Interaction with civil servants • Conversational AI, such as chatbots, natural language processing, computer vision	Kreps and Neuhauser (2013) Androutsopoulou et al. (2019)
Data governance	• Gathering, storing, and processing data: broader inclusion of data and expanding existing systems • Identifying anomalies and patterns: e.g., detecting service needs, identifying potential dangers • Cognitive surveillance and security systems • Diagnostic and predictive analytics	Ahokangas et al. (2012) Schorr and Rappaport (1989) Kankanhalli et al. (2019) Karvinen et al. (2017)
Automatization of practises	• Automation of standard tasks • Document reading and validation, intelligent case management • Higher-level autonomous systems • Knowledge-based systems: expert systems	Kuziemski and Misuraca (2020) Chun (2007) Collier et al. (2017)

(Gupta 2019; Wirtz & Müller 2019). The development of data governance has been supported by the broader inclusion of data in existing systems (Ahokangas et al. 2012) and the expansion of systems from the internet of things (IoT; Schorr & Rappaport 1989). The IoT can successfully expand the breadth of services offered in technologically assisted independent living, linking the inside to the outside of the home, for example with security, tracking, and transport services (Kankanhalli et al. 2019). There are examples of new service models often based on integration, for example, in health and social care integration and children at risk (The Guardian 2019), and in digital phenotyping for personalized medicine (Onnela, 2017). In terms of AI assisting the public sector in communication, digitalization already increases opportunities for communication and the use of conversational AI – for example, using AI-guided chatbots (Androutsopoulou et al. 2019).

Ideally, citizens should participate in critical decisions at all stages of new service development. The public sector is speedily automating its administration. Examples include faster and higher-quality request processing for immigration application forms (Chun 2008; Kuziemski & Misuraca 2020), automated image diagnoses (Collier et al. 2017), and analyzing and supporting the development of the labour market (Kuziemski & Misuraca 2020). AI-enabled innovations in the public sector potentially benefit the efficiency and/or effectiveness of service delivery to businesses and citizens, answering needs and ultimately supporting the level of satisfaction and trust in the quality of governance and public service.

Simultaneously, however, research shows that the results from AI are mixed for citizens (Greene et al. 2019; Coeckelbergh 2020; Dignum 2019). AI innovations pose issues and dilemmas across policy areas, including social, technological, data, economic, political, legal and policy, organizational and managerial, and ethical dilemmas (Dwivedi et al. 2019). The negatives of AI use have been identified, such as issues concerning access and control, data choice bias, and the difficulty of redress (Kinder et al. 2021). To address these issues, numerous expert groups and public and civil organizations have introduced guidelines for designing ethical AI. These include the guidelines of the European Group on Ethics in Science and New Technologies (EGE 2018), AI4People (Floridi et al. 2018), and the European Commission's High-Level Expert Group on Artificial Intelligence (AI HLEG 2019). Overcoming these challenges requires answering the question *by whom, how, where, and when will this positive or negative impact be felt?* (Floridi et al. 2018) What is technically possible may not be desirable or useful: how then do we evaluate the usefulness and ethical desirability of AI innovation?

Since AI is complicated and opaque, information asymmetries arise between stakeholders (consumers and policymakers) and AI experts. This brings out issues of understandability (Gasser & Almeida 2017), what the European Commission calls *explainable AI* (AI HLEG 2019). We prefer the term understandability since instead of presuming the issues are simply one of an AI expert explaining the technology, our view is that also users and providers need to explain emotional touchpoints and user experiences to the AI expert: understandability is a two-way street. Without understanding the basics of *how* and *why*, AI innovation team members lack the ability to justify design decisions to gain the user's informed consent and the ability to puzzle through their implications, always bearing in mind unintended implications that occur anyway in most innovations.

These issues resonate strongly in Finland, the focus of this study, where the Ministry of Economic Affairs and Employment (SAIP 2019) announced "we want Finland to become a leader in applying artificial intelligence and robotics to the benefit of societies and enterprises". Finland is already ranked fifth in global AI-readiness by Oxford Insight, and gross domestic product growth predictions up to the year 2030 are 0.8 per cent without full utilizing AI and 3 per cent with full utilization. Inevitably, AI companies are drawn to the public sector because it has the largest databases and large numbers of intractable problems needing innovative new solutions. Many public agencies lack the resources to employ AI experts and need public–private financing to implement new solutions (Kinder et al. 2020). It is to the issues of AI innovation that we now turn.

Innovations and AI

In a market economy, companies and organizations either *innovate or die* (Freeman 1991). Other issues facing the public sector are austerity, rising demand, and/or quality improvement. Innovation reduces cost by efficiency, a more effective service design, or a new business model. Although the *inevitability of progress* was proposed by the Frankfurt School (Horkheimer and Adorno 1972; Allen 2016), more negative views of technological innovations are also advanced by researchers (Foucault 1997; Sennett 2003; Sandel 2020). Metaphors for innovation include *creative destruction* (Schumpeter 1939), the biological metaphor in evolutionary economics (Witt 1993), and the increasingly popular systems or physics metaphor (Arthur 2015) often related to complexity and ecosystems. Freeman and Soete's idea of the socio-technical paradigms of technological change remains influential (Dosi et al. 1988).

Public services are systemic by nature and do not look to the innovation of autonomous technologies but instead to integrative technologies and service models contrived as ecosystems. The ecosystemic view discusses the systemic nature of innovations and favours a future-oriented, systemic, and multi-agent approach for supporting service innovation: the futures view, systems view, and multi-actor view (Hyytinen 2017). Technologically enabled innovation is future-oriented and therefore often constrained by heritage structures, cultures, and ways of working. Multi-agent approaches often feature stakeholder analysis and prefer long-term visionary targets, though the weighting attached to each stakeholder's interests can cause conflict. The systems perspective focuses on interlinking sub-systems and broadening boundaries.

Technological innovations

Research on technological innovation has established its non-linearity, spill-over effects, unintended consequences, radical or incremental nature (Freeman 1991), closed or open innovation processes (Chesbrough 2011), and adaptation to new contexts and cultures (Wartofsky 1979; Bernstein 2000; Daniels 2016). Learning, sense-making, and recontextualization are essential to all successful technology innovations (Nonaka & Takeuchi 1995). Service innovations have emphasized user involvement in addition to technical interoperability, complementarities, and the coupling between technology-push and pull (Von Hippel 1982). Additionally, innovation research highlights the usefulness of tools such as contextual usability and the importance of human agency in open innovation processes (Kinder 2000). Especially in public services, services-as-a-system "pull" personalized services to citizens that are often organized across organizational boundaries (Laitinen et al. 2018b). When technology innovation brings decision-taking closer to the point of customer contact, it disrupts existing hierarchies and power relations, resulting in new governance arrangements, especially if using hybrid delivery projects, such as PPPs. We note that incentives and motivations for technology innovation are diverse, often in its early adoption stages focusing on cost reductions rather than new business models, i.e., efficiency rather than (more complex) effectiveness. Involving the service user and encouraging learning asks new questions in

innovation processes, such as "how do I feel about it?" instead of simply "does it work, is it faster?"

All technological innovation is accompanied by technical and market risk, and for the public sector, there are additional risks in providing services for vulnerable people (Flemig et al. 2016). Evaluation of success, therefore, includes ethical and subjective factors in addition to cost-benefit analyses and return on investment. Ethical issues are contextual by nature and are always case-specific (e.g., Bowles 2018). The impact of technology concerns not only the direct usage situation but also the many different stakeholders who may have conflicting interests. Risks arise where technologies are *black-box* (Rosenberg 1982; Beck 1992; Adleretal 2018), meaning the inputs and outputs are discernible, but the transformation processes are opaque – often an AI characteristic. In design processes, service walk-throughs and emotional touchpoint evaluations (Radnor et al. 2014) add complexity and potential AI expert misunderstandings.

A central issue then for AI innovation is mutuality and understandability – that is, the preparedness of agents involved in innovation (such as developers, users, and service providers) to give the time and commitment necessary to understand each stage of the new service solution (such as the algorithm, choice of databases, and embedded machine learned patterning) and the user explaining to the AI experts the unacceptability of some algorithm designs or database referencing. For governance arrangements, a key issue is whether the market or non-market dominate, making mutuality a critical point.

In summary, both understandability and mutuality are essential features of technological innovations in the public sector, each of which is influenced by the particular context and culture in which the innovation occurs. Each of these points will feature in ethics decision-making and the wider social evaluation of the innovation's acceptability.

AI in public services

Extensive public-sector digitalization has accrued a vast reservoir of big data: fertile soil in which AI can flourish in dealing with important issues.

These issues include framing AI-enabled innovation to avoid technology-push and instead adopting a human-centred and problem-centred approach (Floridi et al. 2018; AI HLEG 2019). Machine learning AI raises the possibility of the *invention of a method of invention*, a prospect underscoring the need to control AI's rate and direction of diffusion (Griliches 1957). For example, the City of Oulu has developed a system of using the public sector as a testbed for privately launched products, such as a health app, a secure mobile phone, and wearable health data signalling. Is this an advantageous circular economy or alternatively a negative development? We note that Bluetooth signalling from IoT devices is important to AI-related innovations – for example, supporting technologically assisted independent living. What does this mean for 5G infrastructure rollout, and who will bear the cost? AI innovations attract calls for public accountability from a wider democratic footprint (Laitinen et al. 2018a), so what level of public understanding of AI is needed?

Researchers have catalogued AI-related problems in US public services, such as the wrongful denial of benefits (O'Neil, 2016; Eubanks 2017). Some are also evident in the United Kingdom, including contract cancellations (The Guardian 2019). Monopoly exploitation of historic intellectual property (IP) and trolling for IP breaches have become a major problem (Standing 2016). These cases highlight the importance of IP and General Data Protection Regulation (GDPR c)ompliance and the careful protection of new IP, especially of basic research in university commercialization. While AI-enabled robots are likely to feature more in manufacturing than public services (Angwin et al. 2016), we note their use in delivery, surgery, and driverless transport, not to mention the existence of Japanese robot companions. Already, AI is criticized for misreading the faces of people of colour in facial recognition (Eubanks 2017), bias-confirmation in predictive policing (Asaro 2019), and gender-biased classification (Bouolamwini & Gebru 2018). Agents ask *can I sue an algorithm* if it is shown to be biased (Brown et al. 2019)?

It is argued that AI adoption in local authority areas should be part of employment and skills planning and not simply seen as an opportunity for cost reductions (Allam & Dhunny, 2019). Perversely, better public services result in an increase in demand and costs, unlike in the private sector, where additional demand results in raised revenue: AI adoption poses unique issues for the public sector. One such issue is the wider public accountability for AI-related services and the upending of hierarchies and power distribution, creating new inter- and intra-organizational governance arrangements (Cath 2018). Final users in the public sector are often vulnerable, highlighting the need for transparency and careful ethical evaluation.

In summary, AI presents the public sector with new service model opportunities and more effective services, and AI innovation comes with the challenges of understandability, mutuality, and ethicality. Both sets of challenges need to be met if AI is to succeed in the public sector, issues we now examine from practice.

The need for mutuality

Mutuality is a type of governance, in this case suggesting agent interdependency featuring trust in relationships as opposed to (for example) purely market governances in which for-profit principles mediate all decisions. Governance here is deployed in a wide sense as rules and norms guiding decisions and actions (Kinder et al. 2020), and it includes mutuality between private and public organizations.

The institutional drivers influence guiding decisions and actions concerning the mutuality of public and private organizations. Market principles guide innovation towards the lowest cost and highest profit margin, whereas mutuality-based innovation is driven more by agent satisfaction with service effectiveness, especially for users. Our research allows the examination of AI innovations in local public services, which are prone to mutuality governances. One important difference between mutuality and market governance in innovation is the role played by service users. Both are likely to list service users as stakeholders since market-oriented services will only achieve success if users endorse their usability. Where mutuality prevails, the role of users is likely to involve user engagement in all

design and decision stages, and this entails much more time spent by AI experts explaining and ensuring understandability for the service providers and users. Also, in mutuality governance, the AI experts will spend time listening and learning from providers and service users, especially informal and emotive views on how the new service solution will differ from existing (non-AI) arrangements.

The mutuality-based AI innovation process, therefore, differs markedly from market-driven processes in terms of knowledge flows, levels of trust, and time spent on understandability. From the perspective of the innovation assemblage as an epistemic community (Haas 1992), the type of knowledge flow differs from a market-driven project. The latter is concerned with costs and efficiency, the former with relationalities, contextual usability, and effectiveness. Risk in the market-driven innovation project is not technical but social – that users will reject the project citing usability, access, privacy, etc. Risk in the mutuality-driven innovation project is project-creep (too many functionalities added) and loss of cost and time discipline. The discussion of "open" and "closed" innovation projects debates the advantages/disadvantages of each approach (Chesbrough 2011). Part of the closed nature of top-down projects is that projects may be compelled to use a project management programme, such as Prince-2. This brings focus to the activity on project plan deliverables, milestones, waterfall testing, and outcomes, even if this means rejecting changes to the original plan that the stakeholders deemed sensible (Kinder 2010).

Mutuality in innovation processes has a psychological dimension since projects by their nature are time-limited special events, and, in the case of AI, they bring together stakeholders from diverse disciplines and governances. Mutuality can be studied at the level of the individual, envisioning dyadic, triadic relationships (Henson 1997). In our analysis, the members of the project team are the unit of analysis rather than individuals, often with forming-storming-norming-performing being phases of negotiating team governance, language, and ways of working. Most favourably, project teams create a trust that addresses the confidentiality issues Henson (1997) raises. We find analogies, such as parent-child (Tronick et al. 1977) or lover commitments (Drigotas et al. 1999) limited since innovation team members bond around the purposive intent of creating the new service solution, and where mutuality prevails, they put aside dyadic relationalities and play for the team. In the team context, the discourse on mutuality ties it to values, principles, and practices as part of meaningfulness (Yeoman 2019). Understanding meaningfulness and values can be helpful in conceptualizing relationships in innovation work, especially trust, respect, honour (Nietzsche 1988), and emotional attachment (Vygotsky 1934) between agents.

Part of this coming together addresses some of the issues raised about mutuality in organizational studies research (Dabos & Rousseau 2004). Our approach is that exploring organizing is more revealing than studying organizations (Weick 1995) and especially so for innovation. The reason for this is that where projects such as AI-enabled local public service innovation integrate services, they necessarily disturb existing hierarchies and existing power distributions – in short, all existing inter- and intra-organizational structures. For example, the new AI solution may empower the nurse's decision-making vis-à-vis the doctor or redistribute

functions from the social worker to the home care assistant. Whereas psychological exchange is related to old command-and-control hierarchies, integrated service solutions may lead to messy and multiple upwards and horizontal accountabilities for staff (Dabos & Rousseau 2004). We find social exchange theory more helpful in understanding the formation of mutuality, as it seeks to understand trust and acknowledge the boundaries of power and social dominance (Blau 1964). Mutuality in innovative projects often changes old identities, roles, relationships, and responsibilities: we envisage mutuality in AI-enabled projects as dynamic and upsetting previous arrangements. Yeoman's (2019) emphasis on mutuality in innovation projects sharply poses the issues of roles and values in terms of how new arrangements can achieve better service solutions than the old ones. The new "whole" achieves more than the sum of its parts – often described as more from less. The new services-as-a-system is "pulled" by the needs of the user, irrespective of the organizational boundaries.

As we have noted, AI processes of this sort are best envisaged as dynamic ecosystems and not fixed inter-organizational networks. Often this simply acknowledges the cooperative working that local government service professionals have already been practising. Interdependency is best based on trust and mutual respect (Thibaut & Kelley, 1959); without them, service professionals are unlikely to depend upon the behaviour of others, especially in caring for vulnerable clients. In bringing together multiple databases, decision systems, and information flows, AI-enabled innovation can easily not only create mutuality but also conflict (Rossi & Tuurnas 2021), especially if the inter-working between diverse governance arrangements (e.g., market vs. free public services) has not been resolved. An effective innovation project will recognize such problems and take action to resolve them. Often interdisciplinary team meetings that discuss cases and apportion responsibilities are a good forum to identify and resolve problems, remembering that service professions frequently have occupational cultures which place the needs of the client first.

AI innovation processes impact the wider citizenry, either because they use the services (transport, waste disposal) or because they form part of the community's social identity (elderly care, children's education). The accountability of social innovation is tied to the citizenry as a whole (Behn 2001), and similarly, information communication technology (ICT) innovation in public services reveals the importance of social acceptability (Parker & Parker 2007). Research on services-as-a-system in Finland showed that radical alterations in social care, where democratic participation is high and services are localized, require innovations to find acceptability in a wider democratic footprint (Laitinen et al. 2018a). For black-box technologies such as AI, it seems especially important to secure public acceptance of innovative new systems – a wider view of mutuality.

Mutuality then is an important conceptual tool and practice guide for AI-enabled local public service innovations. Mutuality is a way of working (trust, shared knowledge, and emotional attachments), a way of implementing new service models (ecosystems, multiple and messy accountabilities), and (most importantly) a new way for service users to help create public services that meet their needs.

AI and public innovation in practice

The City of Tampere and the City of Oulu have a heritage of being world-leading software clusters, previously supporting Nokia and now supporting advanced software sectors. The cities were chosen because, atypically, they have explicitly decided to re-envision their services through the lens of AI.

The subject of this case study is mutuality between public and private organizations in the development of AI innovations at the city level. The research draws on 20 interviews with AI practitioners, local public service providers, and service co-designers from Oulu and Tampere, Finland. These interviews were conducted by Author 2 in May 2019 and enquired about their ongoing thinking on AI in local public services and the intended future of AI use and ethics attitudes. We used a cognitive conversation method (Geiselman et al. 1985), allowing interviewees to narrate terminology, process inter-relating agents, and sequence cogent stories, linking evidence and interpretation.

All interviewees gave their written consent prior to the interviews, which were subject to guaranteed confidentiality. All interviews were conducted in English, and the results were transcribed.

Table 5.2 Interviewees: gender, designation, position, and organization

City of Tampere, Finland		
Male	CEO	Development agency
Male	Development Manager	Private-sector incubator
Female	Project Manager	The City of Tampere
Female	Project Manager	Tampere region
Male	Development Manager	The City of Tampere
Male	Director	The City of Tampere
Male	Development Manager	Tampere University
Female	Development Manager	Tampere University of Applied Sciences
Male	Development Manager	Tampere University Hospital
Male	CEO	Software company
Male	CEO/Technical Director	AI development company
City of Oulu, Finland		
Male	Member of Council	Youth Council, The City of Oulu
Male	Member of Council	The City Council, The City of Oulu
Female	Manager	Voluntary Organization
Male	Managing Director	Voluntary Organization
Female	Director	The City of Oulu
Male	Director	The City of Oulu
Male	Director	The City of Oulu
Male	Director	The City of Oulu
Male	AI Professional	Oulu City Council

Generalization from the results was needed to follow recontextualization carefully. Awareness of AI-enabled services varied among the informants. Some had a clear picture of how cities develop AI-enabled innovations. Some informants only recognized AI-based practices and tools, like second-generation chatbots, service robots, smart rings, MyData, and data-based decision-making. In the case study, we interpreted the data to create an overall picture of the AI innovation ecosystem. In the analysis, we triangulated between the interview evidence, previous research findings, and our own sense-making.

The dataset does not include the cases of individual AI innovations, but it gives information on a complex environment in which AI-enabled innovations are developed between private and public organizations. For this reason, the dataset is relevant for answering the research question. The informants have an interest in developing services, and many are active in innovation ecosystems at the city level. This also means that many informants look at national AI innovation policy from the perspective of how it helps to develop local practices and services. This has affected the outcomes of the case study.

Innovation initiatives

We begin by specifying the levels of innovation initiatives in the public sector revealed by the data. Innovation operations on the city level – the focus of this chapter – are tied to regional ecosystems and national initiatives that form a complex interdependent environment.

One official explained that the city envisages mutuality as a multilevel and complex environment from which "order" emerges, sometimes in unforeseen ways, and agents in innovation collaboration are nested (Figure 5.1). The analysis of this chapter focuses on the meso-level, where teams operate in city level or regional ecosystems. These are influenced by individual values (Yeoman 2019) and barriers of power and control on the institutional level. For example, a local company might develop an AI innovation that (even unknowingly) aligns with national strategies and occurs because of mutual interdependency between the public and private sectors.

City-level innovation

The interviewees understood the need for mutuality governance between the public and private sectors and the dynamic environment facing AI innovation. The interviewees felt close cooperation was essential and best achieved in long-term relations characterized by trust, which is typical in Finnish local government. At the same time, public agencies need to avoid treating some AI partners unfairly, particularly in competition for innovation project selection. Finland also has traditions of cooperation in the public and private sectors regarding the development of technological innovations, and agents in both Oulu and Tampere cited close working relations between the public and private sectors over the decades with Nokia's research teams.

The City of Oulu and City of Tampere point to successful AI-enabled service innovation projects. In Tampere, these include a MyHealth app, which signals the

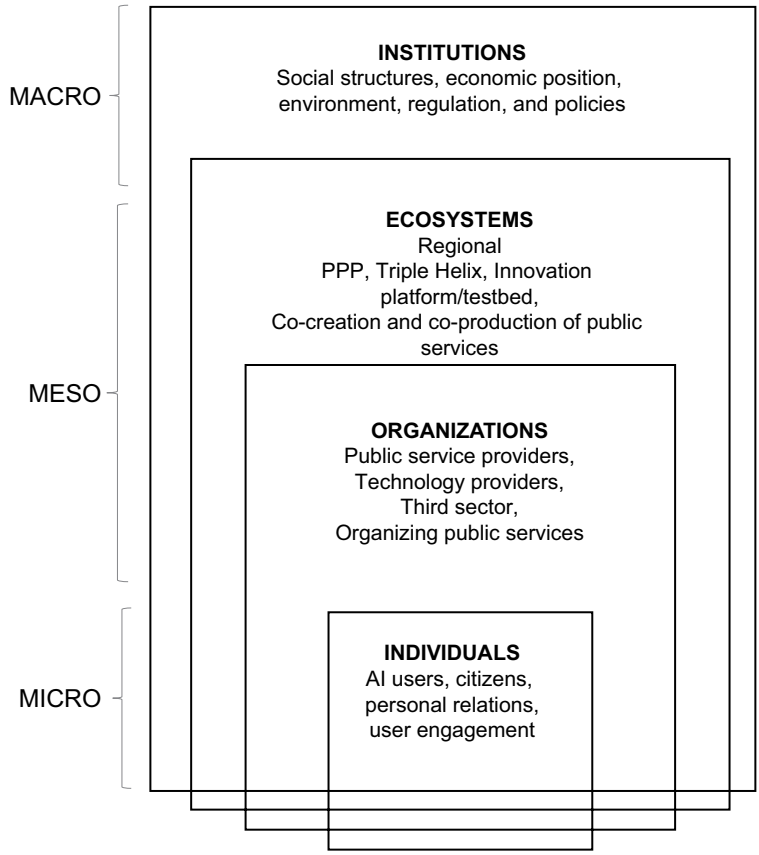

Figure 5.1 Nested operators in the AI innovation process.

need for a doctor's attention, and the extension of technologically enabled independent living supported by the IoT's data-gathering and signalling to ambient service providers. Transport integration and identifying isolated elderly citizens are other successful AI-based projects in Tampere, each of which involves companies and the public sector.

In Oulu, the Oura ring signals health data to doctors, and the second-generation Oulubot chatbot is widely used. The climate (50 km from the Arctic Circle) is important in Oulu, and an AI-enabled prediction centre helps organize local transport and company logistics planning. The IoT is widely used in elderly care systems. We were told that three billion users per day access AI systems developed by small and medium size enterprises (SMEs) in Oulu. The city's procurement system is AI-enabled, combining with adjacent public agencies to reduce costs.

AI regional ecosystems

The Cities of Oulu and Tampere each have the strategic aim of building AI regional ecosystems across the public and private sectors and, in each case, a matrix of

problem-centric and technology-centric self-governing ecosystems. In both cases, the problem-centric ecosystem addresses the integration of health and social care based around city hospitals, which are regional centres. Described as cross-cutting and supporting the *bounce-back* of the local economy (in Oulu), other ecosystems are technology-centred. In Tampere's case, the focal point is the newly merged university, which has AI as one of its strongest research fields. In Oulu, the university is also important, with the Chamber of Commerce playing an important role in informal networking between AI SMEs and public agencies. Since the City of Oulu is geographically situated in an adverse northern environment, the City Council is particularly concerned about expanding companies and encouraging AI start-ups, aiming to continue the high standard of living that prevents population decline. Tax revenues from successful companies are an important revenue source for both cities.

Tampere's ecosystem features city-led networks in transport integration, environmental quality, waste disposal, and social care issues, while in Oulu the city's role is more enabling – for example, as a conduit for ideas, promoting informal information exchange events, and holding impromptu events based on ideas for new services. In Oulu, it is noteworthy that Trade Unions and voluntary organizations are often the source of new ideas, which the city's top policymakers then organize around, offering support and data access to interested companies.

National AI initiatives

The interviews revealed the important role of national initiatives for innovation. From the perspective of cities, the most significant AI-related programme would be the AuroraAI programme. The programme encourages AI innovation based on important transitional life events (family circumstances, educational progression) using multi-stakeholder ecosystems that flexibly interact (SAIP 2019), building new service chains that automatically support life-event transitions. In doing so, service costs can be reduced, and opportunities arise to integrate public and private services. A government policy summarizes the objectives: "Success in reaching the target of public services calls for interconnecting public organizations (AuroraAI network) to interact with the services of other sectors with the help of AI". The AuroraAI programme is leading to a service network that interconnects services so that they can support and interact with each other (SAIP 2019).

Officials from the City of Oulu frame their AI activity within the AuroraAI programme using funding to support service development work. One company representative reported using funding for a nationwide experimental service. AuroraAI encourages the commercialization of new products and services by companies. Ethical evaluation by users and service providers is embedded in the AuroraAI projects.

Mutual governance of AI innovations

In addition to the innovation environment, the interviews introduce several arenas where mutuality governance between public and private organizations is taking place in the development of innovations concerning cities and their services.

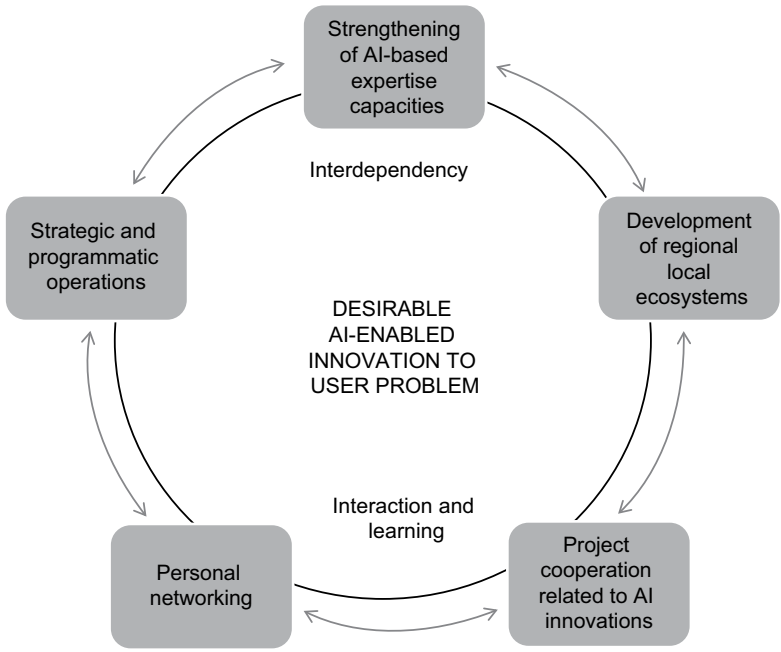

Figure 5.2 Arenas of mutuality in AI-enabled innovation.

These include (1) strategic and programmatic operations, (2) the strengthening of AI-based expertise capacities, (3) the development of regional and local ecosystems, (4) project cooperation related to AI innovations, and (5) personal networking. Some of this is captured in Figure 5.2.

Strategic and programmatic operations

Finland has a very strongly top-down and design-centred tradition in the development of technological innovations (Koskimies & Kinder 2021). This means, for instance, that a new kind of development cooperation and related target settings are typically advanced utilizing national programmes. As mentioned, the City of Oulu is closely involved in the AuroraAI operation. In practice, programmes like AuroraAI can imply that locally developed innovations may turn out to be trendsetters. Programmes are also aimed at generating nationwide benefits from cooperation in innovation development. This calls for open innovation development work that enables different public organizations to utilize innovations in the way they consider practicable. This includes the mutual sharing of information, compatibility protocols, and platforms to build common working spaces in which (cross-governance) development teams operate.

Few public agencies employ AI experts or units dedicated to AI-based research. Instead, city administrations operate using projects constituted to exploit public-sector databases and to address problems. In the City of Oulu, suggestions for projects come from the voluntary sector, the Youth Council, and Trade Unions in

addition to projects framed by the City Council. AI programmes in the city's university are encouraged to create projects jointly with the city. Finland's culture of easy movement between the public and private sectors means that problem-centred project work is quite normal and addresses the AI expertise deficit in the public sector while providing data and expertise from service models lacking in the private sector. The cities' top policymakers are important in Finland: in both Oulu and Tampere, the policymakers are a direct conduit for companies with AI application ideas to approach the City Council. The advantage to City Councils of capacity-building using problem-centred projects is that new service solutions directly address issues in the context and culture of the city, reducing the risk of technology-push by providing user testbeds at the trial, test, and implementation phases. Representatives of each city's universities report that AI projects – jointly framed, scoped, and designed with the City Council – are an ideal learning environment for AI students.

Strengthening of AI-based expertise capacities

Finland already has significant AI capabilities and capacity. In the Cities of Oulu and Tampere, most schools teach AI, encourage AI projects by students, and feature presentations by AI-related businesses in the curriculum. At the university level also, AI features across the curriculum. Finnish universities encourage interdisciplinary undergraduate programmes, including internships and business-linked projects. Nokia's retrenchment into a software company has created a pool of AI programmers in Finland (some estimate 10,000); some work independently, while others work in the plethora of AI-related SMEs now forming half of the company start-ups estimated by the Tampere Chamber of Commerce. In short, Finland has significant human capital in terms of AI expertise.

People working in the enterprise sector, as well as those representing the public sector, strongly emphasize that expertise in the public sector has a significant effect on AI innovations and the related cooperation between the public sector and companies. A deficiency in expertise affects, for instance, the ability to work with AI-based practices. The significance of AI is not necessarily understood well enough in public services. A similar lack of expertise can generally be seen regarding the possibilities of AI in the development of services.

Expertise has several practical implications. It is possible that due to deficient expertise, the public sector is not able to detect the AI-enabled innovations developed by companies that would affect their operations. This is why the public sector is unable to adapt its operations to the companies' innovation operations and to direct purchases to this end. It is also possible that companies capitalize on the deficient expertise of the public sector. They are possibly selling innovations at high prices or when not yet completed. In the latter case, extensive amounts of AI innovation development work would need to be carried out during the implementation phase in service operations.

Most AI project participants recognized the importance of ethical understanding and insist that users and providers judge ethicality at each phase of the project, knowing this requires minds-on commitment, time extensions, and patient,

two-way communications. Ethical assessment begins at the project framing stage, as the project team builds a picture by layering pieces of information, for example, what decisions algorithms might make and which databases are appropriate to reference in the context and culture of the public service. In an agriculture project, the first overall assessment began by referencing general ethical principles (consent, privacy, etc.) and then proceeded to a user evaluation of each emotional touchpoint in the service walk-throughs. As a university development manager commented, "Open discussion of how we use the data is the best way to avoid criticism of unethical uses of AI". The team members felt that applying high ethical standards and using the voice of the customer gave the AI services *brand integrity*: acceptability in Finnish cities would help in the international commercialization of the products. We found projects involving service users at each decision stage, with considerable effort made in educating AI experts of users' ethical sensitivities and the experts ensuring sufficient understandability by users to approve new service designs.

At the city level, the lack of expertise is generally seen in the implementation of AI-based innovations. Both of the cities involved in this study are therefore working in cooperation with companies in order to advance the better practical implementation of AI innovations. Deficiency of expertise is also tackled in Tampere and Oulu through cooperation in training. Companies may also share the view that the more expertise there is, the more willingness there is to adopt their AI innovations.

Development of regional and local ecosystems

Both Tampere and Oulu see ecosystems as solutions in that in AI-enabled innovation operations, mutual adjustments take place between the public and private sectors. Ecosystems are built up with two objectives.

The first objective may be to accomplish an ecosystem around a certain public service operation – such as health care services. In this case, local and regional ecosystems are also producing innovations that would serve the operations of cities or public organizations (e.g., university hospitals) in the area. A second objective may be to generally establish a local and regional business ecosystem for the development of AI innovations. For instance, the City of Oulu has invested particularly in the development of start-ups. The aim of the city may be to enhance the ability of regionally operating companies to jointly develop innovations. One of the tasks of cities is to generate local and regional vitality. This will also have an effect on cities' tax revenues.

There are, however, differing views at the city level on what would be the best way for ecosystems to work in order to promote innovation operations. In many cases, the ecosystems of cities or regions are networks of operators compiled and managed by them. Alongside this, especially the City of Oulu has invested in services answering the needs of companies. Leadership of the ecosystem is complex since as self-organizing entities there is no command and control: leadership is the result of collective consciousness. For Oulu, this is centred on the mayor's office as the source of new ideas and a conduit linking potential partners. In Tampere, the Chamber of Commerce plays an important role with the City Council in

agenda-setting. Each city has a distinctive approach to ecosystem building; from our interviews, both approaches were working well and suited the local context and culture. Overall, ecosystems are creating arenas at the local and regional levels for mutual connections between companies and the public sector. However, it is still unclear what kinds of ecosystems work best.

Project cooperation related to AI innovations

Both Tampere and Oulu have city-level projects where companies and city operators are jointly developing AI innovations. In general, AI companies are drawn to the city's public services because they are the source of the large databases AI requires, and their services reveal a multitude of problems that can be resolved by applying AI to life-as-lived problems. In project cooperation related to AI-enabled innovations, the operations of cities and companies mesh very variedly, case by case. The construction of different entities may be jointly planned by companies and the public sector, which means a joint project application has been made and funding has been sought. Similarly, purchaser-provider cooperation is possible. In this case, the city purchases from companies such innovations that the city expects to need. There may also be so-called innovative purchases. Companies are involved in developing innovations related to a certain entity. This has been the case with Oulubot. The objective of the project cooperation is clearly to create local and regional companionships for the development of AI innovations. Operations made in this way are practicable because cities do not themselves necessarily possess the capacity to produce AI innovations.

Personal networking

Finns build trust in personal relationships, and AI innovation is no exception. The interviewees emphasized how personal relationships are more important than organizational partnerships, especially in a small country in which weather conditions encourage mutual support. At the centre of regional ecosystems is a culture of personal relations built on trust and learning from practice. Although not often articulated, as an interviewee from Tampere said, "[W]ithout personal relationships, there would be no innovation".

Discussion and conclusions

Envisioning AI as a general-purpose technology (Freeman 1991) appears justified given the breadth of applications shown in Table 5.1, with evidence for many found in the case study. This justifies capability-based classifications of AI (Dwivedi et al. 2019), perhaps especially so since we found little evidence of AI experts searching for singularity (Kurzweil 2005) and instead adopting a problem-centric approach to using AI. Our case supports the claim that the IoT will be central to AI innovation, providing appropriate 5G and Bluetooth is available (an issue for remote and rural areas; Kankanhalli et al. 2019). We see this in health apps, health data signalling, transport and logistic integration, and IoT use in technologically assisted independent living. Apart from these areas, an initial wave of AI innovation

is targeting cost reductions (including accelerating and enhancing digital accuracy; Kuziemski & Misuraca 2020). There is no evidence at this stage of radical or transformative AI innovations in the Finnish public sector, though these may come especially as city-regions develop their AI capacity.

Our research question refers to AI altering governance arrangements and mutuality in the innovation process. While trust appears high among innovation stakeholders, a degree of mistrust or wariness about AI exists among some users and service providers. Our study confirms that social and community acceptance of innovative public service change is important in Finland (Laitinen et al. 2018b). This is especially so in services-as-a-system, where introducing AI at any point affects the entire service system. Finnish local government and public services are close to citizens (the average local government unit covers 16,000 citizens who pay high taxes; Finns expect high-quality public services; Laitinen et al. 2018a). There is no evidence from our interviews of AI acting as the *invention of a method of invention* (Griliches 1957). As machine learning expands, this may yet occur. Our view is that radical innovations are likely to involve the IoT and robotics (including surgery, home care, delivery, and autonomous vehicles). The view that deep technological change is always accompanied by hierarchic restructuring and power shifts (Cath 2018) is confirmed by our study in the sense that unpreparedness for these organizational changes may be one reason why more radical innovations have not yet been attempted.

There are exceptional elements in the Finnish case, such as the large number of AI programmers working in consultancy or starting SMEs – a consequence of Nokia's downsizing. Also, Finland's close connections with US venture capital mean there is no shortage of risk capital for profitable ventures. The cases mention Finland's technophilic culture, work-based learning in schools and universities, and the importance of personal relationships based on trust and mutual dependency.

We found little danger of technology-push (Leslie 2020), in that all innovation teams to some degree were problem-centred and sought user feedback. We found evidence of psychological-level (*meaningfulness*) mutuality in the innovation teams of the sort portrayed by Yeoman (2019). Deeper mutuality (Koskimies & Kinder 2021), meaning clearly retaining boundaries between the market and social governance, was less clear. In some projects, public databases were used as a test bed for private-sector product launches, clear examples of market incursions into what had been public domains. However, the interviewees appeared sanguine about these results, perhaps feeling that in other fields of activity (independent living, health signalling, transport) the public–private boundary had shifted towards the public sector. Importantly, mutuality can be interpreted in Yeoman's psychology fashion or from an economic (market-social) perspective. In the case of Finland, neither interpretation posed difficulties for interviewees in the two cities cited.

The city-based AI-enabled innovation development teams in the Cities of Oulu and Tampere take ethics seriously. They all experienced useful and two-way learning from service walk-throughs by users. The close involvement of providers and users provided the AI experts with a clear grasp of the context and culture (*institutional assemblage*; Best 2018) in which the new service would operate. Also,

black-boxing was avoided as the users understood design decisions, building trust among team members. This is especially important when evaluating risks attached to AI projects operating with vulnerable people (Flemig et al. 2016). If AI projects are to be conceptualized as a race between technology and education as Goldin and Katz (2008) propose, it seems fair to suggest that in these cases, education won.

Although research literature catalogues both the positive and negative outcomes of AI use in public services (Eubanks 2017; Kinder et al. 2021), our evidence finds few negatives. We had an indirect report of elders wary that AI might result in fewer face-to-face visits and some concerns that staff training fell behind new system needs. Overall, however, our interviewees reported positive impacts from AI. Perhaps a study more directly and deeply engaged with service users may produce different results. We found that the cities' top policymakers played an important role in instigating and filtering AI projects. It may be that their mediation reduced those AI projects likely to cause a negative impact. Finland is currently building its AI innovation capacity, and from our evidence, it is doing so without negatively impacting individual citizens or communities.

To directly address our research question: *Is AI altering mutuality governance in innovations between the private and public sectors?* We did not study the mutuality governance using technologies other than AI or indeed innovations not using any new technology. All the projects we investigated are PPPs. They differ from some other innovation projects in that user, provider, and AI expert involvement at *every* design stage proved essential, and the amount of learning from users by the technical experts proved profoundly important. Only this high degree of psychological mutuality avoided black-boxing since "inside" the algorithms and databases, linkages remain technically specialist despite the high level of effort put into understandability. Each project was problem-centric, addressing sub-system issues rather than a holistic new system, and this limited ambition enabled success: if AI becomes a technology looking for a problem rather than AI helping to provide a solution, then the success rate is likely to reduce.

The projects aim to brand ethical AI service products seeking internationalization. We note that since each new target use of the technology is likely to have a quite different context and culture from Finnish cities, additional serious learning will be required by AI experts to support product internationalization. We also note that Finland has unitary local authorities – for example, cities provide health and social care – so such contiguous service boundaries may not apply elsewhere and may introduce different governance issues. Recontextualization of the Finnish experience can only occur with a similar commitment to understandability and mutuality. Off-the-shelf AI solutions may work, or they may introduce unfairness and bias.

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6 Data-driven value creation in digitalizing public service

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Introduction

Innovation can be a new practice, an idea, a service delivery, or a technology that can lead to value; public innovation is about innovation in the public-sector context (Bertot et al. 2016). Innovation in the public sector is essential for the enhancement of public performance (Gieske et al. 2019). Incremental innovation leads to great performance benefits, and moving away from the norm to adopt different innovation (types) positively impacts performance (Damanpour et al. 2009). According to Meijer and Thaens (2020), society is being modified at a high rate, and governments are expected to be agile and flexible in addressing the changes with regard to technology, social environments, and citizen demands. It is understood from the aforementioned that public innovation can have performance benefits, a positive impact on society, but requires public-sector organizations to embrace innovation to address changing citizen needs.

The presence of digital platforms changes the way in which digital products and services are being consumed, and these platforms utilize autonomous agents to co-create value (Hein et al. 2020). For instance, digitization has a transformative effect on the degree of openness in innovation and entrepreneurship with regard to who can participate (e.g., actors or stakeholders), what the actors can contribute (e.g., resources/inputs), how the actors can contribute (e.g., processes), and what outcomes are generated (Nambisan et al. 2019). The authors also point to examples of companies like Fitbit Care and Garmin Connect that provide data analysis capabilities to consumers through a digital platform arrangement and that generative actions by third-party developers in a digital platform architecture can lead to innovation. As Zutshi and Grilo (2019) point out, digital platforms function by offering open data and application programming interfaces (APIs) to third-party developers to develop new services, and digital platforms serve to unlock business opportunities and create business ecosystems that facilitate value creation. Digital platforms play a vital role in innovation. For instance, in US manufacturing firms, a 10 per cent increase in IT input was associated with a 1.7 per cent increase in innovation output between 1987 and 1997 (Kleis et al. 2012). Digital platforms help nurture innovation in firms in key activities such as customer relationships, manufacturing, and procurement (Sambamurthy et al. 2003). From the previous arguments, it is evident that digital platforms play an

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important role and trigger innovation-related activities by involving partnerships, technology, and processes.

Moving on from innovation and digital platforms, data is seen as an important resource in organizations. To create value from data, organizations also need to possess data analytics capabilities. For instance, data analytics capabilities have been shown to improve firm performance (Akter et al. 2016; Wamba et al. 2017) and the innovative capabilities of the firm (Ashrafi et al. 2019). A review of empirical studies shows that data analytics capabilities lead to improved business performance, strategy development, decision-making, and innovation (Madhala et al. 2021).

Chesbrough et al. (2018) define value creation as an actor's endeavour to increase value, which is a resource deployment process where the perceived benefits outweigh the perceived sacrifices. Therefore, in this chapter, value is viewed as an end goal based on the interactions between several actors or stakeholders. The actors engage with each other in a digital platform arrangement for public innovation. To provide an understanding of the previous statement, a theoretical framework or conceptual model is introduced which encourages public innovation by looking at two important components – namely, data and data analytics capabilities. These two components trigger public innovation as a result of actor or stakeholder engagement. The two components are chosen because of their potential to create value for organizations. The chapter presents the theoretical explanations of public innovation, data and data analytics, and value creation. The chapter also shows the conceptual model of the public innovation process in a digital platform arrangement with an example case.

Many faces of public innovation

It is first necessary to define what the term "public innovation" or "public-sector innovation" means. Public-sector innovation can be defined as a dynamic process (micro and macro) by which several actors in the public sector and their processes are transformed by the introduction of a novel idea (Potts & Kastelle 2010). Innovation in the public sector is about finding new methods to enhance society, government, and the public (Janssen et al. 2017). According to Arrona et al. (2020), innovation in the public sector differs from innovation in the private sector because public-sector innovation is context-specific and aims at creating public value. Economic benefits are not so important for public innovation, in contrast to private innovation (Fuglsang & Pedersen 2011). Bekkers et al. (2011) describe innovation in the public sector as a learning process in which the government attempts to address certain societal challenges.

Windrum (2008) classifies public-sector innovation into six types – namely, service innovation, where a new service product or its improvement is introduced; service delivery innovation, which involves different ways of delivering to or communicating with clients; administrative and organizational innovation, which deals with organizational structures and routines with regard to services; conceptual innovation, which is about bringing or developing new concepts or trying to alter existing service products or processes; policy innovation, which deals with

behaviours associated with a policy belief system; and systemic innovation, which is about ways of interacting with other organizations and public bodies associated with the organization.

Some of the factors that influence the public-sector innovation process include the role of governance in moulding innovation, source of ideas for innovation, innovation culture, capabilities and tools required for managers to facilitate innovation, objectives, outcomes, drivers, and hindrances (Arundel et al. 2019). Several drivers have been identified as having an impact on innovation. Agolla and Lill (2013) identify internal drivers (strategy, climate, leadership, entrepreneurship, resources) and external drivers (political, economic, social, technological, ecological, legal) for public innovation to take place. Public innovation is driven by external parties (e.g., enterprises and citizens) combined with internal processes (Janssen et al. 2017).

Four levels of the innovation process in organizations in the public-sector domain are identified: (1) introducing innovation into the overall strategy, (2) management's role in promoting innovation, (3) structuring or aligning innovation processes, and (4) organizational competencies (Bloch 2011; Cepilovs et al. 2013). There are also barriers to innovation. According to Bloch (2011), barriers to innovation can spring up due to many factors, such as political factors (e.g., lack of funding, lack of impetus for an organization to be innovative, stringent laws and regulations), organization and culture (e.g., possibility of failure, absence of cooperation within the organization), internal conditions (e.g., scarce/poor allocation of time for innovation activities, lack of reasons for staff to innovate), external conditions (e.g., rules of the contract hinder any collaboration with stakeholders or suppliers, fixated on suppliers who lack innovative capabilities, user resistance to changes).

Four different types of antecedents were found by De Vries et al. (2016) – namely, environmental antecedents (e.g., public demands), organizational antecedents (e.g., incentives/rewards, conflicts, leadership styles), innovation characteristics (e.g., ease in use of innovation, compatibility), and individual antecedents (e.g., organizational position, creativity, knowledge, and skills related to the job). Empirically, the authors found effectiveness (28 per cent), increased effectiveness (27 per cent), decreased effectiveness (1 per cent), increased efficiency (10 per cent), private partners' involvement (6 per cent), customer involvement (5 per cent), increased customer satisfaction (5 per cent), other (safety, fairness, etc., 6 per cent) as possible outcomes of public-sector innovation. In their study, Vigoda-Gadot et al. (2008) provide a theoretical model of the antecedents (responsiveness, organizational politics, professionalism, leadership and vision, ethics and morality) and outcomes (trust in governance, public-sector image, citizens' satisfaction) of public-sector innovation.

Data-driven value creation

Data plays a central role across many sectors and has become a form of capital for many industries – namely, manufacturing, finance, infrastructure, technology, and energy (Sadowski 2019). It is an objective fact about events (e.g., purchase

transactions; Davenport & Prusak 2000). Over the years, the size of data has increased tremendously and is often termed "big data". When the dataset sizes become bigger it becomes difficult to handle them using traditional database software tools for capturing, storing, and analyzing (Manyika et al. 2011). This occurrence of the massive size of data is due to the widespread use of social media (e.g., YouTube, Facebook, Twitter), applications resulting from the "internet of things" (IoT; Fosso Wamba et al. 2015), clickstream data from the web, location data from mobile devices, and data from RFID chips and sensors (Davenport 2012).

All of the data that is collected is analyzed to find answers hidden inside the data. According to Guerrero (2010), data analysis is performed to answer one significant question: "What does the data reveal about the underlying system or process from which the data is collected?" In scientific research, data analysis is used for evaluating or finding evidence in data (Hicks & Peng 2019). Analysis of data is necessary, and according to Liew (2007), data leads to information and knowledge. Over the years, data analysis has been used as a significant tool for business. Data analysis is a key component in the process of mining business data (Bose & Mahapatra 2001) and is a useful tool in creating business value by assessing hotel performance from online consumer reviews, for instance (Xie et al. 2014).

The firms that aim to improve their performance using data analytics must also possess data analytics competencies or data analytics capabilities. Data analytics competency can be defined as the ability to deploy data analytics–based resources in combination with other firm resources and capabilities for enhanced and quicker decision-making (Ghasemaghaei et al. 2018). On the other hand, big data analytics capability is the ability of an organization to make use of data in combination with IT and human assets to create a competitive advantage (Garmaki et al. 2016). In other words, a firm can group and deploy its big data resources (Gupta & George 2016). According to LaValle et al. (2010), there are three levels of data analytics capabilities (and these levels follow a linear path with regard to functionality): aspirational, experienced, and transformed.

Value creation is examined from two perspectives – namely, value-in-use (subjective conceptualization of value) and value-in-exchange (objective conceptualization of value) (Eggert et al. 2018). For instance, value-in-use is related to the qualities of the product or service and is subjective in nature, and value-in-exchange is the price paid for the product or service. The product has both types of value at the time of sale (Bowman & Ambrosini 2000). Chesbrough et al. (2018) define value creation as an actor's attempt to increase value through the two aforementioned perspectives. In the value-in-use perspective, the authors define value creation as the effective use of resources to achieve a certain goal, and in the value-in-exchange perspective, value creation is defined as providing resources to a partner who values the resources based on potential later use.

According to Kristensson (2019), value creation specifies how actors (e.g., consumers, business customers, citizens, and patients) benefit by using one or more combinations of resource offerings. Individuals, organizations, and society act as a source of value creation (Lepak et al. 2007). These different actors form relationships in which capabilities are joined to co-create value. What the end customer perceives as valuable defines what kinds of capabilities are needed in creating the

value (Helander & Kukko 2009). As Brandenburger and Stuart (1996) point out, value creation stems from the "willingness to pay" of the buyer, i.e., the end customer, and the "opportunity cost" of the supplier. Value creation depends on the context in which value is discussed. For instance, Sweeney and Soutar (2001) identify three dimensions in the context of consumer value: emotional, social, and functional. These value dimensions further lead to value creation (Suseno et al. 2018). Value creation is also important in the public sphere, where public value is the key factor in the development of new public services, for example, on-demand government services (Chatfield & Reddick 2018) and prediction of food safety (McBride et al. 2019). Digital innovation ecosystems enable the creation of value through the development of new products and services (Suseno et al. 2018). Therefore, different sources of value creation enable the creation of different types of value.

Public innovation process in digital platform

The public innovation process under a digital platform arrangement is shown in Figure 6.1. The new process begins with the identification of data-driven digital technologies. The term "data-driven digital technology" refers to technology applications that collect data from external objects or processes. These include barcode technology, contact memory buttons, RFID, smart labels, GPS, laser scanners, webcams, and portable computers (Caldas et al. 2017). RFID and IoT are two digital technologies that can be grouped into a data collection architectural layer (Pagoropoulos et al. 2017). Therefore, several digital technologies like the ones previously mentioned enable the collection of data in the digital platform. In this regard, this study considers all types of applications that enable the capture of data to be data-driven digital technologies.

Upon identifying the data-driven digital technologies, it is important to look at the framework from the perspective of the resource-based view introduced by Barney (1991). Due to the continuous flow of data from data-driven digital technologies, it is vital to recognize data as an important resource and valuable ingredient in the process of value creation. Data from digital technologies will be used as input for the creation of value for the stakeholders involved in the digital platform arrangement.

As understood in the literature, data analysis is used for finding information hidden within the data. The data analytics process is vital to the transformation of raw data into meaningful information. However, this also raises the question: How does the data owner transform raw data into value? In a digital platform consisting of many stakeholders, there is a need to identify the capabilities of each stakeholder involved in the process of public innovation. After identifying who has what capabilities, it is vital to discuss the potential for stakeholder agreement on providing capabilities to other partners in the digital platform to enable the process of value creation. The stakeholder connection in a digital platform in the context of public innovation is illustrated in Figure 6.1.

The example shown in Figure 6.1. is of an arrangement where there are many stakeholders. In a real-world scenario, the number of stakeholders is not limited,

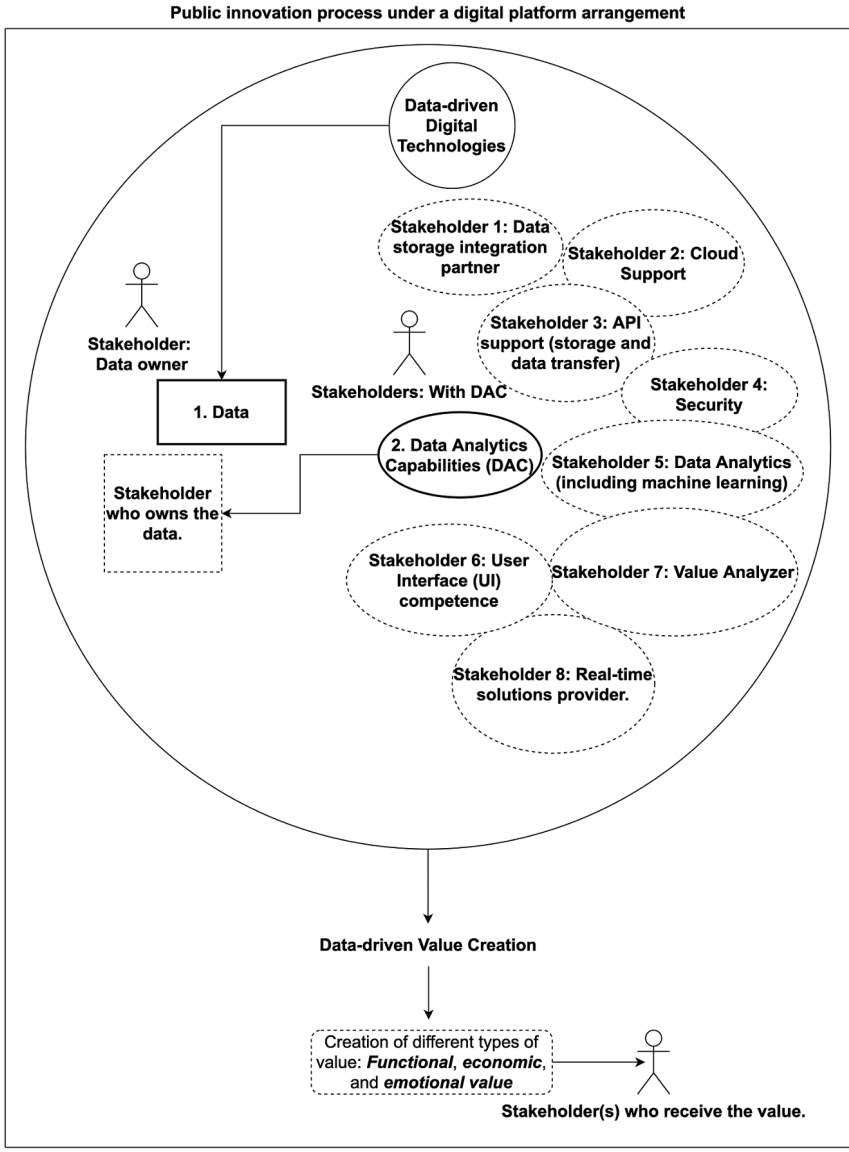

Figure 6.1 Public innovation process under a digital platform arrangement.

i.e., it can be n number of stakeholders. Referring to Figure 6.1, the stakeholder (data owner) has the capabilities (which may also include infrastructure) to collect data and the other stakeholders in the digital platform arrangement have data analytics capabilities. Another way to look at this is that, for instance, the data owner and other stakeholders (on the right side of Figure 6.1) have capabilities that are of mutual significant importance. The solution providers (cluster of n number of stakeholders) provide the data owner with data analytics capabilities. The result is

that a service or a product is created that serves as a valuable offering for citizens, the municipality, and the school, who are important stakeholders in the public innovation process.

The framework proposed in this study highlights three different aspects of the process of public innovation. First, the recognition of data as an important resource. Second, the emphasis on data analytics capabilities in the digital platform arrangement. Third, value creation is the consequence of the first two factors. As mentioned before, there can be room for more stakeholders who can act as sources of data and others who can provide data analytics capabilities. Finally, value creation is not considered a unidirectional process, as there is also the presence of perceived value gained by stakeholders other than citizens. However, this claim should be evaluated based on empirical examination.

Data-driven value creation in practice

The 4APIs research and innovation project, funded by Business Finland,[1] brought together several actors, including universities, companies, the public sector, and funding organizations, to understand the role of APIs in value creation. As part of the project, a case prototype was developed, which incorporated the concepts of digitalization, digital platforms, public innovation, APIs, data analytics capabilities, and value creation. In this digital platform arrangement, the City of Turku[2] was able to leverage capabilities from several actors to enable the digitalization process to produce innovations that create value. In brief, the goal of the project was to accomplish the following:

1) Define techniques and competencies for creating APIs for systems that consist of numerous subsystems, where newly introduced IoT capabilities enable connectivity.
2) Pilot the techniques in the context of the participating companies and their existing technologies.
3) Experiment with innovation ecosystem creation using the defined APIs and potential business models in the context of the participating companies, possibly including customers.

The research was carried out in close cooperation with the participating companies, who also participated in the steering group of the project. Company use cases and needs also drove the technical prototypes and pilot ecosystem formation effort. In summary, new business may stem (items 2 & 3) from an improved understanding of digitalization as a whole (item 1).

As part of the project, it was decided to experiment with innovation ecosystem creation using real systems, provided by the participating companies. As part of this experiment, APIs were used to access key functions and objects that would be designed, tested, and evaluated, in the best case with potential customers or true early adapting end users. Concrete means would include industrial hackathons, interviews, and prototype implementations, which would also serve as starting points for ecosystem building with external

companies. Furthermore, the experiment would also serve as a criterion for selecting some of the project participants.

As the concrete case, the public building called Ypsilon was selected. The Ypsilon building is a community centre located in Yli-Maaria, Turku, Finland. The case was carried out by a large group of actors in order to achieve a true value co-creation process.

The Ypsilon building offers public spaces and connectivity – for instance, sensors that can be used to measure temperatures, relative humidity, in and out airflow in real time, and the number of people in a room. The public spaces include normal multipurpose classrooms; rooms for teaching handicrafts, sports, etc.; a public healthcare centre; and a library. Illustrated in Figure 6.2, this environment would support numerous roles for participants, including, for instance, building information management, document management, security-related operations, service management, and networking facilities for accessing the sensors. As a new urban building, numerous data sources contain different kinds of information about the Ypsilon Community Centre, its connection to other urban environments and infrastructures, and daily activities and maintenance in the building. In addition, the data from the sensors provided an opportunity for data-related operations.

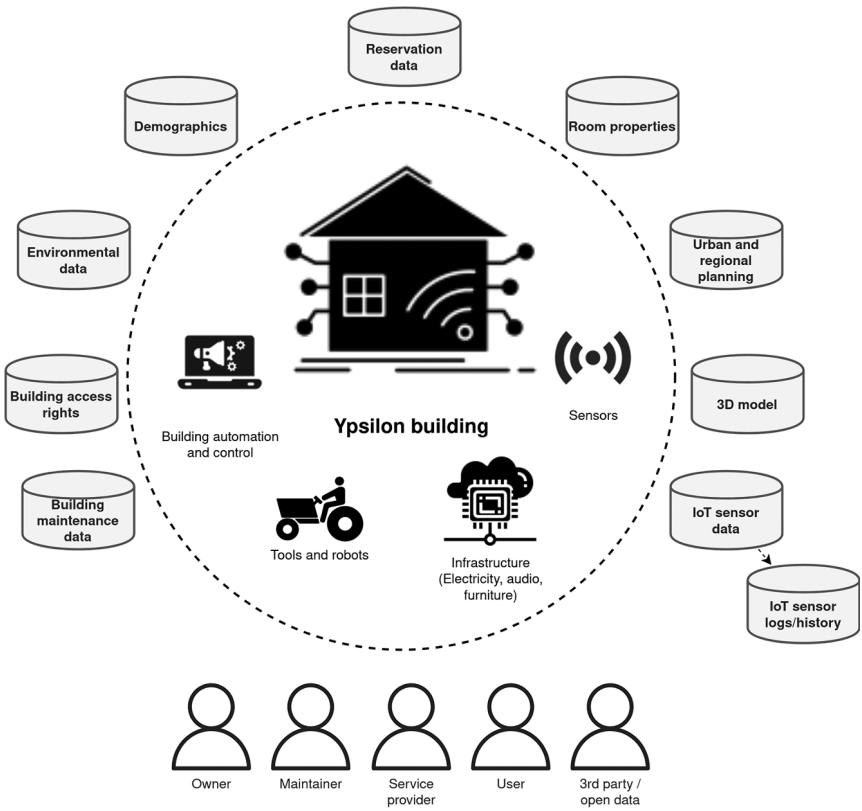

Figure 6.2 Domain model.

Figure 6.2 Domain model representing the Ypsilon building, its surrounding environments and infrastructure, daily activities, and related data. Within this environment, the majority of the planned participants were able to identify their roles and to combine their own knowledge and data processing capabilities.

Service design workshop and stakeholder interviews

To further study the value creation potential in the case, a service design workshop and stakeholder interviews were held. The service design workshop was organized in the Ypsilon building, especially for exploring the potential value propositions. The workshop included participants from the aforementioned project organizations and employees of the City of Turku responsible for infrastructure and was facilitated by an experienced service designer from Digia. In the workshop, the potential users of the envisioned service were first identified, which included housing co-operatives, societies, or clubs, groups of friends, and businesses. Moreover, various objectives were also identified, ranging from better services for citizens, optimizing the use of the Ypsilon building, and sustainability. Finally, different use cases were innovated and captured for the users and the objectives. In the workshop, use cases were primarily identified for access and use outside school hours. In addition, security and energy saving were other key themes covered by the use cases.

In order to elaborate on the potential value prospects, we conducted three stakeholder interviews using a semi-structured qualitative approach. The interview data was analyzed thematically to find categories of perceived value. All of the interviewees were potential users of the building information modelling (BIM) and data solution, covering roles from energy operations (from the City of Turku) to school management (school principal) and real estate services (at the Ypsilon building).

The general perception of possibilities from the interviewees was mainly very positive. We found this perception of potential value to be based mainly on the promises of efficacy, safety, and well-being. By "efficacy", we refer here to the precise allocation of scarce resources ranging from money, energy, and environment to space, time, and attention. Data combined with BIM holds a lot of promise as a tool for better understanding of very context-specific conditions, their variation over time, and anomalies that we might otherwise have difficulty perceiving. Possibilities, especially with real-time data, predictive modelling, and machine learning can enhance the excitement and the feeling of novel opportunities. One key aspect of efficacy would also be the integration of data from several, currently fragmented, information systems into one real-time API.

The themes of "safety" and "well-being" were raised especially in the context of a very special concern, even a public trauma of sorts, regarding some of our public spaces. Throughout recent decades there has been growing concern over the quality of indoor air, especially in schools. Being able to collect more precise and rich data on the environments in which children spend their days could have a reassuring function. When data indicates problems in conditions, especially

problems that are difficult for human senses to perceive directly (e.g., related to correct humidity levels), proper actions can be taken in time. Another given concrete example relates to acute crisis situations, e.g., a fire, when real-time data could be used to monitor the flow of people to get everyone safely out of the building.

Other potentially valuable functions included the use of BIM and data as pedagogical tools and as examples of smart tech relating to the very meaningful and tangible environment of everyday life for pupils and teachers alike. What holds promise here is the possibility of combining two types of information: First, the subjective and sensory information directly generated by embodied engagement, observation, and sensing the environment, combined with the objective and unobservable conditions provided by data and BIM. The subjective experience gives meaning to the environment and its changing conditions; this is then given complementary illumination from data on objective conditions such as temperature or humidity level. Together they show how the subjective and the objective relate and might differ, acting as cues from one modality of information to the other. By helping to perceive the effects of even minor adjustments and optimizations in conditions and behaviour alike, data and BIM could also be used to provoke awareness and positive behaviour change towards environmental goals, for example.

This combination of physical, tangible, and sensory information provided directly by the human body and the objective information provided by data is nicely mediated by BIM. The 3D model makes data-measured conditions easy to perceive, understand, and interpret in relation to the actual environment. This has been illustrated in Figure 6.3.

In the interviews, this was also brought up in the context of maintenance, where the solution could provide help when people were not physically present to perceive the environment (e.g., remotely and holistically grasping the conditions

Figure 6.3 A virtual reality illustration of the Ypsilon demo (BIM).

of the whole building quickly) or when physically present but now also being able to perceive and locate more objective data-informed conditions and their temporal variation (e.g., history, future predictions).

Technical implementation

The project resulted in a prototype application optimized for a mobile device for monitoring heating, ventilation, and air conditioning (HVAC), and person count. The architecture follows state-of-the-practice, micro-service architecture with REST APIs and JSON messages deployed in a Microsoft Azure cloud infrastructure, as depicted in Figure 6.4. The HVAC and other sensors in the Ypsilon building produce sensor data that is pushed to the microservices in the cloud, i.e., storage that divides the data stream into a hot path and a cold path, meaning almost real-time access to data and storing data for later usage, respectively. Another essential source of data was the more static 3D BIM of Ypsilon that enabled viewing of different rooms, the locations of sensors, and other information about the building.

The resulting application based on the hot path shows the user a browsable 3D model that is augmented with almost real-time sensor data from the cold path. The user can see both the BIM model and sensor data, separately or combined.

The data from HVAC sensors in the cold path along with BIM information is used for advanced analytics purposes for the prediction of temperature and CO_2, beyond simply displaying different sources of information (depicted on the left of Figure 6.4). The analytics rely on machine learning (ML) and its typical processes: exploring different ML models and their options, resulting in selecting boosted regression trees, teaching the selected ML models, and deploying the model to provide the user with analytics information.

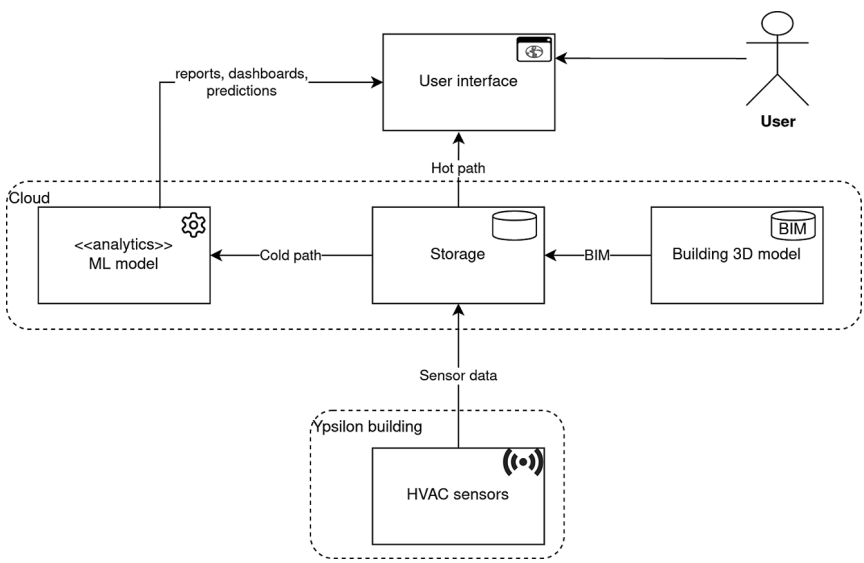

Figure 6.4 Technical architecture.

Figure 6.4 shows the technical architecture of the prototype created for real-time building monitoring. Several stakeholders were involved in this technical implementation.

Table 6.1 expresses the multiple roles of the stakeholders in the project.

Figure 6.5 shows the process of value creation and the various stakeholders involved in the project.

As far as the types of value created by data in the Ypsilon case are concerned, there were signs of functional, economic, and emotional elements of value. However, as the building is owned and operated by a municipality, there were no direct monetary incentives apart from a desire for more efficient use of buildings.

Table 6.1 The roles of the stakeholders in the project

Stakeholder	*The Role of the Stakeholder*
Digia[3]	Digia is a Finnish information communication technology (ICT) consultant, which played a lead role in setting up a cloud computing environment where various services, provided by the different actors, could be easily integrated. In addition, they were, in general, in charge of technology selection.
F-Secure[4]	F-Secure, one of the leading security companies globally, provided new technology for monitoring API usage which can recognize possible deviations from usual operations.
HH Partners[5]	HH Partners is a law firm based in Helsinki, Finland, that serves business customers in most areas of law, including in particular intellectual property rights and technology law. They provided legal support for determining privacy and copyright issues.
M-Files[6]	M-Files is a Finnish software product company whose key offering is M-Files intelligent information management platform. In the demo, they provided document management software for archiving and sharing purposes.
Solita[7]	Solita, a Finnish ICT consultant company, creates impact that lasts by combining tech, data, and human insight. The Ypsilon case was brought by Solita, and Solita had a role in integrating and aggregating the data sources.
Vaadin[8]	Vaadin offers an open-source platform that makes API usage easier. The Vaadin platform handles data transfers between several parts of the demo. The company also provided the user interface (UI) and technology related to UI.
Vertex[9]	Vertex Systems has its own CAD software together with a visualization (Vertex Showroom) and their role was to create and visualize the 3D BIM models that enable visualization of temperatures and relative humidity in real time.
University of Helsinki[10]	University of Helsinki, Department of Computer Science assumed the lead in data operations involving ML and in-service access at an architectural level. In addition, it participated in implementation-related tasks.
Tampere University[11]	Tampere University, Unit of Information and Knowledge Management was responsible for analyzing the value creation potential in the demo.

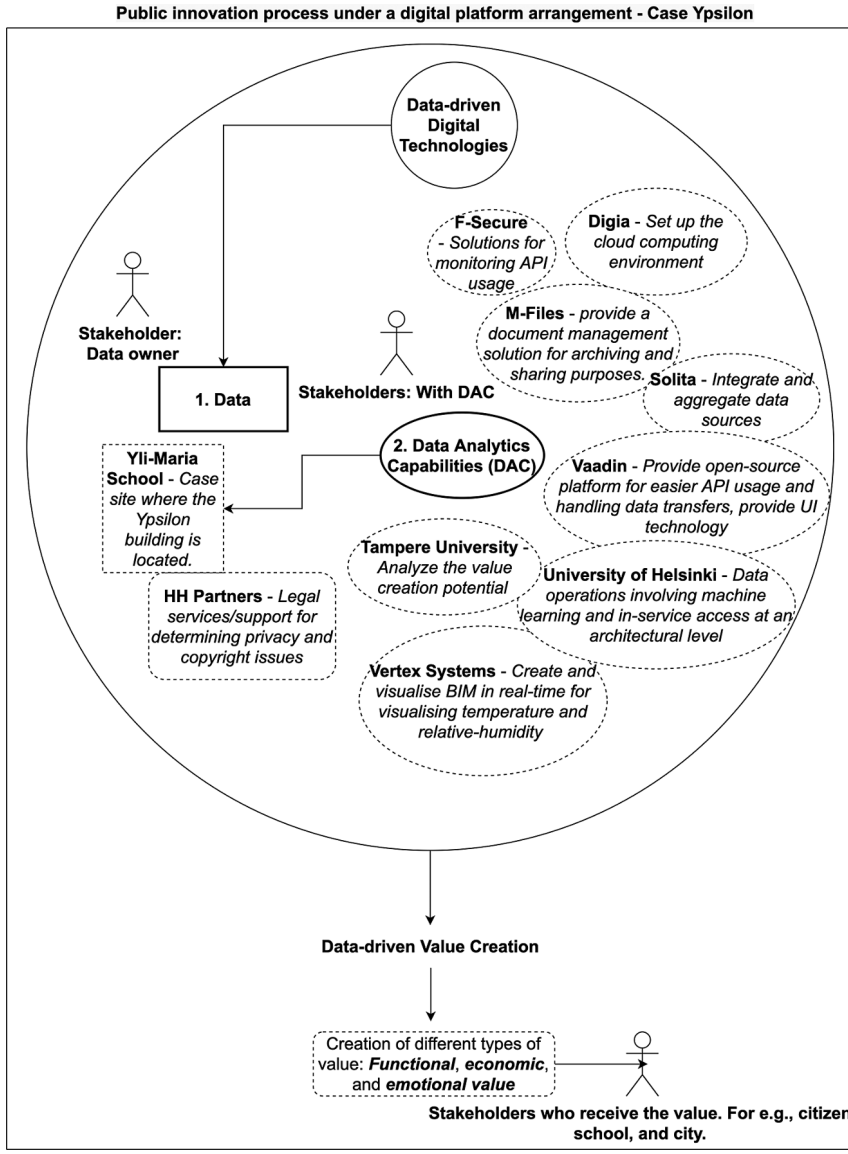

Figure 6.5 Value creation process involving different stakeholders.

In other words, functional value gains had a more central role than direct economic value gains. Sustainability is also nowadays a key concern, ranging from simple energy saving to the broader societal context of avoiding long journeys, and facilitating the use of public transport, bicycles, and walking. Moreover, it is desirable for efficacy and sustainability if the same building can be used efficiently for different purposes rather than constructing and maintaining many buildings. For example, a school occupies a building only for a limited time of day and year while

the building remains empty most of the time. In terms of emotional value, the interviews were able to show that many emotional elements are also involved. However, many of the elements raise the question of conflicting values and legal restrictions on surveillance and privacy. For example, the identified value conflicts concerning digital services built on top of the application infrastructure were related to security, safety, and privacy. To enhance security and safety, data about the presence of people, especially children, in the building could not be disclosed to the public in real time. Disclosing full data even in a delayed manner was not feasible as outsiders would be able to predict the presence and activities of children and other people. Privacy is related to data about people in the building. For example, although personal information cannot be interpreted from data directly, teachers tend to have their own specific classrooms; combining the information on which rooms teachers use with information about when there are people in the room could reveal when a specific teacher is in the room, thus violating the teacher's privacy.

Although we mentioned economic value as an outcome of the digital platform arrangement of stakeholders, this is only on the surface and through the perceptions of the interviewees. This is a limitation as we did not attempt to uncover the detailed aspects of how economic value is created in the context of public-sector innovation. Even though it is the municipality that owns the building and hosts the services, this provides an opportunity to understand the operational elements and support business opportunities for sustainable buildings. These complementary services have business potential, which can be understood through the lens of business models and at an ecosystem level.

The innovation potential of the public sector organizations is evident from the present case. The City of Turku has established an innovative culture by creating different types of value through this arrangement. Since the digital platform arrangement has many stakeholders, more empirical data to identify what is valuable for different ecosystem actors is needed.

Based on the Ypsilon case, we can state that it is vital to make the value potential as concrete and visible as possible. Naturally, this is not easy when speaking of data because data as such is not information; it does not inherently lead to understanding, let alone require actions. In fact, it rarely does. This is something we know about our cost from encountering organizations that equate more data with better decisions. Interpretation can be tricky. Easy-to-grasp communication, intuitive visualization, and contextualization of data are usually important factors. "No one is interested in my Excels! … But when I have nice visualizations to show…," in the words of one interviewee.

This need for easy interpretation holds especially true for multipurpose premises with modifiable spaces like the Ypsilon building. Data on Ypsilon (and similar sites) has a broad spectrum of potential user groups, ranging from building maintenance and its partners to energy authorities and more site-specific user groups like service coordinators, teachers, pupils, and local residents. Therefore, we need to help different users to read, contextualize, and understand the data, as "with new data, there's always the possibility of misinterpretation" (as stated by the aforementioned interviewee). Yet even this is not enough. Even after data turns into

understanding, understanding still needs to be turned into action. For this, we need to consider the organizational drivers of action and work to incentivize and structurally motivate people's behaviour. Otherwise, the possibilities for efficacy, safety, and well-being will remain only latent.

The value categories such as functional, emotional, and economic are evident from the case. However, these categories should not be considered as absolute (in reality) value categories concerning public innovation. Even though it is not explicitly stated, the City of Turku is expressing a symbolic or even social value among its category of schools. The innovative culture established by the municipality through innovation can also be seen as social status and establishing a sense of identity and standing out among other municipalities regionally or nationally, the City of Turku's way of branding itself.

Discussion and conclusions

The world is constantly being filled with new innovations that embody little to no understanding of the very people that the product or service is built for. They fail fast. It is common knowledge that most new products do not make it through their first year on the market. Some thought has probably been given to the "users" of the product or service, but too often only in the form of unvalidated hypotheses conjured out of thin air, or by reflecting the needs and assumptions of the team building the product, and then projecting those assumptions onto the market. Challenges are also introduced when insight into users is formed only by looking at people from afar, through spreadsheets and quantitative abstractions that lack a tangible understanding of what really drives potential users and their perception of value.

The first question of any innovation work should be: how does this product or service of ours relate to and produce anything of value for people and society? What kind of needs does it answer? What kind of human and cultural practices, functions, and meaning should it be part of? What actual problems might it solve for actual people and how? How does our product make life better? Suffice to say, this was something we also needed to think hard about during the 4APIs project and in the Ypsilon case. As such, our BIM and data may be of no value. They will become valuable only through performing functions and holding meaning perceived to be valuable by people and institutions. Can they make life better? For whom? How? How do they create value and for whom?

In this case, there are no business reasons to restrict access to data. However, allowing access should neither cause harm nor extra data maintenance effort. Access to data is also limited by the practical concern that digital services and data management are not among the core competencies or duties of municipalities. Therefore, while a lot of data exists, it is not necessarily in a convenient form and accessible through APIs even if the data is publicly available. In addition, there are other challenges such as evolution and data ownership that, however, appear to be quite general, not case-specific (Joutsenlahti et al. 2021). This also brings our attention to the topic of data ownership. As it is evident that data is a vital resource in creating value, the question concerning who owns the data is no trivial matter.

Does it belong to the public or the private sector? The case outlines this aspect clearly where the public sector owns the data about the citizens and the digital platform arrangement brings in the private sector to create the value. Similarly, should the resource that is gathered via the use of the building be given back for public usage? These are some of the issues that must be addressed more. In conclusion, this case was able to reveal or confirm previous ideas already presented in the literature and, additionally, to present some big questions that merit further investigation.

Notes

1 https://www.businessfinland.fi/en
2 https://www.turku.fi/
3 https://digia.com/
4 https://www.f-secure.com/fi
5 https://www.hhpartners.fi/fi/
6 https://www.m-files.com/
7 https://www.solita.fi/
8 https://vaadin.com/
9 https://vertex.fi/
10 https://www.helsinki.fi/fi
11 https://www.tuni.fi/fi

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7 Big data visualizations for systems thinking in public innovation

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Introduction

In current high-technology business-oriented environments with multiple stakeholders and multifaceted information and knowledge, managing and governing projects has become an increasingly complicated task (Kerzner 2017). In this sense, viewing modern projects as complex systems, where innovation, creativity, and unpredictable emergent properties evolve over the project course lends itself to a systems thinking approach to be adopted for managing projects. Projects can be regarded as examples of complex systems (Curlee & Gordon 2010; Skyttner 2001; Jaafari 2003; Shenhar & Dvir 2007; Aritua et al. 2009; Morris 2013a; Morris 2013b; Van der Hoorn 2016). Systems thinking approaches can provide unique advantages in framing and solving problems from diverse perspectives and relationships (Sankaran et al. 2010; Williams & Hummelbrunner 2010; Locatelli et al. 2014). In line with a systems thinking approach, a new "rethinking" paradigm within project management advocates a holistic rather than reductionist approach for project management (Kapsali 2011; Svejvig & Andersen 2015; Daniel & Daniel 2018).

Systems thinking is not new to project management with a recent report from the Association for Project Management (APM 2018) highlighting that project managers do use some form of systems thinking at least half of the time. However, they note that systems thinking tools are not widely used and their application is not well understood. Systems thinking, or thinking systemically, considers three main concepts related to a system: interrelationships of elements, taking different perspectives, and considering the system's boundaries (Williams & Hummelbrunner 2010). Systems thinking is a way for managers to take a holistic approach towards the world and to make sense of it based on interactions of different systems' elements rather than just describing the world within narrow boundaries. Jackson (2003) calls this type of project management "applied system thinking". It is often contrasted with linear thinking, which takes a reductionist approach and focuses on components rather than on their relations (Monat & Gannon 2015).

Within the category of computer-based tools, one of the possible solutions to the design and development of a tool that will help to reduce cognitive workload and to tackle the complexity of project realization is project data visualization.

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The benefits of visualizing data have been discussed by different researchers: Larkin and Simon (1987), Tufte (1990), Azzam et al. (2013). Data visualization can be a useful tool which can help to bring the project management rethinking agenda into practice because data visualization will enhance systems thinking due to its ability to reduce cognitive load and will help to adopt a holistic approach towards project management. A better fit between a tailored visual representation and the project task reduces the time required to complete the task (Teets et al. 2010; Basole et al. 2016; Killen 2017). Any project accumulates large amounts of data, either in digital or another form, qualitative or quantitative, and different types of data can be considered for visualizations. Studies on the effects of visualizations on better project information comprehension and effective decision-making are relatively new, and this area needs further exploration (Warglien & Jacobides 2010; Basole et al. 2016; Killen 2017). Digital technology provides an opportunity to process big data and to present it to project managers in a meaningful way (Williams et al. 2014; Whyte et al. 2016). For example, for engineering projects where multiple types of digital files are generated during a life cycle of a project, the files can be utilized in order to provide useful feedback to project managers via a dedicated dashboard. Such project behaviour feedback based on the project's digital footprint can be a useful tool for complex computer-aided, engineering-related projects (Aramo-Immonen et al. 2016; Hicks et al. 2016). Digital files generated during an engineering project can be treated as big data, which possess the potential to generate knowledge and to facilitate decision-making, along with the challenges of these data interpretations and visualizations (Cota et al. 2017). Given both the potential of data visualization and the emergence of techniques for real-time analysis of the digital footprint of engineering projects, we hypothesize that visualization of the digital footprint of a knowledge project can encourage greater systems thinking, and hence contribute to tackling the complexity of modern engineering and other socio-technical projects. In order to test this hypothesis, this chapter presents a combination of design science research (Collins et al. 2004; Spinuzzi 2005; Peffers et al. 2007) and action research (Chandler & Torbert 2003) applied to an engineering project in the public-sector higher education (HE) context in order to evaluate the digital footprint visualization tool for project management.

Big data visualization and systems thinking in practice

To understand the context of our research case of a student project at a UK HE institution, it is useful to appreciate the HE context in the United Kingdom. Currently, HE in England is directly funded, in part, by the UK government through the Office for Students and Research England. In 2020–2021, approximately 29 per cent of funding for English universities came from public-sector funding directly (with the remainder funded by student fees; Bolton 2021). University funding has shifted towards fees as the main source of funding. Previously, particularly before 2012, the public sector contributed a far greater proportion of HE funding. However, student fees are supported by student loans, and as Bolton (2021) noted, "[T]he ultimate cost to the public sector is currently thought to be around 54% of the face value of loans to full-time undergraduates".

HE can be seen as beneficial for society in many ways. Addie (2017) noted several ways specifically: as economic engines, improving the built environment of an area, recruiting internationally, building up networks, addressing societal challenges, fostering innovation, and finally that HE improves lives. Willetts (2015) maintained a number of societal, non-financial benefits of HE as a public service – namely, longer life expectancy, lower obesity rates, better health overall (both physical and mental), lower propensity to commit crime, and greater knowledge in society are just some of the benefits documented. Stiglitz (1999) noted many other benefits, including financial arguments for HE that provide justification of HE as a public service and good that creates benefit for society at large.

To test our hypothesis on the benefits and effects of digital footprint visualization in a public innovation, we have applied different research strategies at different research stages. First of all, we were interested in a utilization of the project footprint of the digital data for creating a project data visualization tool; then we applied the tool in real project settings and evaluated the intervention results with the help of analysis of interviews with the participants. The evaluation stage presented in this work addresses the effect of action research and features of the visualization dashboard from systems thinking enabling perspective. During the action research stage, a quasi-experimental design (Cook et al. 2002) was applied with semi-structured interviews as the data collection method (Rabionet 2011).

Project visualization tool

The project data visualization tool designed at this initial research stage was focused on understanding and utilizing the digital footprint generated by engineering project work, such as digital communications (e.g., email and social media), (e.g., reports, documents, and presentations) and design representations (e.g., computer-aided design (CAD) models) in the context of the Language of Collaborative Manufacturing (LOCM) project.[1] Using this low-level output data to provide student project managers from the university with dashboards supporting high-level insights into project changes and progress, we evaluated the effect of an information visualization tool on project progress understanding and knowledge discovery. The study was performed with a project team of the university engaged in the Formula Student (FS) competition (IMechE 2018). The FS is a yearly international competition where project teams of approximately 25 multidiscipline engineering university students design, manufacture, and race a single-seat racing car.

An FS team will generate approximately 8–9 terabytes of project-related data over the course of their project life cycle. In developing a dashboard tool, our aim was to develop automated analytic and information visualization approaches using this low-level output data to provide project managers with dashboards supporting high-level insights into project changes and progress. Ultimately, to support informed decision-making towards optimal performance and productivity. We adopted end user–participatory design while developing the digital footprint dashboard visualization tool for the mechanical engineering team.

The monitoring of the digital footprint was performed using a custom software tool that monitored the activity of the FS team's shared network drive

(https://www.npmjs.com/package/fal). Over the course of the project, 129,377 files were created, and 870,134 updates were made. This includes the creation, deletion, and modification of the files on the shared drive. The shared drive contains files pertaining to all activities of the project. The files were further classified by engineering activity defined by file type, with activities associated with engineering activities where software use is specific to an activity type (e.g., CAD files – Design), or to a general form of activity where software use may be for multiple purposes (e.g., documents, presentation slides – Documentation).

In addition to the shared drive, the social media communications of the team were also recorded. This was achieved by recording the public tweets and Facebook posts of the team and placing them in the context of all other FS national teams with the help of a Python script which ran weekly. The script extracted public tweets and marketing Facebook post from all UK-based FS teams. This enabled the communication patterns of the case study team be compared to other FS teams. A total of 1,342 public tweets and 20,070 Facebook status messages were captured for all teams during this project. From this initial exploration, nine broad data analytic metrics emerged (discussed further in Hicks et al. 2016), which could be leveraged to support the monitoring of project activities. Through a series of iterative user-centred design interviews, focus groups, and workshops with stakeholders and FS user groups, a suite of initial interactive information visualizations was designed and developed using Tableau software (Tableau 2018) for data visualization. Dashboard design requirements and principles were formulated based on users' needs and available data during participatory user-centred design sessions (Gulliksen et al. 2003; Maguire 2001; Spinuzzi 2005).

A final dashboard consisted of five data tabs, with one data visualization tab presented at a time via a web-based Tableau application. The tabs were presented in the following order: Raw Folder Activity, Activity, Activity Drill Down, Twitter, Facebook (see Figures 7.1–7.3). The users were able to navigate through the tabs at the bottom of the display in order to access different data analytics and visuals developed from the data on the project's digital footprint. The dashboard was presented on a laptop computer with a 27" touchscreen monitor during interviews with half of the project managers (Dashboard experimental group).

Data visualizations procedure and participants

Six project managers, all male, from one team took part in the final evaluation study. Each manager was responsible for managing different sub-teams across the project. Participants received £10 for each session they took part in. To test the effect of project digital footprint data visualizations, a quasi-experimental design was selected (Cook et al. 2002). The participants were not randomly assigned to the treatment conditions; instead, the dashboard visualizations were presented to the groups depending on the participants' availability and scheduling of their project subgroup meetings.

The aim of the quasi-experiment was to evaluate how the provision of the knowledge project management digital footprint visualization dashboard enhanced FS project managers' systems thinking applied to an interpretation of project

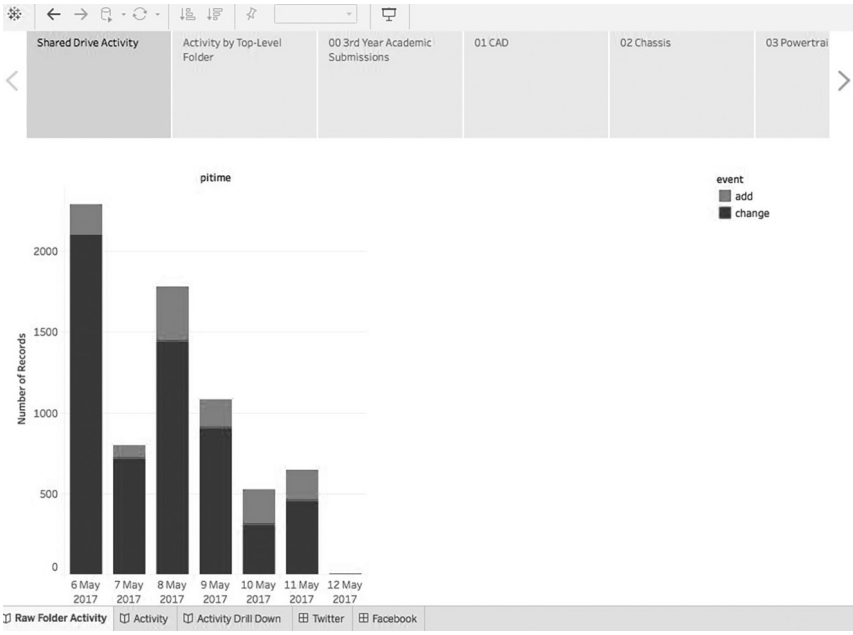

Figure 7.1 Total files added and changed on the shared x-drive by day.

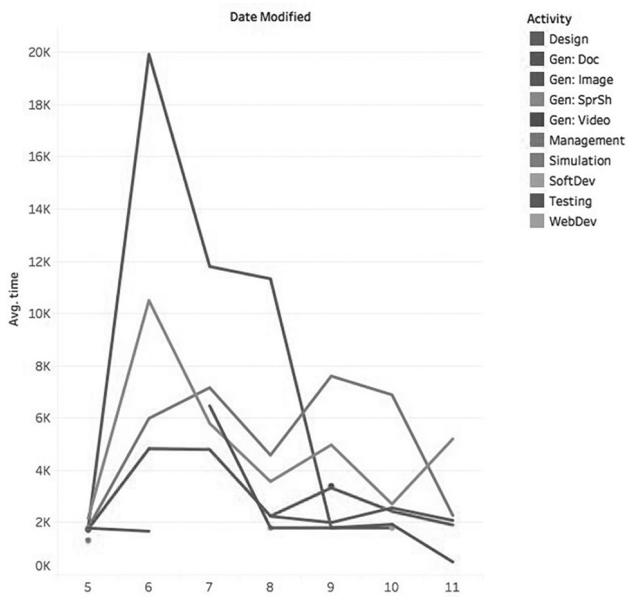

Figure 7.2 Type of activity by day: design, reports, images, video, management, simulation, software development, testing, web development.

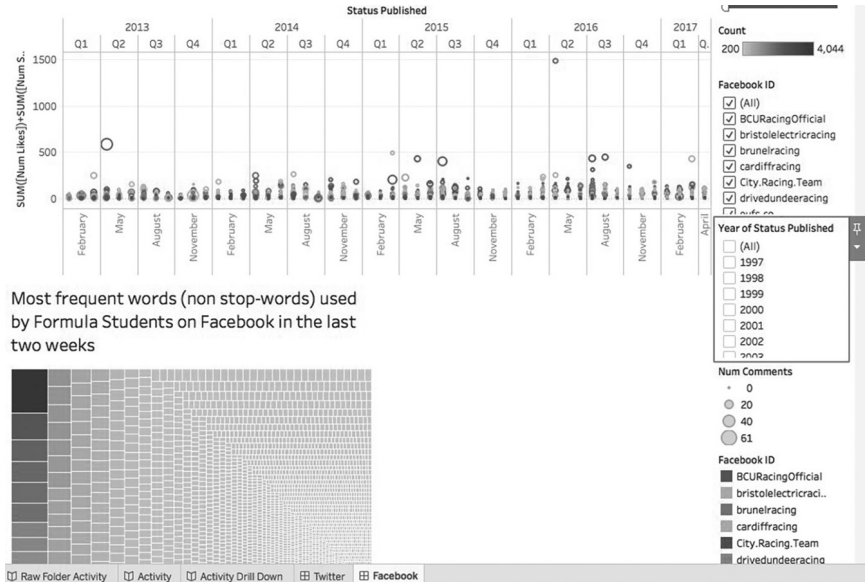

Figure 7.3 Facebook analytics dashboard: impact (likes and shares), engagement (comments) across 43 FS teams' posts, trending words/topics being used by FS in the last month.

activities and events. A visualization present vs. absent mixed design was employed where sometimes the same participants were treated with both conditions in the course of the study. The dashboard effect was tested with the help of semi-structured interviews (Rabionet 2011) with the six project managers. Managers took part in four evaluation sessions, which were part of project team meetings, one every two weeks over an eight-week period. Each session consisted of a semi-structured think-aloud task in which managers were asked to consider and verbally walk through their thought process around the project's progress and performance over the past two weeks. Experimenter prompts contained the project's main goal, activities, and issues encountered. An example of the interview prompts is: "What have been the main activities and goals you were working towards this week?"

As this type of project review activity was generally performed as a group within the team, half of the evaluation sessions were group sessions and were conducted with a maximum of four managers in the Dashboard Present group, and a maximum of two managers in the No Dashboard group. Across the four sessions, the Dashboard Present group had access to the developed dashboard and was encouraged to use and explore the data to help them reflect on project activities. Prior to the first session, this group was given a brief training session, walking them through what data and visualizations were available to them in the dashboard. Evaluated separately, the No Dashboard group did not have access to the dashboard and was asked to simply reflect on and discuss their project activities. Each session lasted between 20 and 45 minutes, with both groups' comments audio recorded, and the Dashboard Present group's interaction with the dashboard was video recorded using screen capture software.

Systems thinking evaluation framework

Given the elusive and abstract concept of systems thinking, there are multiple systems thinking definitions, frameworks, and tools described in extant literature. For example, Arnold and Wade (2015) propose a system test to define if systems thinking framework can pass a high-level systems definition test: the proposed elements for testing are "system's purpose", "elements", and "interconnections". Sweeney and Sterman (2000) propose six specific systems thinking skills: (1) understand how the behaviour of a system emerges from the interaction of its parts over time (dynamic complexity), (2) discover feedback processes (both positive and negative), (3) identify stock and flow relationships, (4) recognize delays and their impact, (5) identify nonlinearities, and (6) recognize the boundaries of mental and formal models of the system. These skills are mainly focused on system dynamics representation. Squires et al. (2011) also propose six systems thinking abilities: (1) use multiple perspectives, (2) work with "fuzzy" boundaries, (3) understand different operational contexts, (4) recognize relations and dependencies, (5) understand complex system behaviour, and (6) predict the impact of change to the system. According to Williams and Hummelbrunner (2010), a system is characterized by its elements, the interrelationships between them, and the system's boundaries. This definition is too generic to be applied for a tool evaluation. The DSRP framework of Cabrera et al. (2008) was specifically designed for the systems thinking evaluation purposes and consists of four elements: Distinctions, Systems, Relationships, and Perspectives (DSRP; Cabrera & Cabrera 2015). Given the context of the given engineering project, we had the motivation to evaluate attention to systems thinking and a requirement for a straightforward framework for content and visualization analysis. At the same time, a framework should be generic enough to be applied to other project contexts and easy for generic concept operationalizations in the data visualization context. Having these requirements in mind, we selected the framework of Cabrera et al. for the evaluation of the design and action parts of the current research. DSRP provides the mechanism for a view of concepts as dynamic and complex. Theoretical, empirical, and practical examples exist for each of the individual patterns of D, S, R, and P, and the related work is often transdisciplinary which occurred across different research and practice fields (Cabrera et al. 2008). The framework is represented in Figure 7.4. Each of these four DSRP rules can be viewed as a relation between two elements: identity – other for distinctions, affect – effect for relationships, part – whole for systems, and subject – object for perspectives.

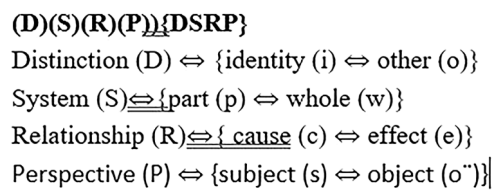

Figure 7.4 Systems thinking component rules. Adapted from (Cabrera et al. 2008).

Given the context of project knowledge management and time constraints that are part of the project success evaluation framework on the one hand and the importance of time dynamics as an element of complex systems (Sweeney & Sterman 2000; Stave & Hopper 2007; Arnold & Wade 2015), we added *time dynamics* to the four dimensions proposed by Cabrera et al. to the current systems thinking analysis framework.

Content analysis of interview transcripts

In order to analyze the text of the project managers' discussions, the project meetings sessions with and without dashboard visualizations were recorded across the four evaluation sessions and subsequently were transcribed for coding by two coders. A coding framework based on the systems thinking framework of Cabrera et al. (2008) in the given engineering project context was developed. We applied content analysis executed by two human coders in order to evaluate the effect of dashboard visualizations on systems thinking. A wide range of theoretical approaches can be called content analysis (Denzin & Lincoln 1994; Miles & Huberman 1994; Bailey 2008; Mayring 2014). A central concept in the content analysis as a research methodology is the focus on language and its importance in human cognition (Sapir 1944). Krippendorf defines "content analysis as the use of replicable and valid method for making specific inferences from text to other states or properties of its source" (Krippendorff 1969, 1980). We applied the content analysis with a deductive category application according to the steps defined by Mayring (2014). A coding agenda was developed within this method based on the theoretical framework of Cabrera et al. (2008) (see Table 7.1). In order to apply the generic systems thinking rule of system (see Figure 7.4) to an engineering project management context, we developed a hierarchy of project management system elements related to three main aspects of an engineering project: product, process, and people. The distinction between product, process, and actor constituents of product development is very common in mechanical engineering project management (Boujut & Laureillard 2002). The division of the hierarchical layers can be arbitrary, for the simplicity we divided all project system elements into three main hierarchical layers: the highest and the most global one – macro-level, the middle layer of the system description – meso, and the most local layer of elements – micro (see Figure 7.5).

In the context of the given project where a racing car is being designed and manufactured, these three hierarchical layers are specified for product, process, and people aspects. For example, for a coder to classify the highest global macro-level mentioned within a product perspective, a car should be mentioned in interview transcripts. For the meso-level, such parts of a car as chassis or powertrain are mentioned and some specific micro-components of a chassis, power train, or other car parts are classified as a micro-level of a system. Further, for the distinction component of systems thinking, a linguistic element was classified as having a distinction in thinking and reasoning if an individual name or an element was mentioned (see Table 7.1 for the detailed coding agenda). Perspective and system aspects were subdivided into three categories each, and together with distinction, relationship, and time resulted in the coding process across nine categories in total.

Table 7.1 Coding agenda based on the systems thinking evaluation framework

Category	*Definition*	*Examples*	*Coding Rules*
Perspective	Taking perspective of a subject or an object		Perspectives as not mutually exclusive, it can be more than one perspective in one statement
Perspective: Product (Sub-category)	A physical part of the racing car or its functioning	"So that's been some work in the steering assembly for the design stuff".	Macro (the whole car, "the thing", etc), meso (powertrain, chassis, wheels), micro (electronics, whole, aero, dyno – they are all sub-parts of previous parts)
Perspective: Process (Sub-category)	Any project or non-project-related activity to achieve a particular goal	"It's just pushing on and getting everything ready for launch".	Process perspective – macro (working on the launch, pushing forward, etc), meso (project activities like static events, admin, social media, manufacturing, etc), micro (specific examples like report A, report B, Post A, Post B, Video A, costing report)
Perspective: People (Sub-category)	Any project or non-project-related person or human actor(s)	"X is the best person to ask about that".	Individuals (micro), stakeholders, competitors, teams (macro), and sub-teams (meso) are mentioned
Distinction	Identification of an object or phenomenon that is different from others	"X is the best person to ask about that".	If an individual name, proper noun, or an object/process/phenomenon distinct from the rest is mentioned, something that is specifically emphasized and separated from the rest
System	Identification of parts of the whole system of interrelated elements, level of granularity or abstraction		

(*Continued*)

Table 7.1 (Continued)

Category	*Definition*	*Examples*	*Coding Rules*
System: Macro (Sub-category)	Lowest level of granularity of project-related processes, events, actors, or parts of a final product	"So, for instance, while the chassis is out being vinyled, the role beam can go off and be powder coated on the same day – try to do two things so we don't lose a day".	Process perspective: micro (specific examples like report A, report B, Post A, Post B, Video A, costing report) Product micro (electronics, whole, aero, dyno – they are all sub-parts of previous parts) People micro (individuals person A, person B)
System: Meso (Sub-category)	Intermediate project-related processes, events, sub-teams, or sub-parts of a final product	"Also trying to fix some last-minute design issues in other areas".	Process perspective meso (project activities like static events, admin, social media, manufacturing, etc), product perspective (powertrain, chassis, wheels) Meso (project activities like static events, admin, social media, manufacturing, etc), from the people perspective – team A, Team B
System: Macro (Sub-category)	Global project-related processes, events, actors, or final engineering product	"It's just pushing on, getting everything ready for launch".	From the process perspective – macro (working on the launch, pushing forward, etc), product macro (the whole car, "the thing", etc), people macro – the team
Relationships	Causal relationships between phenomena or events	"Yeah, but that's going to be skewed because you had it open for a long time as well".	Cause-effect relations
Time Dynamics	Understanding how the behaviour of a system emerges from the interaction of its elements over time (dynamic complexity); capability of reasoning about time and understanding changes over time, having time awareness	"So it's been a lot of manufacturing then organizing everything, trying to balance the time so there is minimal down time".	References to past and future, remarks on evolving over time – e.g., words like "last month", "next week", "yesterday"

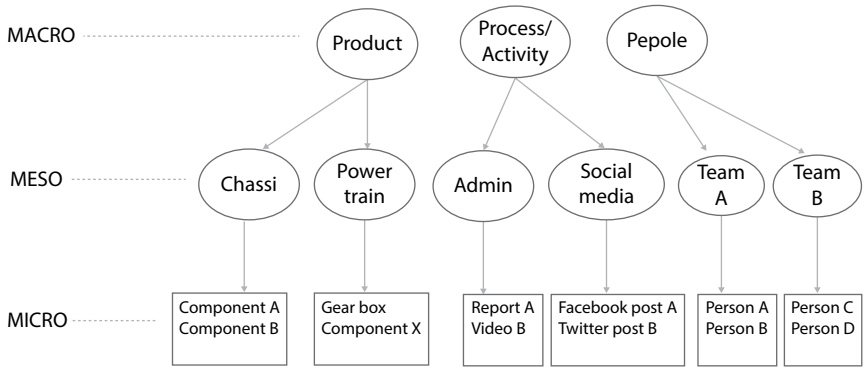

Figure 7.5 Examples of the systems thinking classification framework in the context of an engineering project: System and perspective dimensions.

Using dashboard visualization

Participants in the current dashboard visualization evaluation study had a free choice of which visualizations to use. They used the visual analytics information presented within four tabs of the dashboard out of five tabs available: types of project activity derived from x-drive files extensions (Figure 7.2), number of records by each x-drive folder (Figure 7.1) and Facebook and Twitter (social media) impact posts (Figure 7.3). They did not use the activity drill down visualizations tab.

Initially, one coder analyzed interview transcripts and coded them according to the framework described in the previous section. The second coder then coded two interview sessions where the visualizations were present and absent in order to calculate Huberman's intercoder reliability (Miles & Huberman 1994). The coders employed an iterative coding process to try to avoid subjective views on how the concepts should be instantiated. Before the second coder started the coding process, the coding framework was discussed between the two coders to achieve a mutual understanding of rather abstract concepts of the framework. In the first round, the coders discussed their coding results of one session to develop a common conceptual understanding. The second session was used to calculate the intercoder reliability across the four dimensions of the framework by Cabrera et al. (2008) with the fifth additional dimension of a time aspect.

In order to interpret the system thinking elements occurrences in project managers' conversations, we should note that different evaluation criteria are applied to different dimensions of the systems thinking evaluation framework. For *distinction*, *relationship*, and *time dynamics*, we assume that a higher number of occurrences of these elements indicates a higher degree of systems thinking. For the *perspective* and *system* elements, the assumption is that not the frequency, but a more equal frequency distribution within the subcategories of these dimensions, indicate a higher degree of systems thinking. The explorative results provide some indications for the advantage of *distinction* and *relationship* dimensions of systems thinking (Figure 7.6) for the Dashboard Present visualizations group.

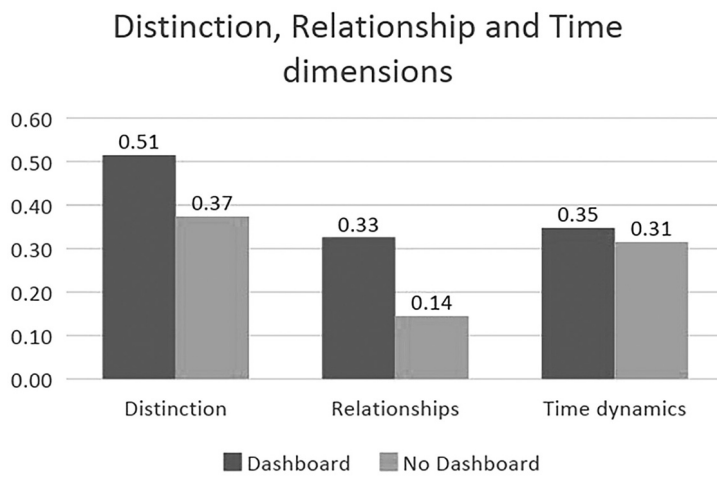

Figure 7.6 Proportion of occurrences of three systems thinking dimensions: Distinction, relationships, and time dynamics for dashboard present and no dashboard groups.

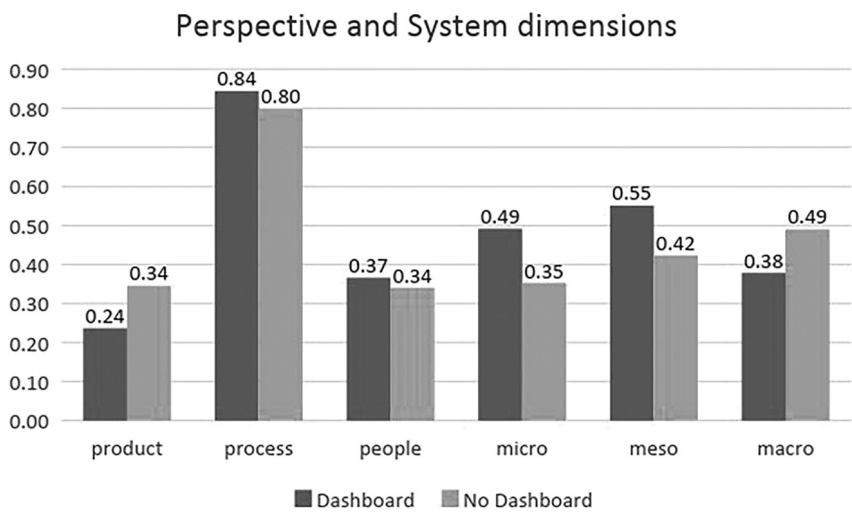

Figure 7.7 Proportion of occurrences of two systems thinking dimensions: Perspective and system for dashboard present and no dashboard groups.

There were 14 per cent more occurrences of *distinction* making in the visualization group and 19 per cent more occurrences of relationship statements. There were only 4 per cent more occurrences related to *time dynamics* in the visualization group, which indicates a very minor difference. Regarding the perspective dimension, the visualization group demonstrated a slightly less focus on the product part of the project (Figure 7.7).

For the *system* dimension and the level of granularity of the project view, the Dashboard Present group had 14 per cent more focus on the micro-level and

13 per cent more on meso-levels of the project compared to the No Dashboard group. At the same time, there were 11 per cent fewer occurrences of discussions at the macro-level of the project in the dashboard visualizations group. There were no substantial differences between groups regarding their attention to process and people perspectives (3–4 per cent), though there were 10 per cent more occurrences of product-related conversations in the group without visualizations.

Discussion and conclusion

We analyzed a project footprint data visualization tool as a means for project knowledge through the lens of systems thinking using the framework of Cabrera et al. (2008). The analysis results demonstrated an effect of dashboard visualizations on four out of five systems thinking dimensions (except for *time dynamics*): *distinction*, *relationship*, *perspective*, and *system*. There was a positive effect on *distinction* and *relationship* dimensions of systems thinking in the dashboard visualization groups. For the *perspective* dimension of systems thinking, there was a very small difference in occurrences of people and processes elements, though there were more occurrences of product-related conversations in the group without visualizations. Ideally, the distribution of perspectives mentioned during the conversations should be equal across all categories – product, process, people – or in the context of the given project with slightly more focus on the product. However, in both participants' groups processes were the dominating category.

Regarding the *system* dimension, the findings provide an indication that the dashboard visualizations directed the conversations into a more detailed view while slightly distracting from the global picture. The macro-view was prevalent in the group without the dashboard visualizations.

A surprising finding was that there was no difference between the groups with respect to the *time dynamics* aspect, especially given the design bias of the visualizations towards the time representation feature (*time dynamics* dimension according to the systems thinking assessment framework). Another interesting finding was that in spite of the fact that the dashboard was not specifically designed to represent relationships directly, it still induced better reasoning about relations within the visualizations group. It can happen due to the inherent properties of the visualizations, which help with dimensionality and complexity reduction (Meyer 1991; Mikkola 2001; Warglien & Jacobides 2010; Killen 2017).

Based on the findings, two discussion points emerge in the context of the participatory design approach towards the presentation of big data visual analytics. First, in the development of the dashboard, a participatory design approach was employed. This has the potential to limit the number of desirable features since the participants might not be aware of the importance of some crucial for systems thinking (or any other qualities) features of visualizations. Another point is that the visualization tools should allow for a balanced information presentation without a distinct bias towards certain project-related information features because it might skew the focus of a project. The current visualizations were dominated by process perspective representations, and it was reflected in the discussions of the project managers. However, we cannot make any conclusions regarding the direction of

this effect in the context of the given project: either the managers were initially focused on processes and suggested processes representations during the dashboard user-participatory design or their attention focus and the project perception during the project meeting discussions was influenced by the dashboard or both.

The main limitation of the current study is that due to the small number of participants and the short time span of the evaluation period (approximately seven weeks) it became an exploratory case study which cannot provide a solid basis for generalizations due to the impossibility of a statistical analysis of the results and the impossibility to observe the whole project over time. Further, the project digital footprint dashboard was not designed with a goal to enhance systems thinking, its design followed a user-centred approach where users' preferences and needs were mainly addressed which was not necessarily holistic thinking and approach towards project knowledge; we just hypothesized that dashboard visualizations will have the inherent property of inducing systems thinking due to the properties of visualizations – their ability to compress complex cognitive information. There was a bias in the current system towards the visualization of processes and product parts – not people's activities or people; the tool visualizations were also more focused on meso- and micro-levels of the project.

Given the promising results of project data visualizations effects on systems thinking, future research should explore this potential by addressing the limitations of the current exploratory study: more participants should be included in order to be able to generalize the research findings on the impact of project digital footprint visualizations, longer time span of a project data visualizations, and the consideration of the participants' evaluations. In the current study, the dashboard visualizations were only presented to the project managers and only during their regular biweekly meetings and were not used by the managers or other project members beyond these hours. It would be interesting to test the effect of the visualizations with other project members and to design a stable tool to be used on a daily basis. In the dashboard design research part, systems thinking enhancing elements should be considered first, also the visualization tool should be tested in a non-student organization context. Also, another systems thinking evaluation framework can be applied and tested. More research is also needed to evaluate the effect of systems thinking on decision-making and actual project knowledge management performance in the public sector.

This work contributes to better knowledge management of big data emerging from the digital footprints of public innovation projects in a HE context. Any project will accumulate large amounts of data, either in digital or other forms, qualitative or quantitative, and different types of data can be considered for visualizations. Studies on the effects of visualizations on better project information comprehension and effective decision-making are relatively new, and this area merits further exploration. Digital files generated during an innovation project (public, private, or hybrid) can be treated as big data, possessing the potential to generate knowledge and to facilitate decision-making along with the challenges of interpreting and visualizing this data.

We propose a visualization tool for big data in project management and evaluate it against an explicit framework for systems thinking as an example of

sensemaking for knowledge management. Systems thinking approaches can provide unique advantages in making sense of complex innovation projects by framing and solving problems from diverse perspectives and relationships. Systems thinking is a way for managers to take a holistic approach towards the world and to make sense of it based on the interactions of different system elements rather than just describing the world within narrow boundaries. This approach could be very useful in complex public-private hybrid projects, for example. The sensemaking systems thinking framework was applied for the evaluation of dashboard visualizations. The performance of two groups of engineering project managers was compared against the framework: one group with the dashboard visualizations and one without.

The project context was a Formula car project, led and executed by a team of 30 final-year engineering students at a UK HE institution. Action research and content analysis of interviews with the project managers revealed the potential of utilizing digital footprint data visualization in improving systems thinking and decision-making within projects. The work demonstrates the usefulness of data visualizations for knowledge management of both project managers and project team members, by improving knowledge and the provision of information to engineers in support of their project understanding. Both private and public sectors can benefit from better project data management by transforming big data into valuable insights and knowledge that will contribute to better decision-making. However, we should have more realistic expectations when considering big data knowledge management in the public sector where privacy is a fundamental value and decisions are subject to multiple actors and negotiations.

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Note

1 http://locm.blogs.ilrt.org

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8 E-construction

Public innovation platform

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Introduction

Within a city and public services context, digitalization has the inherent potential to drastically change procedural methods employed for city planning and public services offered to its citizens. Digitalization advancements have extended the decision support for strategic city planning, space planning, public asset management, and scenario simulation.

Digitally twinning smart cities is the latest phenomenon to reach public city council innovation strategies that are most commonly yoked with existing smart cities initiatives. Digitally twinning cities is quintessentially a 3D model replica of the physical built asset with accessible life cycle–related semantic parametric information associated with the geometry (Pärn et al. 2017; Roberts et al. 2018). In a professed movement towards smart cities where built assets are linked with ubiquitous computing and sensing (using smart sensors), building information modelling (BIM) and geographic information systems data will become pivotal in the setting out many city-scale digital twins. Consequently, digitally twinned cities for the public will form a cornerstone of a digital economy that seeks to (1) provide more with less, (2) maximize resource availability, (3) reduce cost and carbon emissions (throughout the whole life cycle of buildings), (4) enable significant domestic and international growth, and (5) ensure that an economy remains in the international vanguard (HM Government 2015). Yet, for most public services wishing to adopt a service innovation platform to help create tech-savvy smart city services for its citizens using digital platforms is not as well understood. Nor is the concept of digital twins within a city scale. Against this backdrop in a modern digital economy, public administrators of smart cities are faced with the likely influence of conceptual coalescence – namely, (1) servitization, (2) informatization, (3) digitalization, and (4) creativization (Anttiroiko et al. 2014).

Arguably creating a knowledge gap in the 21st-century digital economy where advances in information and communication technology have led to the creation of successful transaction and innovation platforms (as witnessed in the private sector, Google, Amazon, Airbnb, Alibaba) leveraging complex relational structures among different actors (e.g. companies or public organizations). The actors are loosely connected to each other to create added value and, on the other hand, without an equivalent transfer to public service providers. One small country in

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the Baltics, Estonia, with a recent history of developing digital public services, may just have the answer: offer a digital construction platform that can be improved by third-party developers, citizens, and/or entrepreneurs to create a digital twin of its cities. To better understand this phenomenon, we present a detailed case study of the Estonian e-construction platform, which serves as a springboard for public and private innovation in the public services domain. While it is not classed as a smart city initiative, it can be deemed a necessary stepping stone to successfully achieve what many governments have failed to achieve: a successful smart city initiative.

Public digital services in E-Estonia

The selection of Estonia as a case study was not of any coincidence, the Estonian government has gained steady prominence across the world stage as a leader in government services digitalization and has continually sought to innovate itself digitally. Particular noteworthy exemplars are the introduction of an eID system (2002), i-voting (2005), and e-Health (2008), offering huge benefits for the everyday Estonian with efficient, secure e-services. Whether through the recent decision to store every citizens' healthcare records on an immutable, verifiable blockchain or the rather bold attempt of amassing ten million "e-Residents" by 2025, Estonia's status as a digital nation is rarely disputed.

With digital Estonian government services today, citizens can vote online, complete tax returns digitally, and receive health prescriptions electronically. Citizens elsewhere rarely have such a one-stop shop for all of their public services: Estonia is certainly an exception to this rule.

All of these government services are kept fully functioning by yet another Estonian creation: X-Road. This microservice is understood to be the backbone of today's Estonian public services. X-Road provides vital cryptographic services and infrastructure, enabling data to be securely exchanged between different information systems, registries, and databases but also allowing all of Estonia's e-services to connect seamlessly across a decentralized network.

The case of the e-construction platform is another digital initiative to rapidly expand the digital services of public and private actors wishing to set in place faster planning permissions and delivery of construction projects across the country.

Although Estonia's public services circumstances are somewhat uncommon, even in the developed world, they still offer a fascinating snapshot of a government in the 21st century looking to push the boundaries of platform services and microservices offered to its citizens and entrepreneurs. Estonia's "start-up" mentality means that it is often open to such radical initiatives, such as creating an innovation platform through public digital services, compared to the United Kingdom or other Western governments.

Platform business models and innovation platforms

Digital platform business models in a public setting are maturing and with it the need for businesses and organizations to increase their capacity for adopting data-driven business models (Zaki 2019). For many government service providers, such

data-driven business models transcend the narrow confines of the information and communication technology sector alone and are becoming more ubiquitous throughout all industries, particularly with newly emerging resources offering a myriad range of tools to quickly deploy bespoke technology solutions from more general-purpose technologies.

In the private sector, a platform typically has one leading organization that promotes the rules of operations of the platform and generates a shared vision that joins the platform organizations together (Gawer & Cusumano 2014). This leader has a central role in the platform design stage and the success of the platform (Gawer & Cusumano 2014) – e.g., by ensuring the possibility for knowledge sharing and adaption. In addition, the platform leader facilitates the creation of an innovation environment where all ecosystem players contribute and stabilizes the platform in such a form that the ecosystem organizations commit to it in the long term.

The key drivers for growth with platform business models have been attributed to: network effects, low legislative barriers; advertising-driven business models, high venture capital investments, consumer/customer centric offerings, business model innovation, open platformatization to third-party developers, patient investors pursuing a winner-takes-all approach, data-centric services, regulatory entrepreneurship, political economic institutional support, and multi-sided platform/markets (Gawer & Cusumano 2014; Zutshi & Grilo 2019). Of these approaches, an open platformatization sometimes referred to as the innovation platform approach is the easiest strategy for publicly owned platforms to adopt.

Innovation platforms are an amalgamation of products, facilities, or services that other companies besides the owner can also use for the creation of innovations. Development of such innovation in the business-to-consumer (B2C) domain has required a managerial structure to enable platform development, as well as effective participation of platform users and "ecosystem companies" (Gawer 2009; Gawer & Cusumano 2014; Cusumano et al. 2019). Typically, the actors (businesses) surrounding innovation platforms work together in a loosely connected network with an interdependency.

A key characteristic of innovation platforms is generativity. Generativity enables novel use of digital technology to generate or produce new outcomes; generativity that emerges from a digital platform not only stimulates service innovation but also new business models and unpredicted opportunities for new digital services. In this context, we interpret that generativity stems from boundary resources, and the capacity to foster complementary innovation and extend the scope and value of the public services for the citizens and entrepreneurs who rely on these services.

Research design

We frame the empirical investigation as a case study of business model innovation interaction and innovation platform strategies and argue that a case study approach offers a useful methodological approach to addressing our research questions. A case study method is advantageous because it allows for in-depth analysis to provide context-dependent insight into the details which could otherwise be

lost (Feigin et al. 1991). It also provides authentic industry-fed data encompassing important contextual conditions (Bakis et al. 2006). Additionally, rather than isolating particular variables, context and complexity can be incorporated through a case study approach (Flyvbjerg 2006). Conventional wisdom suggests that a single case study is limited in credibility because the findings from such may be ungeneralizable (Campbell & Stanley 1966). For instance, Kitchenham et al. (1995, 2007) noted that a single case study was limited to a single phenomenon and as such was largely limited to the subjective interpretations of its researchers. Albeit, a single case study can nevertheless demonstrate greater depth and penetration when investigating a contemporary phenomenon. By contrast, Flyvbjerg (2006) argued against this stance stating, "[A] scientific discipline without a large number of thoroughly executed case studies is a discipline without systematic production of exemplars, and that a discipline without exemplars is an ineffective one." We argue that this research fulfils all these criteria.

Interviews represent a research data collection method that has been applied across a plethora of research disciplines (DiCicco-Bloom & Crabtree 2006), for collating opinions and knowledge from research participants. Interviews, in the conventional sense, are a questionnaire survey held as a verbal discourse and can vary from structured to semi-structured formats (Mason 2018). While a structured interview rigidly adheres to a pre-set number of questions, a semi-structured interview is formed with a selection of pre-determined open-ended questions which prompt discussion and allow the interviewer to explore emergent themes further (Mason 2018).

Formulation of interview research questions is analogous to the gap-spotting of under-researched areas (Alvesson & Sandberg 2013). However, the interview method is not without its own limitations and has often been criticized for being (1) biased – due to selective questioning, (2) subject to error or variation – due to poorly articulated questions and/or responses, and (3) prone to inaccuracies – due to poor recall (Friborg & Rosenvinge 2013). Consequently, an important phase of conducting interviews is to address relevant biases in interview questions. Here to prevent, or at least minimize, bias in the design of their questionnaires observed for the 48 biases outlined by Choi and Pak (2005). During this study, different biases and the phases in which they can occur were identified.

To understand the current platform strategies and the e-construction platform practices of the Estonian government and Tallinn city municipality, a semi-structured interview survey methodology was adopted. Here, the term "survey" refers to the selection of a sample of people from a population, followed by the collection of a relatively small amount of data from those individuals. Triangulation was employed by accessing publicly available documents about the municipality services, as well as internal planning documents for the e-construction platform.

To make sense of the business model or value proposition for the government and citizens, a business model scoping method was used to design and formulate the questions. This is to make sense of participants' understanding of the constructs of the value proposition of the e-construction platform. The design of interview questions followed a strict format of questions in line with the theories in the used model to structure understanding of the business model construct (Zeithaml et al.

2019; Prescott & Filatotchev 2020). This meant that questions were structured using the following categories: (1) construct hunting, (2) construct trapping, (3) building if then propositions, (4) if then propositions.

The e-construction platform business model

This chapter is intended to transfer knowledge and advance academic and industry domains concerned with innovation platform strategy formulation for digital building services for the public. The e-construction case study demonstrates the e-construction business model characteristics and its typology. This typology will help other governments, policymakers, and public and private services to explore the key determinants to enable a successful innovation platform strategy formulation to achieve a business case for digital twin servitization of cities and construction for public and private actors. We offer guidance for governments on how to successfully formulate innovation platform digitalization strategies to help achieve commercial exploitation of digital twin innovation platforms.

A plethora of definitions and ontologies are available in the academic realm to describe, define, and construct the term business model. This chapter has adopted Al-Debei and Avison's unified V4 business model framework to structure the understanding of the business model of digital twins within the Estonian Ministry and its wider cooperation with start-ups and entrepreneurs (Figure 8.1).

Value proposition dimensions

Value proposition dimension explains the way in which an organization creates value for two distinct dichotomies: for its citizens (customers) and each party involved (businesses, partners, wider stakeholders). This value proposition dimension covers knowledge of products and services offered, citizen value (for citizens and businesses), and ownership structure of digital twins products and/or services.

Citizen (customer) value refers to the type of citizen value for both direct customers and other businesses. With digital twins, value proposition for citizens can

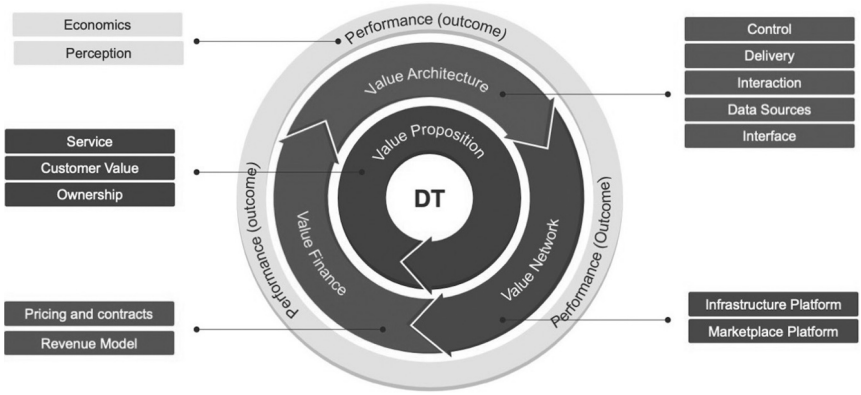

Figure 8.1 Digital platform business model taxonomy.

consist of the following: decision support, personalization, process optimization and transparency, customer/operator experience, and training.

Service refers to the services provided by the digital twin both for internal services and citizen-facing services. This can consist of any of the following: condition monitoring, visualization, analytics, data selling, training, data aggregation, and lifespan extension.

Ownership refers to the data ownership of digital twin products and services. This can consist of any of the following: digital, physical and digital, or physical only.

Value creation architecture

Value architecture is the resource-bound view of business models that sees them as structures of the organization consisting, namely, of technological infrastructures, organizational infrastructures, and their configurations (Al-Debei & Avison 2010).

For the digital twin relationship, a business's value architecture should consider the following resources, configurations, and core competencies: value control, value delivery, interaction, data collection, and interfaces.

Value control refers to the approach an organization takes to control value in the ecosystem. This is akin to understanding whether a company seeks to operate within its own ecosystem of digital twin services and its control over other ecosystems.

Value delivery refers to one of three ways of delivering digital twins – namely, centralized, decentralized, or hybrid. It also seeks to understand factors that may inhibit value delivery of digital twins to citizen interaction with the digital twin. Common examples of interaction include desktop, mobile app, virtual reality, and augmented reality (AR) interactions.

Data collection refers to the configuration of the digital twin value proposition, which is data-driven business models and services. Here data collection can be viewed as a combination of the following: sensor-based and/or supplied/purchased data.

Interface refers to the boundary resources made available to enhance network effects and scale of digital twin services. This typically comprises the following: application programming interfaces (APIs), hackathons, software development toolkit, and forums.

Value network and finance

The value network concept in business models originating from the late '90s during the dot com bubble (Stabell & Fjeldstad 1998) has become increasingly resolute in the 21st century where connectivity between customers and businesses is witnessed in the greatest abundance. This understanding of business models views the inter-organizational connections and collaborations between a network of parties, organizations, and stakeholders. In the context of digital twin services, this dimension becomes inevitable as the value delivery mechanism of digital twins relies on a multitude of organizations, technological infrastructure, and stakeholders for it to function. Due to the digital nature of such services, we categorize this as the operating mechanism of a digital twin that most often relies on third-party

developer networks, infrastructures as a service, and many other digital platform services, as well as technology integrators, partnerships, and alliances. This operating mechanism can be divided into two dichotomous groups, depending on the openness of such networks (open or closed operating mechanism).

Operating mechanism refers to the digital platforms (third party or in-house) needed to deliver the digital twin services; this most often alludes to the level of openness with the type of digital twins and services provided.

Value finance dimension defines the approach to costing, pricing methods, and revenue structure for digital twins. For the digital twin relationship to a business's value, finance should consider this from two perspectives; the revenue model and pricing model adopted with digital twin products and services.

The Estonian e-construction platform

The Estonian e-construction platform is technically an integration environment with which a number of already existing and used systems are interfaced. In commercial terms, it is the centre of communication between the participants in the entire life cycle of a building and the public sector. The platform provides API services for third-party interfacing, covering the entire life cycle of a building from design to demolition. The private sector can interface its solutions with the platform and offer its services to all users. The e-construction platform supports the dissemination and deployment of privately created services that follow agreed principles and requirements through a so-called marketplace model, where the creator is responsible for the services provided but the service can be found on the platform, which is the main entry point for building life-cycle services.

There are various motivations on behalf of the digital government of Estonia for developing and implementing e-construction platform services. The main motivator has stemmed from the issue of low productivity in the Architectural Engineering and Construction (AEC) industry, which is lagging behind globally, compared to other industries. Additionally, Estonia is also statistically behind at the regional (European Union (EU)) level of construction productivity, with the most commonly alluded to reason being the low digitalization of the construction industry as a whole. To catch up with the EU average, the productivity of the Estonian construction industry should be increased three times by 2030. This is not only the view embraced by the public sector but also by leaders in the private sector. Construction productivity has been discussed in terms of long-term strategic planning (Civitta 2021). In addition to increasing productivity, there are other important factors motivating the development of these services and binding them with the e-construction platform: making life easier for all members of the public and stakeholders related to the AEC industry; having access to AEC industry services in one central location which is logically systematized, thereby merging the long-standing siloed structures of the built environment; and sharing of knowledge.

The e-construction services architecture is based on the concept of microservices so that each part can be considered as a separately operated service. The software architecture of the e-construction platform (see Figure 8.2), consists of a user interface, web server, application server, and database.

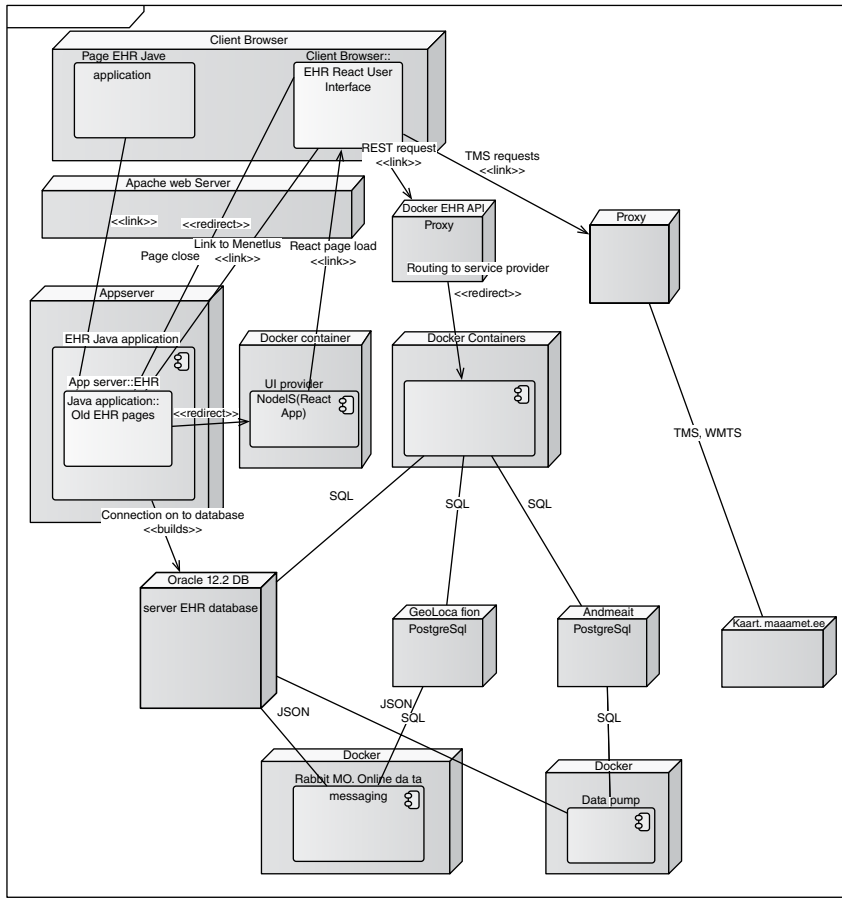

Figure 8.2 Technical architecture of the e-construction platform.

When connecting new services to the e-construction platform, some non-functional requirements must be met in addition to the technical architecture. These non-functional requirements with some provided examples can be categorized as follows:

- User interface – When creating an application, the possibility to make it multilingual (e.g., English, Estonian, Russian) must be considered. The design of the application user interface must be based on the e-construction style guide. The user interface of the application must adapt to different screen views (PC, tablet, and mobile phone). User interface components must be documented.
- Organization – The source code created during the development project is documented through the code management environment. Versions of applications created during the development project are marked according to the Semver 2.0 standard "version-xxx". Version numbers must be reflected in the Git Tags of the code store.

- Quality – API application endpoints must conform to the Electronic Health Record (EHR) API service names and service descriptions. Generally, API queries must return a result to the browser, and user interface (UI) HTML must load with styles and JavaScript in less than one second. Helm chart must include installation instructions with the application to operate the necessary secretion and configmap variable description file app-readme.md and installation of the variables in the file descriptions questions.yml.
- Information security – The application must ensure the processing of personal data in accordance with the General Regulation on the Protection of Personal Data and the Personal Data Protection Act: Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016. The application must store all passwords in encrypted form only. The API application must be secured against Denial-of-Service (DOS), Cross-Site-Scripting (XSS), Brute Force, and SQL/NoSQL Injection cyberattacks.
- Infrastructure – The information system to be created will be housed in a national cloud environment and must be considered when planning architecture. Application servers and database services must be run in a block storage environment. When creating a file warehouse, it is preferable to use the object storage environment with the S3 REST API.
- DevOps – For installation in Kubernetes, a Helm chart must be added to the application, which considers that the application will be installed in various Rancher projects.
- eID – The application must work with web browsers that support the latest version of ID card software, and it must use the central TARA authentication service to identify the user.
- Analytics – Statistical parameters are measured through the Google Analytics environment. The subscriber provides the data for the corresponding Google Analytics account.

Services in Estonian e-construction platform

The e-construction platform consists of many public services and is also open to third-party services from the public and private sectors. Some of the most important public services, offered via the e-construction platform, are described in this paragraph to give some content information, as mentioned in the interview findings.

- **National Building Registry** is a national database through which construction-related documents such as building permits, building notices, certificates of occupancy, and energy labels can be submitted and processed, and information on buildings can be viewed and managed. National Building Registry contains data on both existing and planned buildings (see Figure 8.3). On the website of the registry, it is possible to access the technical data of buildings and the documents submitted about the buildings (see Figure 8.4). The data is mainly submitted to the registry by local governments and is managed by the Ministry of Economic Affairs and Communications. National

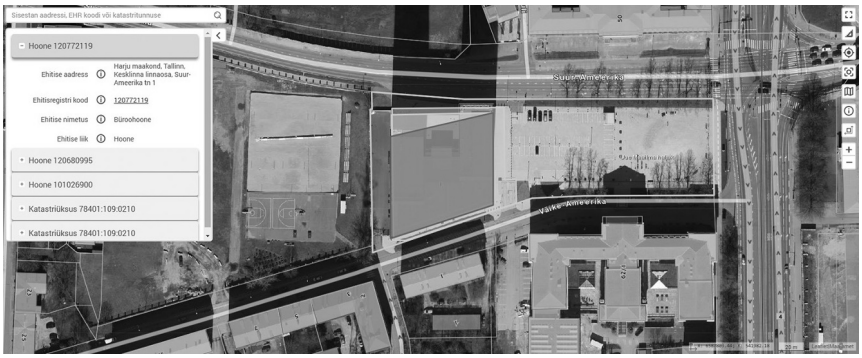

Figure 8.3 2D map presentation from the National Building Registry.

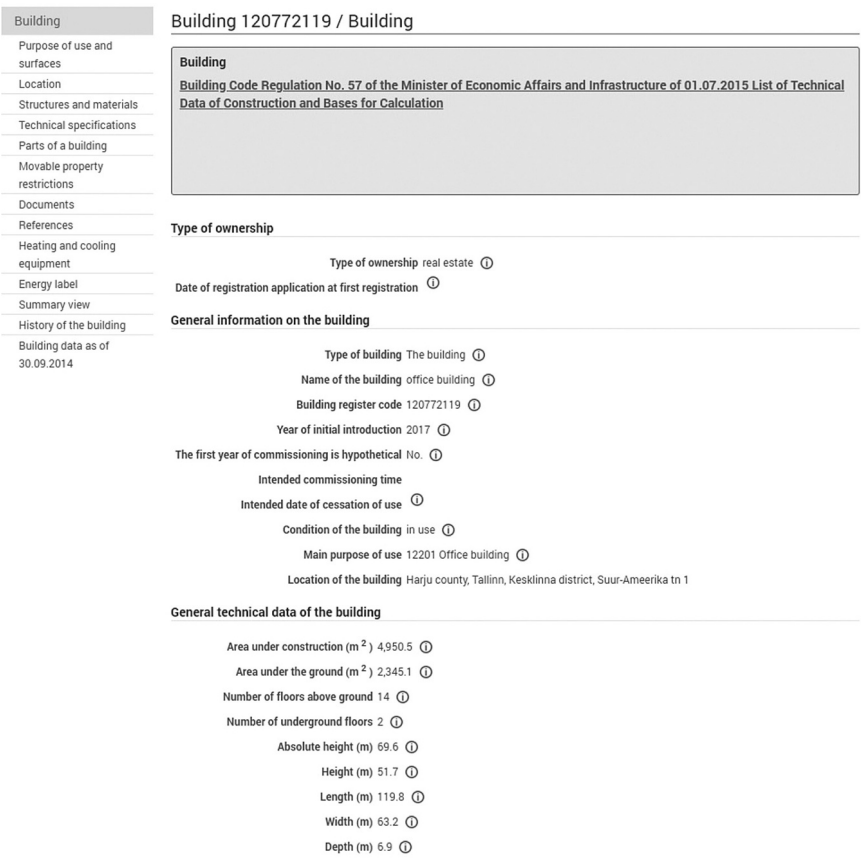

Figure 8.4 Technical data of building in the National Building Registry.

Building Registry purpose, maintenance, and processing are regulated by the statute of the building registry – a government regulation.

- **Procedural environment** development including BIM-based building permit services is very closely linked to the National Building Registry. The purpose of procedural environment service is to centralize all construction-related permit submission and processing in one environment. Subsequently, the permitting process is similar in all 79 local municipalities in Estonia, and applicants do not have to use disparate systems or planning portals when they are building in different locations. BIM-based building permit service UI consists mainly of a BIM viewer (see Figure 8.5) – that is, integrated into the National Building Registry and regulatory checking engine that enables the user to run a certain number of automated checks to shorten planning permit issuing time.
- **Utility Network Database** is planned as an environment (database) where spatial and attribute data and drawings about network facilities are stored in machine-readable format. The purpose of data collection is to reuse them in order to simplify and streamline the planning and preparation of construction design and the documentation of the construction process. When the Utility Network Database is completed, the possibility of automatic data exchange will arise, and the availability, reliability, and quality of data will improve. For example, reliable data can prevent power outages due to excavation works. Only the smallest possible amount of information about utility network is collected in the database. Detailed technical data is and will remain managed by network operators for security/privacy purposes. The Utility Network Database creates a basis for displaying the spatial and attribute data of network facilities in the 3D digital twin of the city. The Utility Network Database consists of data about electric land cables and overhead lines, heating and cooling pipes, sewer and water drainage pipes, water pipes, communication network land cables and overhead line, and 5G access points (see Figure 8.6).

Figure 8.5 BIM-based building permit model viewer.

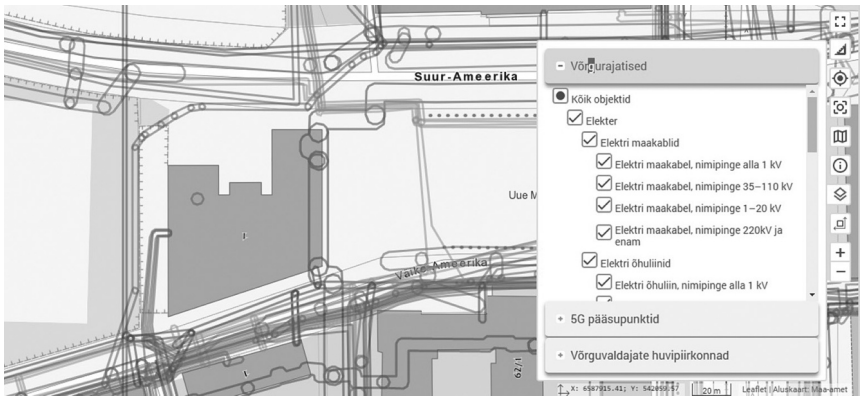

Figure 8.6 Utility Network Database visual representation.

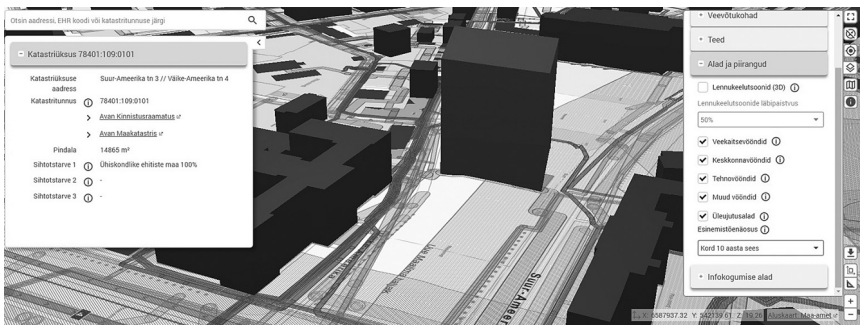

Figure 8.7 Digital twin representation of LOD1 data with restrictions.

- **Digital twin of the built environment** is a 3D model visualization application of the built environment, which allows the user to view buildings and building data in relation to the surrounding environment, also in a temporal manner (considering historical data), i.e., at different times fixed and stored state. The digital twin is the most important part of the UI of the e-construction platform, and most of the information displayed in it is obtained from data sources interfaced with the platform. The Digital Twin UI component is based on Cesium, which is a comprehensive 3D geospatial data platform that manages data optimization visualization and analysis. Some of the many options that digital twin provides for its users are 3D visualization of buildings in Level of Detail 1 (LOD1) precision (see Figure 8.7), which are buildings according to the National Building Registry database, and in LOD2 precision, which are buildings according to data from light detection and ranging – LIDAR (National Oceanic and Atmospheric Administration 2021) measurements done by the Land Board. There are also layers for utility networks, easements, restrictions, etc.
- **E-construction Developer Portal** provides API service documentation, interface instructions, and references from organizations that already use the

services and data of the e-construction platform to offer their services and products. Developer Portal is the service that should be used to connect any third-party service to the e-construction platform

Value proposition in the Estonian e-construction platform

Citizen value

Value proposition of the e-construction platform is to connect data and services across the building life cycle without loss of information. Information exchange is designed to be easy and user-friendly. Citizen (customer) value: comes from a platform connecting different parties – a single point of contact for the construction industry where all parties can get and deliver information. To have all the information available in one place so that there would be no need of finding the information from various websites/documents. The e-construction platform is a local connected database (not a centralized database), as data itself is scattered and connected from different databases (for instance, address registry, citizenship registry, utility network, building registry, etc.). All this data is delivered to ordinary citizens and users through common UI in a web-based platform. Another important citizen value proposition lies in information sharing: on the business side, private companies could also offer their services and search for customers or their construction project through the e-construction platform.

> Customer value: A platform for connecting different parties. A single point of contact for the construction industry where all parties can get and deliver information. To have all the information available in one place, so that there would be no need of finding the information from various websites/documents as it is at the moment.
>
> (Deputy secretary general for construction)

> Main value is that it connects data and services across building life cycle without loss of information and easy information exchange.
>
> (Head of digital construction)

The vision to create an e-construction platform was drawn as early as 2018. During this time, both public- and private-sector representatives were involved in formalizing the vision. The only actors not connected with platform design regularly were local (regular) citizens. Numerous interviews and workshops with representatives of local governments; architecture, engineering, construction, and facility management companies; and state departments like Transport Administration and State Real Estate took place, all of which are evidenced in the respective report – e-construction platform vision (Civitta 2018).

Before creating the vision, there were two possible paths: (1) a strategy of plain digitization which did not make sense for Estonia due to the high digitization of other sectors, including government services, and (2) focused action: a certain focus, not to be deviated from, was chosen – namely, the e-construction platform. To ensure focus, the development team contracted by the ministry, held a very extensive background in different stakeholder groups such as architects, civil

engineers, ex-municipality officials, and information communication technology (ICT) professionals were involved.

Customer value of the e-construction platform consists of all the following: decision support, individualization, process transparency, customer insight, data selling, and employee training. The central value proposition is decision support followed by process transparency.

The ministry's vision was to create a platform that acts as a connector. Organizations' approach to e-construction platform customer value is the same for each project type. All projects are linked with the departments' vision and project managers carry out that vision throughout the project. Though the approach is the same, the goals may slightly differ. For example, the Utility Networks Database's main goal is to prevent accidents; the National Building Registry's main goal is to centralize the building permit process and data about the built environment.

In addition to public services provided by the ministry, the e-construction platform is open for private-sector services if they are connected with the platform by following rules set by the e-construction Developer Portal.

E-construction platform services consist of all the following elements of value: construction insight, analytics, servitization, and visualization. The core is the data, which needs to be trustworthy and reliable for good analytics and servitization because all public services operated through the e-construction platform are based on these streams of data.

The e-construction platform also provides the value of new customer experiences. A good example of public service offering a new customer experience via the e-construction platform would be the 3D-model-based (BIM) building permit process, which enables the customer to apply for a building permit using the 3D model as a construction design document instead of the traditional 2D drawings in PDF format. Automated rule checking results give applicants a visual overview of construction design quality, with an error report in BIM collaboration format to correct the mistakes before submitting the application and therefore saving time for the applicant and the planning services. Thus, these services are transforming from human-to-human into machine-to-machine service interactions. It must be mentioned that this service is still under development and is aimed to complete in late 2021 and it is anticipated that circa 60 checks will be automated, albeit some rule checking will still be done manually by municipality officials in the next few years before the entire process is autonomous.

Part of the platform is also reserved for private-sector services, which would also provide the value of a new customer experience. For example, these services could offer real-time data from sensors, machine-readable construction diaries, and AR tools for construction and supervision. Although these services don't exist on the e-construction platform yet, they can all be connected through the Developer Portal over APIs and use the data provided by the public databases on that platform.

Key drivers for better customer experience with the e-construction platform are speed of information, speed of processes, and transparency. The e-construction platform is developed in a way that meets the requirements of any modern IT system, which is also a driver for a better customer experience.

Service

There are a lot of different services offered via the e-construction platform. The Estonian Ministry of Economic Affairs and Communications is developing public-sector services such as the Utility Network Database, digital twin of the city (ground and vegetation model, utility networks, buildings in BIM, and information about geological surveys, land parcels, easements, and restriction), National Building Registry, procedural environment for permit issuing, and energy certificate calculator. There is also the possibility of connecting third-party (private-sector) services with the e-construction platform. These services on the e-construction platform can be divided into four different groups:

1) Public processes – National Building Registry, procedural environment development including BIM-based building permit
2) Preventative analysis – Utility Network Database for ensuring the quality of information about underground structures to prevent, for example, power outages due to excavation work
3) Integration of different services – digital twin of the built environment, visualization, and a real-time data visualization platform of the city and its infrastructure
4) Miscellaneous – third-party services initiated by the private sector connected via APIs

The e-construction platform also creates an opportunity to create the best living environment for all citizens. Both the public and private sectors receive and exchange construction-related information. The private sector can provide all the services needed in the AEC industry, even if they are meant for smaller interest groups and are not reasonable to develop by the public sector with the budget coming from central taxes.

E-construction platform services overall consist of service elements of simulation, data analytics, customer experience, and lifespan extension. Building permit procedure is not so much about data analytics but can be applied to it. Simulation services are part of the energy certificate calculator, where users of that service can simulate their energy costs for planned buildings. The digital twin of the city can also simulate scenarios, such as flooding areas and sun studies to display shadows cast by planned and existing buildings. It must be stated that the e-construction platform itself is not a product, but rather a mediator pointing in the right direction and guiding users to service providers.

> Starting from National Building Registry – construction permit and public processes. Another group is related to decision support and analytics. To go to preventative analyses. Third group would be integration – bundling different services together. Fourth group is miscellaneous – third party services for example digital construction diary.
>
> (Product owner of Building Registry)

Ownership

The Estonian Ministry of Economic Affairs and Communications has a common definition and principles of ownership with the e-construction platform and its data. The platform as infrastructure and public-sector services that belong to the state. The principle behind it is that the owner takes the responsibility for services, controls their quality, and implements a mutual style guide for a better customer experience. Some data is also owned by the state – for example, laws, regulations, and guidelines provided by the ministry. Most of the data belong to the data owners themselves – for example, building data related to permitting is owned by local governments; construction diaries and construction design documents are considered private companies' data. Data ownership principles make it more difficult to make changes in services which are heavily related to data. For example, in the digital twin for the city, building shapes in lower detail (LOD1) are formed based on the data owned by local governments. If the data on the building height is missing or inserted wrong, the result will be displayed accordingly – LOD0 if data is missing and 1,000 times higher buildings if millimetre is inserted instead of metre. In that situation, the ministry must contact the local government and ask to change the data instead of changing it by itself.

Third-party service providers connecting with the e-construction platform have sole ownership over their services and data, which are provided by them, but they need to follow platform governance on the style and rules of the e-construction Developer Portal, and they must be as open as possible about their services and preferably allow API connections to their services. At the time of writing this chapter, there are only government services on the e-construction platform.

Ownership is important mainly because of responsibility, and it is implemented according to public-sector legislation. Open data can be used freely in private-sector business models. Ownership of the e-construction platform consists of both physical and digital, but mainly digital components.

> Data is always with the owner. E-construction platform does not take part in ownership. Government services should have mutual style guide. Being part of platform creates a need to be open about services.
>
> (Head of digital construction)

Value architecture in the Estonian e-construction platform

Value control

The best analogies of ecosystems approach for value control are Android (open ecosystem) versus iOS (closed ecosystem). The approach of the organization to controlling value in the e-construction platform ecosystem is a hybrid ecosystem. It is more towards an open ecosystem, especially regarding third-party services. The principle here is to remain open for sharing as much information as is allowed by legislation. As a public entity, the ministry does not want to limit possibilities for new services, which would be useful for end users. On the

other hand, there are some services like building permit handling, which is a very controlled process and would be rather an example of a closed ecosystem. In this kind of system, an iOS alike closed ecosystem works better because it's easier to control value, and it's cheaper. In such public services, the ministry stays in a closed ecosystem in the current phase for the next few years at least. By combining both examples, it is neither an open nor closed ecosystem, but rather a hybrid ecosystem. Value control for the e-construction platform is exercised strictly within the ecosystem.

> More towards android as an open ecosystem. As a public entity, ministry doesn't want to limit possibilities for new services. But for example, building permit is very controlled process, which would be rather a closed ecosystem.
>
> (Head of digital construction)

Value delivery

The ministry has a common understanding of how value is delivered to customers with the e-construction platform. The value of an e-construction platform is mainly the creation of infrastructure for the delivery of various services. For connecting services to the platform, there are different rules and guidelines. The value delivery mechanism is a very decentralized system. It is similar to X-Road (Estonian e-government data exchange platform), but the e-construction platform does not regulate at a high level like the X-Road protocol does. There are some principles that API should follow, but they are more guidelines rather than very strict rules. Value is delivered to customers through better services, which are connected via the e-construction platform. All construction-related services can be accessed from one place. Most of the services that are run on the e-construction platform are either totally or to some extent open via APIs. If someone wants to connect with services, the ministry is open to that.

> Value is delivered to customers through better services. Services that are connected together.
>
> (Head of digital construction)

Interaction

There is a common understanding of the methods of interaction with e-construction platform services for the customers inside the organization. The main interaction is via website and through the Developer Portal. If customers have a construction-related question, they should end up on the e-construction platform. For some services, there are also possibilities for citizen interaction via AR, virtual reality (VR), and mobile apps. There are three types of interaction used: UI and end services are with human-to-machine interaction; customer support of end services can be very specific and additionally to human-to-machine interaction also human-to-human interaction remains as a possibility;

the e-construction platform itself is accessible with machine-to-machine interaction either via X-Road services or APIs.

> Via website and portal approach. If you have construction related question you should end up there
>
> (Product owner of Building Registry)

Data collection

Data collection is an important part of value architecture. E-construction platform services offer data collection to customers by structuring the data for ease of access. Structuring data is done via digital services – data which is created with these services is recorded in a meaningful way. Instead of facilitating data collection, the ministry is making sure that data collection happens. Citizens or municipalities are contacted only if the collected data is incorrect. Contacting process is not used to collect data. Data is collected into the system for example via various permit requests, and it is stored in different ways to create a trustworthy database. Another example of data collection is the BIM-based building permit – not only the BIM model itself is stored but all necessary construction-related data is parsed out from it and stored in the National Building Registry database.

Using public data offered via the e-construction platform can also be used in third-party services business models. An example of using this kind of data offering is related to construction materials and the age of the building: as there is data on the number of sloped roofs in Estonia, their finishing materials (metal sheets, ceramic/concrete tiles, etc.), and the age of the building, this data is available, and a private-sector company could use this data to offer roof replacement/maintenance service or validate its business model related to the number of potential customers on the market. Additionally, construction design documentation can be downloaded from the database to calculate material take off and estimate the complexity of the renovation if the customer does not find original documents.

The e-construction platform consists of data collection in the form of supplied third-party data. There are benefits and drawbacks of externally supplied data. All interviewees have stated that advantages are greater than disadvantages.

- Benefits: There is a large amount of data that is sufficient for statistical decision-making. All construction-related data is accessible from services via the e-construction platform and can be reused. The additional benefit of reusing the data is that the data is validated already and is, therefore, more trustworthy.
- Drawbacks: The reliability of the data may be an issue. For example, in a digital twin for the built environment, the creation of the visual side is partly data-driven, and reliability can be checked. Some data is difficult to verify, and it just needs to be believed.

There can be unexpected outcomes of developing and implementing a business model around data collection and data management. Unexpected outcomes have

been rising with the development of e-construction platform services. The main reason is the type of development. All e-construction platform developments are agile developments, and there are always pros and cons regarding that. When obstacles have arisen, they have been remedied due to an agile process, which means that cons are easily turned into pros because of the agile approach. Other negative aspects are related to the renewal of services like the National Building Registry. Both services, old and new, need to be used at the same time, which creates a problem of data synchronization and data migration.

Unexpected outcomes can also have a positive effect. In the fullness of time, the ministry expects different drawbacks created by the network effect coming from exponential growth.

> Digital services – data which is created with these services is recorded in meaningful way. Instead of facilitating data collection, we should be sure that data collection happens.
>
> (Product owner of Building Registry)

Support interface

The support interfaces for the clients and the developer network consists of a developer portal – the main interface for third-party services connection with e-construction platform via APIs and National Building Registry interface, with client support. Third-party services cannot be run on the Government Cloud; therefore, there is a question still unsolved if another interface is needed for private services after their connection with the e-construction platform.

At the time of writing this chapter, there are no third-party services on the e-construction platform, but the opportunity of connecting is available from Summer 2021. To encourage the private sector to connect to the e-construction platform, the ministry plans to launch a support mechanism in the form of funding in 2022 to accelerate third-party services' connection to the e-construction platform.

Boundary resources such as APIs are valuable to e-construction platform clients because machine-to-machine communication is autonomous and less prone to human errors. There is also no other way for moving a big amount of data. In addition, other support resources are used to enable better usage of the e-construction platform. These resources are forums, for example, the communication environment of local governments, and hackathons, for example, one was held in 2020, and a new hackathon is planned for 2021.

A literature review also describes software development toolkits as a useful support resource, but they are common to central systems. The e-construction platform is a microservice-oriented platform and therefore a decentralized platform.

> Developer portal is main interface. And also using Building Registry client support. The main question is do we need another interface for private services.
>
> (Head of digital construction)

Value network and finance in the Estonian e-construction platform

Operating mechanism

The e-construction platform operating mechanism relies directly on third-party services, as all services provided by the ministry are run in the Estonian Government Cloud, which is a third-party service from the point of view of the ministry. The reason for storing all information in the Government Cloud is the need to store government services information in Estonia. The Estonian Government Cloud is quite like Amazon's service in terms of working principles, but it is a state-managed cloud environment that enables the provision of central IT infrastructure solutions and services to the public sector. It is a technological solution that consists of hardware and software components and the necessary support services, which are created in cooperation with public and private sectors.

Third-party, private-sector services that will be connected with the e-construction platform would not be stored in the Government Cloud. They would be located in the service providers' own preferred local cloud or server and connected to the e-construction platform through the APIs.

A literature review describes that operating mechanisms can consist of technical platforms and marketplace platforms. Some authors believe data marketplaces for e-construction platform data can also become a new business model for architecture, engineering, and software companies. For example, Finland currently offers a Platform of Trust, run by a private entity monetizing the data collection. There is currently no marketplace platform for public services in Estonia, and the e-construction platform is strictly a technical platform.

Revenue model

The e-construction platform does not rely on standard platform-based revenue models. The e-construction platform and public services are exclusively financed from the government budget. There had been discussion about putting some fees on certain services, but it did not make sense and was discarded. The e-construction revenue model is rather about how much money is saved for its customers – citizens. The idea is that customers get their tax money, which goes to developing platform services, back through the efficiency of the platform.

It must be mentioned that there is a service fee for building permits and certificate of occupancy services on the National Building Registry, but as that fee goes directly to local governments, it can be considered as part of the local government revenue model, not the e-construction platform revenue model.

Third-party services that will be connected with the e-construction platform are free to use their own revenue models, as long as they are legal and transparent. X-as-a-service and subscription models would apply the best in such cases, as they are most commonly used with software services.

The e-construction platform can be partially described as a data-driven business model, but it is mostly open data. For example, the data stored in the National Building Registry is open and free to use for all authenticated users. There can be also some drawbacks: when data is collected from others, there is the issue of data

ownership. It is not a big issue at the moment, but that question could arise when the e-construction platform expands due to the growth of services.

> Public funded exclusively. There has been discussion about putting some fees on some certain services, but I strongly believe that it does not make sense. Our revenue model is how much money we will save for our customers (citizens).
>
> (Product owner of Building Registry)

Pricing

The pricing model with e-construction platform services can be slightly different depending on the service and the end provider of that service. For example, using the digital twin of the built environment and Utility Network Database is free of charge. These kinds of services are considered public services provided by the ministry and do not use a pricing model at all.

Issuing a building permit and certificate of occupancy are local government services that use the procedural environment of the National Building Registry service on the e-construction platform. These services are priced according to local government rules. There is no additional charge for using the e-construction platform service environment. Third-party, private-sector services are free to use their pricing models, and for that, there are no restrictions by the ministry at the moment.

> Third party services are free to use their pricing models. Public services don't use pricing model and are free. Some Building Registry services are priced, but the revenue goes to local governments not to the ministry.
>
> (Head of digital construction)

Discussion and conclusion

The key strategy in this case study was the platform business model, with a focus on what is needed by stakeholders in the industry. A strategic vision must be created with an agile approach, which is necessary for any software development or digital services, as it helps make necessary modifications better during the development compared to the waterfall method. The construction industry has many facets; therefore, it is almost impossible to digitize them all with one central software, and microservice architecture is needed to reach the goal of digitalization, to keep maintenance and further improvement of software realistic in the long-term view.

Another important strategy is related to organization. People behind managing and developing digitalization should not be only from the IT industry. Construction industry knowledge is necessary to understand the needs of stakeholders and thereby create a better solution for end users.

Data is one of the keywords in construction industry digitalization. There is a lot of data about planning the building, infrastructure around a building, the construction process itself, and facility management, which is the longest and most costly stage in the building life cycle. Therefore, quality and accessibility of data are

extremely important when creating digital solutions in the construction industry. Estonia has the National Building Registry to gather and maintain that data. The creation of a similar national database is highly recommended to accelerate the digitalization process.

The key inhibitors to the success of any digital service that relies on platform strategy can be summarized into four distinct categories: technical, financial and political, organizational, and cultural.

- Technical – With the massive amount of data behind all services, the question of how to keep the platform running and up to date arises and must be dealt with. One of the biggest obstacles so far has been renewing the National Building Registry service, which is a legacy system with obsolete architecture. Technical issues most frequently arise with system integration and migrating from legacy systems.
- Financial and political – E-construction platform is a public-sector platform and funding, which mostly comes from the state budget, is related to political decisions. At the moment, there is strong political support because of IT and innovation, and it is strongly supported by all political parties in Estonia. Developing digital services in the construction industry is a costly and time-consuming process. Therefore, continuous political support is needed, as public-sector platforms are funded from the state budget.
- Organizational – The team behind developing the platform should have enough knowledge and experience from the industry to create a successful result, which helps to increase productivity for end users. People can be the biggest inhibitor; therefore, a team with the right skill set is needed from the beginning.
- Cultural – All stakeholders from the industry must be involved in the process of platform development from the beginning so that the most important problems would be addressed, and digital services would help not hinder the work processes of end users of the platform. Failing with communication can increase inhibitors' success.
- Security – Cybersecurity must be addressed to make a safe environment for users. For e-construction platform services, several security protocols must be followed to maximize the cybersecurity of the platform. For example, to ensure application and database security, Open Web Application Security Project best practices must be followed, and the requirements of the Estonian information security standard that is developed for the public sector (ISKE) must be followed. The API application must be secured against DOS, XSS, Brute Force, and SQL/NoSQL Injection attacks.

Subsequently, it can be said that although there are some inhibitors to the operation of the e-construction platform, they have been mostly minimized during the development process and are not affecting the further development of the platform. Inhibitors must be taken into account in the future as well so that they will not become blockers of progress.

Machine-to-machine interaction in digital services of the construction industry has been promulgated to improve the productivity of public officials. A good example of autonomous services in the e-construction platform is automated BIM-based building permit approvals. Where a 3D model of the project (in BIM) can be automatically checked against local building regulations without planner involvement, assuming that the checkable building code is machine-readable, and all necessary BIM requirements have been followed by architects and engineers. Presently, the e-construction platform provides a hybrid solution, meaning both human-to-machine and machine-to-machine interactions are applicable simultaneously, but the goal is to move towards a fully automated system as soon as stakeholders are ready to comply with the requirements.

The case study offers a series of decision-making implications that may be particularly helpful to government officials, city councils, and municipalities already leveraging digital platforms for public services or planning to do so. As the built environment infrastructure becomes more digitally connected, selecting specific business models or introducing a new service becomes an increasingly complex task for public officials, as well as creating complementarity for public services to support local entrepreneurs. This is because public service providers often lack the knowledge, vision, cultural acceptance, and, most importantly, relevant intangible resources to make them distinctive to create innovation platforms that can stimulate new services for private entities that complement government services. One of the main reasons digital twins for cities are gaining in popularity is that it promises to create business value – either through efficiency or new value-added services based on data. Therefore, the practical need for a business model value framework is clear as public services providers that have designed a new digital platform often ask: how to implement public private digital services?

Creating a successful digital platform that can stimulate small business owners' and citizens' values is challenging to say the least. Yet, the Estonian e-construction platform offers a vignette into the type of municipalities that have taken lessons from the private platform business model and instilled similar strategies of data openness, boundary resources, and support systems for third-party developers to promote network effects with its own strict guidelines and governance for use of the platform. A single point of information for the construction industry was the vision of the Estonian government, and yet the result offers so much more. The e-construction platform is a public and private digital platform with service offerings for the public and an interface for private services. The platform strategy adopted by the government shows entrepreneurial orientation and a government that is attuned to the technological turbulence.

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9 Driving organizational digital transformation through innovation labs

Francesco Santarsiero, Giovanni Schiuma, and Daniela Carlucci

Introduction

Competition is accelerating faster than ever before (Lianto et al. 2018; Nonaka & Takeuchi 2019); the rise of digital and fintech start-ups is changing global competitive dynamics; mobile is becoming the channel of choice; the innovation pipeline and consumer expectations are changing (Carlucci et al. 2018). The technology and competitive landscape are evolving dramatically, and traditional industries and incumbents are challenged to embrace digital transformation. Digital transformation is not an easy process. There are no standard road maps for digital transformation, and companies need to overcome various obstacles to successfully develop digital transformation (Schiuma et al. 2021). The lack of technological and financial resources to invest in new high-tech solutions as well as of digital skills among internal employees, the low awareness of the potential of adopting digital solutions, and the reluctance of management to activate new working and management methods are the most common factors that hinder digital transformation (Hadjimanolis 1999; Madrid-Guijarro et al. 2009). Often, hiring digital experts and investing in digital technology seems to be the optimal solution to address the challenges of digital transformation. However, this creates only a technological store window, with digital experts remaining isolated and other employees unaware of the reasons for technological transformation. The critical challenge is that digital transformation is not just technology (Nonaka & Takeuchi 2019; Schiuma et al. 2021), and it requires a radical shift in cultural and corporate attitudes. The real challenge is developing and facilitating the gradual implementation of a company's digital strategy and sharing a digital plan that aligns the company's strategic vision and employees' ambitions.

An emerging organizational practice is represented by Innovation Labs, which can be considered a valuable response to companies' needs to develop digital strategies and promote digital adoption (Memon & Meyer 2020; Osorio et al. 2019; Santarsiero et al. 2019, 2020; Turrin 2019). Innovation Labs are innovative spaces that can take the form of a physical, virtual, or hybrid environment and foster creative and innovative thinking, support user-driven and open innovation approaches, facilitate stakeholders' engagement in innovation processes, allow to understand user needs better, drive digital transformation, imagine and define innovation opportunities, and develop new solutions that provide value to society

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(Santarsiero et al. 2021). Innovation Labs can help an organization find the best ways to adopt technologies, digitize operations, and implement digital strategies.

The chapter draws on the findings of a literature review on Innovation Labs and digital transformation and an exploratory case study conducted in an Innovation Lab to provide new insights into the role of Innovation Labs as facilitators of organizations' digital transformation. The chapter describes the key features and functions of Innovation Labs and shows how they promote digital capabilities and digital transformation processes and strategies in organizations.

Many faces of digital transformation

At the heart of the digital transformation is digital technology (such as big data, analytics, artificial intelligence), which increasingly impacts business efficiency (Berman 2012; Muro et al. 2017). Digitally based solutions in the form of multi-channel relationships, chatbots, live assistance, etc., are increasingly being used by companies to solve everyday problems quickly and transparently, thus fostering loyalty and customer retention (Shrivastava 2017). Digital technologies are also changing the ways companies implement their operational and management processes. Moreover, the proper exploitation of new technologies calls for the development of digital skills and culture among employees. According to Solis (2016) and Westerman et al. (2014), digital transformation is not simple, and it mainly affects three areas – namely, customer experience, operational processes, and business models. Each of these areas is distinguished by three different sub-elements, which are divided into nine building blocks. According to scholars, digital transformation impacts customer experience through customer understanding, revenue growth, and customer touchpoints. Specifically, digital transformation enables a more comprehensive understanding of customers by providing new methods, tools, approaches, and digital solutions to recognize and identify their needs, habits, attitudes, and behaviours. Companies that can monitor and analyze online customer data and social media interactions can better market segmentation and empathize with consumer needs. Therefore, they can offer tailored solutions, promotions, or discounts to meet customers' needs. The benefits of having a comprehensive understanding of customers lead to increased sales of products and services. It also helps to improve customer loyalty and retention through active customer engagement and improved online experience. Digital transformation is also impacting customer service (Shrivastava 2017). Digital-based solutions in the form of established multi-channel relationships, chatbots, and real-time help can help solve everyday problems quickly and transparently and increase loyalty and fidelity. In addition, digital transformation promotes acceleration of revenue growth through predictive marketing analytics or digital tools to digitally improve sales or process automation through digital plug-ins to simplify the customer buying process. Looking at operational processes, companies can leverage digital transformation to increase the efficiency of their functions by digitizing or reengineering operations using innovative digital tools or workflow automation software (e.g., enterprise resource planning, ERP). This allows employees to focus on value-added activities and let the software or robots do the alienating work.

Other digital tools, such as digital printing or rapid prototyping, can also reduce production time and costs and help companies improve the scalability and efficiency of their processes (Ivančić et al. 2019).

The introduction of digital technology into everyday processes also has an impact on people.

Often, organizations have entrenched and codified practices that sometimes prove outdated and not in line with new technologies. Therefore, digital skills that allow breaking the rules and thinking "out-of-the-box" are recommended. The redesign of the workplace, the introduction of collaboration tools, video conferencing, etc., can enable people to work anywhere, increase their productivity, and harness and encode knowledge, becoming a powerful tool for knowledge sharing. In addition, the data collected can feed into the decision-making system and help make the management of the business more data-driven.

The last area impacted by digital transformation is one of the business models (Berman 2012). Emerging technologies rarely have a fundamental impact on business; instead, the outcome depends on how the technology is exploited. The exploitation of technology can radically change a company's business model in many ways, e.g., by incrementally changing the existing business model, developing/generating a new business model that reshapes the company's boundaries, or finally, by optimizing service extension through digital globalization. It follows that the effectiveness of a digital transformation journey depends more on developing the organization's digital capabilities and the attitude to understand the potential of technologies rather than on the availability of the latest high-tech digital solutions (Schiuma et al. 2021). In this sense, the critical digital capabilities are related to the management of analytics to transform data into insights supporting decision-making and provide real-time key performance indicators to monitor performance and customer interactions.

Emergence of innovation laboratories

In recent years, Innovation Labs have proven to be a valuable solution to support the development of corporate innovation capabilities in driving digital transformation and business model innovation. Innovation Labs can foster creativity and critical thinking and help an organization find the best ways to generate knowledge and digital culture, adopt technologies, digitize operations, and implement digital strategies to achieve durable and sustainable innovation paths (Santarsiero et al. 2019, 2020). Recently, the analysis of Innovation Labs has attracted increasing interest among scholars and practitioners (Fecher et al. 2018). Several authors have highlighted the usefulness of these Labs as catalysts for promoting digital transformation and business model innovation in organizations across different sectors (Schmidt & Brinks 2017; Memon & Meyer 2020).

The term "Innovation Lab" has been introduced in the management literature to denote the space created by an organization to support the improvement of innovative capabilities and the development and testing of innovative ideas and solutions. Lewis and Moultrie (2005) define an Innovation Lab as a facility that encourages creative behaviour and innovative projects by providing appropriate

resources. Similarly, Magadley and Birdy (2009) have pointed out the role of creative space in fostering innovation and described the Innovation Lab as a physical environment where employees can interact to express their creative thinking beyond the usual boundaries. Identifying physical spaces dedicated to developing creative and innovative skills is often defined as a critical feature of Innovation Labs (Bloom & Faulkner 2016; Schmidt & Brinks 2017). In such a prospect, the Innovation Lab is considered a collaborative creative space that can help organizations overcome the barriers of traditional labs and allow diverse people such as employees, users, and all potential stakeholders to participate in creative and innovative activities. A key trait of Innovation Labs is that they are innovation spaces that allow companies to collaboratively develop potentially successful innovations by breaking down the hierarchy and engaging stakeholders to incorporate various forms of open innovation and the paradigm of user-centred innovation and collaborative innovation (Lewis & Moultrie 2005; Schmidt et al. 2014; Osorio et al. 2019).

Although innovation space is an essential feature of Innovation Labs, many authors have pointed out that Innovation Labs that focus only on creating innovation space risk becoming "innovation theatres". One of the main potential misuses of Innovation Labs is that they can be used merely as promotional tools to showcase innovation rather than being designed and implemented as a management initiative focused on developing organizational innovation capability (Blank 2013). The Innovation Lab should act as a management plan rather than a mere "innovation theatre" and should represent the "innovation engine" that influences the organization's innovation readiness behaviour (Lewis & Moultrie 2005; Magadley & Birdy 2009; Memon & Meyer, 2020; Zurbriggen & Lago, 2019) and can drive and successfully support the innovative behaviour of an organization. The Innovation Lab activities must be aligned with the organization's vision and strategic goals and should be inspired by innovative methods and practices that promote stakeholders' participation and satisfaction (Fecher et al. 2018; Osorio et al. 2019).

Drawing on the results of a systematic literature review about the conceptualization and the practices of Innovation Labs in the management literature, it is possible to recognize three pillars characterizing the Innovation Lab as an innovation management model (Santarsiero et al. 2019, 2020):

1) Innovation atmosphere, i.e., building an innovation space that can be physical, virtual, mixed, or relational, supporting interaction and the innovation environment
2) Exploration time, i.e., defining time for critical thinking to foster innovative ideas about future challenges
3) Experimental platform, i.e., providing tangible and intangible infrastructures and tools that can support prototyping, experimentation, and diffusion of possible innovative solutions

Based on the three pillars, an Innovation Lab aims to (1) promote innovative thinking, (2) support user-centred, open, and continuous innovation methods, (3) encourage stakeholders' participation in the innovation process, (4) better

understand users' needs, (5) promote digital transformation, and (6) identify and define innovation opportunities and continuously develop new solutions to add value to society.

An Innovation Lab requires a management cycle to transform ideas and resource input into innovation results to work effectively. The five key stages of an Innovation Lab management can be determined as follows: (1) focusing, (2) engagement and enabling, (3) developing innovative solutions, (4) delivering and application support, (5) reviewing and consolidating (Santarsiero et al. 2021). The "focusing" phase involves setting the strategic intent, developing a shared vision, and identifying the resources needed to create a project plan. The second phase, "engagement and enabling", is dedicated to activating support mechanisms to enable users to participate and foster a working atmosphere that reduces hierarchies, promotes empathy for specific challenges, and stimulates creativity and innovation (Lewis & Moultrie 2005). In addition, depending on the needs of the users and the innovation goals pursued, an Innovation Lab can act as an innovation facilitator and provide opportunities for community building and partnerships with different stakeholders (Memon & Meyer 2020). After the challenges and goals have been mastered, the "developing innovative solutions" phase begins. Here, the traditional phases of innovation management intertwine to leverage innovative projects that transform ideas into solutions or develop users' innovative skills and mindsets (Thorpe & Rhodes 2018). At this stage, the Innovation Lab can provide coaching, mentoring, or hosting for meetings with end users to get feedback and control the risk of failure. In addition, tools, equipment, and technology for testing and prototyping should be provided as part of the funding. After the innovation and development phase, the "delivering and application support" phase aims to deploy and apply the solutions value-added. In this phase, the Innovation Lab provides consulting or guidance services to help users formulate strategies to launch, enter, or grow the market and synthesize learned knowledge into documents or improve routines. In this phase, Innovation Labs can also play a strategic role by bridging the gap between the firm and the market (Fecher et al. 2018). The last phase is about "reviewing and consolidating". The developed activities are critically reviewed. The result of the activities is compared with the original goals to gain lessons learned and encourage further action to design innovative activities and strategies.

To date, there has been widespread interest in describing the structure and function of Innovation Labs. Still, little research has been conducted on the management of these Labs and on investigating their role as platforms enabling organizations' digital transformation (Osorio et al. 2019). For this reason, this chapter proposes the analysis of a case study aiming to provide a helpful empirical basis to understand the management of an Innovation Lab as a "guide" for organizing a digital innovation journey.

Research design

The empirical investigation refers to the analysis of a single case study, i.e., an Innovation Lab founded to support organizations and the local innovation

ecosystem in boosting digital transformation and disruption. As discussed by the management literature, adopting a case study-based approach is recommended to identify relevant insights supporting the elaboration of a theory (Eisenhardt & Graebner 2007; Yin 2014). Case studies enrich the empirical base for a later theory-building process by asking "how" and "why" questions in a real-life context (Glaser & Strauss 1967; Yin 2014). Moreover, according to Yin (2014), a case study approach fosters collecting valuable insights and detecting critical learning points related to the field of analysis (Amabile et al. 2001). Through an in-depth investigation of a real-life case study of an Innovation Lab, this research has attempted to enrich knowledge on "how" an Innovation Lab can be managed to foster digital transformation and business model innovation in organizations.

The methods used to collect data varied and ranged from participant observation (Longhurst 2003) to semi-structured interviews (Spradley 2016) with the laboratory head, the project manager, staff and experts, entrepreneurs, or critical stakeholders involved in the Lab's activities. To ensure adequate data collection, one of the authors contacted the head of the Innovation Lab directly to arrange a time for the interviews and obtain permission to visit the laboratory, observe, and collect data during the exploitation of the Lab's activities. Therefore, he paid particular attention to observing, coding, and reporting key findings and generated knowledge about each exploited activity. The authors then triangulated the empirical evidence from the case study analysis with the literature review on Innovation Labs data. This approach enabled the control and reduction of bias arising from a single observation (Tarrow 1995). The approach was designed as a sequential process. The first step was to sift through the notes collected immediately after the interview to extract new concepts and insights. Then, manual transcription, review, and coding were conducted. The coding process, which is the analysis process to evaluate the data to make sense of the notes, was completed using deductive methods. Each transcribed interview was explained using patterns from the literature on digital transformation and Innovation Labs. The outputs of these processes were the identification of the critical stages and activities that differentiate Innovation Labs and promote digital transformation and business model innovation in organizations.

In terms of validity and reliability of the study, the research was conducted in accordance with Yin's (2014) guidelines for strengthening the validity and reliability of qualitative case studies. This research combined data collection methods of participant observation, semi-structured interviews, active listening, and understanding online webinars. By using these different methods, the knowledge gained was triangulated to improve the validity of the findings.

Innovation Lab as a platform for digital transformation

The case study refers to an Innovation Lab operating in Finland, which aims to promote digital transformation and disruption of organizations and the related local innovation ecosystem and support them in accelerating time-to-market, sales, and R&D&I processes. The Innovation Lab functions like an "innovation platform where leaders and winners meet". The overall goal of the Innovation Lab

is to bring leaders and winners together, i.e., to bring companies and researchers together to develop and leverage joint innovation projects. Digitization and digital transformation are among the top priorities of the Innovation Lab, and it works with organizations to implement digital transformation plans. However, they recognize that digital transformation is not just about technology. It is a process that encompasses many aspects of the organization, from mindset, culture, processes, and attitude to politics, society, and behaviour. In particular, the Lab's digital transformation activities aim to increase the local health-sector community's chances of success by providing expertise to start-ups and incumbents, health-sector developers, researchers, and healthcare workers. The Innovation Lab provides space and a wide range of opportunities to network, find collaborative partners, and carry out joint development projects. For example, the programme "Intelligent Industry Ecosystem: Turning Digital into Practical" aims to bring together leading device manufacturers and digital solution providers to drive and realize the immense opportunities of the new era of smart industry.

Specifically, the Lab's activities begin with an annual meeting with employees, companies, and stakeholders who participate or are interested in the community to understand the needs or issues that need to be addressed. Several critical topics that companies want to pursue or invest in are identified. At this stage, the Lab's operators act as facilitators and mediators. They offer companies and research institutions various optional projects or colleges (e.g., demonstration booster programmes, testbeds, machine learning colleges, post-doc projects, digital transformation pathways) to foster the development of innovative solutions. For example, the Lab organizes the "Smart Steel" programme, where participants are challenged to develop new digital markers, fingerprints, and identities for steel based on challenges they have identified with leading companies. To develop the innovative skills of the participants in the field of artificial intelligence and machine learning, the programme "Machine Learning Academy" is also organized.

In addition, the facilitator held discussions with participating companies and research institutions. The Innovation Lab can also gain insight into the type of technology being used to solve the problem. Once each lead organization knows what stage of innovation the project being developed is in, the activity takes place outside the Lab, i.e., within the boundaries of the partner organization. This phase is carried out according to the co-creation method with the participation of research institutions and experts. Participants can complete the project or selected projects while attending the Innovation Lab seminars on topical issues to promote the mechanism of continuous learning and receive the continuous support of the Lab. The next step is the core business of the Lab. Here, the scope is to shorten the time-to-market for new digital solutions developed by the company. In this case, the Lab promotes networking activities and helps large companies vertically integrate the solutions of start-ups, small and medium size enterprises (SMEs), or talents into their supply chains. Through strategic partnerships and with the "Demo-Booster" service, for example, the Lab helps organizations hunt for killer applications and create and test minimum viable products and proof of concepts. As a final step, the Lab seeks to collect feedback at the end of each activity and conduct a systematic survey of stakeholders. The data from the survey and the

discussions with shareholders allow the Innovation Lab to determine the evolution of the daily activities and the challenges to overcome.

Discussion and conclusion

The collected data, participant observations, and semi-structured interviews highlight that Innovation Labs can be an effective model for promoting a company's digital transformation.

Regarding how Innovation Labs promote digital transformation, the case study shows that the main activities of an Innovation Lab to catalyze digital transformation can be grouped into the five phases distinguishing the management of an Innovation Lab (Santarsiero et al. 2021). Specifically, in the "focusing" phase, the manager of the investigated Lab meets with shareholders once a year to find out what issues the companies are facing and which they want to invest in. The "engagement and enabling" phase starts during the previously mentioned meetings with shareholders. Here, activities and programmes like those mentioned, including "Intelligent Industry Ecosystem: Turning Digital into Practical", enable participants' to empathize with detected challenges and opportunities and to meet cooperation and open innovation opportunities to design and start innovation and digital transformation projects. In the "developing innovative solutions" phase, the investigated Innovation Lab provides companies and engaged actors with the required support to carry out and execute the designed innovation and digital transformation projects (i.e., "Smart Steel"). This is a practical phase where digital transformation takes shape within the Lab and needs to be delivered to the application context and the final users. In the "delivering and application support" phase, the main goal is to accelerate the time-to-market of new digital solutions developed by companies. In this regard, the Lab facilitates networking activities where large companies are supported to vertically integrate solutions offered by start-ups, SMEs, or talents into their supply chain (i.e., the 'Demo-Booster' mentioned earlier). Finally, regarding the "reviewing and consolidating" phase, it is common to seek feedback at the end of each activity and conduct systematic surveys of shareholders and stakeholders. The data obtained from the surveys and discussions with shareholders allow the Innovation Lab to identify challenges from which ordinary activities can be developed and addressed. Despite their importance, the actions of "reviewing and consolidating" are unstructured. To date, there is a lack of rigorous and planned methods for evaluating the impacts generated on a company's performance and, more widely, on its ecosystem. According to the interviewed managers, this is due to the limited time spent on evaluation activities and difficulty determining valuable indicators. However, this is a critical issue that managers are focusing on.

The case study revealed the importance of applying a human-centred, user-driven, and open innovation approach to enable people, employees, stakeholders, and organizations to participate in the local innovation ecosystem actively. According to this approach, each engaged participant in the Lab activities can shape digital solutions that meet user needs and actively participate in the digital transformation and innovation process. This, in turn, contributes to improving

customer satisfaction and experience. The Innovation Lab can act as a testing environment and help organizations test solutions directly with end users. This way, feedback can be collected to improve the solution and constantly understand the market's actual needs. Active participation in the testing of solutions and all phases of the digital transformation and innovation process can also improve the quality and effectiveness of the operational process. The Innovation Lab can also serve as an innovation catalyst and open platform for the local innovation ecosystem. It can promote dialogue and active collaboration between institutions and companies with innovative start-ups.

Innovation Labs are emerging as a valuable response to companies' needs for developing digital transformation and business model innovation. This chapter uses a case study to analyze the role of these Labs as a helpful management model that can support organizations to address the critical challenges of digital transformation. The research highlights how these Labs can be effectively managed and provides academics and practitioners with useful insights and suggestions for developing and managing the Labs' activities. In particular, the case study highlights the importance of applying a human-centred, user-driven, and open innovation approach to enable organizations to embark on a digital transformation journey. It also confirms the usefulness of managing Innovation Lab activities according to several stages ranging from a clear identification of organizations' needs and requests to the engagement of all its stakeholders in developing new digital culture and solutions, to accelerate the time-to-market of new digital solutions developed and to the review the carried-out activities and obtained results.

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10 Future avenues of digital transformation

Next steps?

Jari Kaivo-oja, Mikkel Stein Knudsen, and Theresa Lauraéus

Introduction

Digital transformation offers a chance to provide better public services to citizens in the future, as seen in the preceding chapters of this book. Digitalization may be a boon to efficiency and public productivity – with digital tools, governments can offer the same solutions as before, now only faster, cheaper, or both. However, digital transformation also allows for provisions of services not previously available nor perhaps even imaginable. However, this requires public actors to adopt experimental cultural practices and actively innovate new products and services – the subject of this book.

While the processes and incentives for innovation in the public sector are different compared to the private sector, an obvious path for the future would be to embrace the same ideas, inventories, and innovations that the private sector embraces, applies, and uses. We can call this strategy an *imitation* strategy. The public sector can just imitate the activities of the private sector. More promising, though, is to do something more than mere imitation. This is, of course, a more demanding strategy for the public-sector agencies, but the most promising future avenues of digital transformation in the public sector do indeed stem from achieving something above and beyond private-sector imitation.

The big challenge is to identify the appropriate means of encouraging creativity and public innovations within the essential framework of democratic accountability (see, e.g., Altshuler & Zegans 1990). Well-functioning digital transformation needs to re-think appropriate means of encouraging creativity and public innovations in the public sector. Also, public–private innovation networks need more attention (see Tahi et al. 2021) because there is a need for a business model (Coskun-Setirek & Tanrikulu 2021; Usai et al. 2021) and governance regeneration.

In Figure 10.1, we have visualized digital transformations and their impacts on innovations in government and public-sector agencies. It is good to remember that the private sector and the government and public-sector agencies are interlinked. The next avenue may be to study more deeply these interactions. Figure 10.1 describes four key process models, which drive four key forms of innovations.

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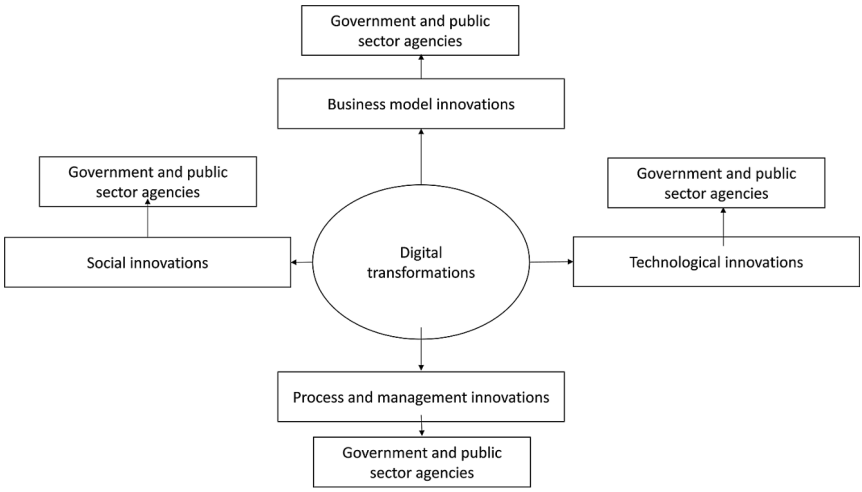

Figure 10.1 Digital transformations and impact of innovations on the government and public-sector agencies.

We suggest that future avenues of innovations will come in each of the four domains, as well as in interactions between the domains of technological innovations, process and management innovations, social innovations, and business model innovations.

Furthermore, during the rest of this final chapter, we speculate that the most promising strategies for digital transformation and public innovation will rest on three separate, but often interlinked, legs: (1) *the experimental government*, (2) *the inclusive government*, and (3) *the anticipatory government*.

Government is used here as an umbrella term for any public actor capable of providing value-add on its own (international organizations, regional public authorities, governments of larger cities, etc.).

The experimental government

First, we suggest a strong emphasis on the idea of the experimental government. This is by no means a new idea. Already the philosopher, MP Lord Chancellor and Attorney-General, Sir Francis Bacon, in his 1624 book *New Atlantis*, proposed a utopian state with a proto-government-backed centre for science and experimentation (Breckon 2015). While the attempt to set up a "Salomon House" institution initially fell on deaf ears, it helped inspire the establishment of the *Royal Society* in 1660. Later in the 19th century, the concept of "social experiment" was very popular in societal debates and dialogues. Thinkers such as Auguste Compte, John Stuart Mill, and George Cornewall Lewes used it as a metaphor for what might be learned from events, where normal life was disrupted by "Acts of God", such as famines and floods (Breckon 2015). The idea of trials controlled and executed by the researchers was considered unethical by this group of early social scientists. However, their ideas about using natural experiments to learn about social systems have lived on. The 20th century saw a rise in government experimentation arising

from the combination of increasing interest in applying Bacon's logic of science to social phenomena and the development of the welfare state of Western governments. It is not a big surprise why some scientists consider Sir Francis Bacon as one of the founding fathers of futures studies.

Learning by doing

Writing in the early 1960s, Stanford professor and future Nobel Prize winner Kenneth Arrow, wrote a much-cited article about "learning by doing" (LBD), essentially following on Bacon's core tenets. Arrow advances "*the hypothesis here that technical change in general can be ascribed to experience, that it is the very activity of production which gives rise to problems for which favourable responses are selected"* (Arrow 1962). It is through the doing – through experience and experimentation – that learning is accelerated and productivity gains harvested. The idea of LBD gained traction by offering a source of technical change which was intuitively plausible and invited to appropriate policy interventions without similarly extending the complexity of optimization much (Thompson 2010).

Of course, LBD is not the only source of technical change in society. There is a full school of innovation literature focused more on models of deliberate invention compared to invention as a serendipitous by-product of experience (Young 1993). Others have also complemented Arrow with concepts such as learning from others, learning by investment, and learning by reading. However, the innovation potential from production, from doing, and from experimentation should still be valued today.

We hypothesize that one main avenue of future public innovation comes from experimentation with data and new digital tools. Among the important research fields will be sensemaking scientific experimental research on artificial intelligence (AI), various forms of learning, and the social functioning of algorithm economy. There is also a need for more research consideration in the field of public governance for persistent and bold experimentation with big data analytics and data pools. In the future, experimental governments use digital opportunities to try out ideas before applying them at scale, while also using digital transformation for rapid policy design (Longo 2018) and small-scale policy prototyping (Kimbell & Bailey 2017; Kimbell 2019). Addressing 21st-century problems with old tools and methods is unlikely to be effective, and, luckily, many governments around the world have started to explore new opportunities (see, e.g., Tonurist 2018 for cases).

It has recently been lamented (Bravo-Biosca 2020) that while the main aim of innovation policy is to support experimentation with new technologies, products, processes, or business models, innovation policy itself is paradoxically not very experimental. The winning innovation strategy of future governments should challenge this paradox. Controlled trials for government Science, Technology, and Innovation (STI) programmes will be needed more in the future. The broad motivational factor on this future avenue is better public–private quartet (or Guadalupe) Helix collaboration in the field of STI policies. We can find the political roots of these ideas in John F. Kennedy's "New Frontier" and Lyndon B. Johnson's idea of "Great Society" in the 1960s. Now the idea of scientific social experimentation has

gone beyond national boundaries, especially in the European Union (EU) and in other big countries. The role of BRICSA countries (Brazil, Russia, India, China, and South Africa) is growing relative to G7 countries, and we can observe multi-cantered digital innovation hubs and innovation centres. A good example is the growing network of European Innovation Hubs (European Commission 2021).

Beware the "Hawthorne Effect"

A critical and broad scientific question is whether these kinds of programmes are real digital innovation programmes or digital intervention programmes and whether they are actually capable of inducing transnational experimentation and LBD. Too often, planning, programming, and budgeting logic lead researchers to overpromise and overstress what they actually can deliver, while political decision-makers are (too) impatient for successful scientific progress. The classical "Hawthorne Effect" is still a relevant threat to STI policies. The Hawthorne Effect means that, sometimes, public officials try to make the intervention look especially good because they are under the watchful eye of an experimenter. This is one reason, why "reforms of experiments" need more critical scientific attention in the future. However, even if the STI policies need a "trial and error" process, increased digitally aided experimentation will be a plausible avenue towards better public governance also in the future.

The inclusive government

Smart governments leverage the inputs of stakeholders for the co-creation of digital transformation and digital innovation. This is in line with the broad set of five trends that have been guiding the debate on innovations in public administration over the two latest decades, as described by Cavalcante and Camões (2017). These include improvement of mechanisms of transparency and open government, increased citizen participation in public administration, encouragement of more active roles of citizens in the creation of political capital, networks and partnerships of state actors, social, and private enterprises, as well as the use of information communication technology (ICT) to increase the quality and efficiency in the delivery of public services. Famed Nobel Prize winner Elinor Ostrom highlighted the importance of co-production of public services (Ostrom 1996); later public administration trends have moved on from co-production to co-creation (Lember et al. 2019). We might see this as a normative turn towards a premise of *distributed agency* in innovation policy, where public-sector dynamic capabilities are generated through learning from wider societal engagement and coordination (Kattel & Mazzucato 2018). The determinant of who gets to participate in public innovation processes should not be organizational boundaries, but the possession of relevant innovation aspects, such as ideas, visions, experience, and implementation capacity (Ansell & Torfing 2014). Essentially, this is also drawing on the Arrowian theory of LBD – if production and applications are among the foremost mothers of invention, public innovation processes must include those stakeholders involved in actual service production. Taking away organizational boundaries as a limitation,

this list of stakeholders may include everything from researchers, citizens, and street-level bureaucrats to social movements, private service providers, and industrial interest organizations. Akin to the much-discussed change from shareholder theory to stakeholder theory in the corporate world, we might designate this as a shift of public administration from new public management (NPM) to new public governance (NPG) (cf. Ansell & Torfing 2014).

Digital innovation ecosystems

Grand challenges are best solved through dynamic public–private partnerships (Kattel & Mazzucato 2018), and the innovation spearhead of inclusive governments are thus public–private innovation ecosystems. Recent research on the genesis of such systems in a pan-European context suggests that, hitherto, value-creation tends to be biased towards incumbent firms and complement challenges, inclusion biased towards certain engineers and researchers, and that knowledge of application domains strongly contributed to the emergence of bias (Asplund et al. 2021). This suggests that appropriate management is required to avoid innovation ecosystem failure (Asplund et al. 2021).

How might digital co-creation of public innovation avoid such innovation ecosystem failures? There are already numerous studies with policy suggestions for creating ecosystems (see, e.g., Autio et al. 2018; Gomes et al. 2021), and this is a sure-fire major research theme for both innovation policy and public administration scholars in the years to come. One promising avenue is to create public digital ecosystems with direct inspiration from software ecosystems, such as is being done with the upcoming trillion-euro EU investment "Destination Earth" (Nativi et al. 2021). This emphasizes as constitutive criteria

- high flexibility and modularity;
- independence from any specific provider, technology, or licence;
- preserve and facilitate the co-evolution of the "digital species" populating the digital environment of the ecosystem;
- equal opportunities of access across organizational size and location in the ICT value chain; and
- meta-systemic governance of the ecosystem to govern emergence, adaptation, mutations, and strains.

In a world where digital transformations are often thought of as speedy, volatile, and almost unpredictable, this is a remarkable example of taking the long-term value-creation and long-term resilience of an ecosystem into account already in the planning phase. Built around offering new levels of data collected by publicly funded entities, as well as user-centric stimulants for data usage, to a wide range of user groups, we can also frame it as an example of moving from "Open Government 1.0" towards a more co-creational approach. A decade ago, the opening up of government data was talked about as almost revolutionary, and, for example, an influential Finnish think-thank paper boldly claimed, "*Open data has been hailed as one of the most important public policies of our time, and the potential impacts of sharing*

such data cooperatively are enormous" (Halonen 2012). The impact of open government data was anticipated to increase public accountability, improve public-sector efficiency, fuel the development of services by third parties, and foster innovation (Magalhaes & Roseira 2020). Unfortunately, there is little post hoc empirical evidence to support the hypothesized impacts (Tai 2021; Zuiderwijk-van Eijk & Reuver 2021). Instead, it is becoming increasingly clear that "just" making data available – often somewhere, almost invisible, on a remote server – is not enough to induce the desired effects; instead, the government must take on an entrepreneurial role as co-creating data/digital ecosystem manager.

There are co-evolutions between digital technologies, innovation ecosystems, and skills (dynamic capabilities). These kinds of co-evolutions both require and are driven by a reorganization of productive and innovation processes, both within and between firms (Ciarli et al. 2021). These evolutionary processes may require a new set of stylized facts to better map the main future trajectories of digital technologies, their adoption, use, and recombination in organizations, to improve our understanding of their impact on productivity, employment, and inequality. This scientific observation (Ciarli et al. 2021) is relevant also to the public sector and governments.

In Figure 10.2, we have visualized interconnections between innovation ecosystems, dynamic capabilities, and digital technologies. The evolution of AI waves is a key element of digital technologies.

We cannot talk about ecosystems without also talking about platforms. However, we should not see platforms as a technology, but more as business models, where both public and private stakeholders act as the owner of the platform and orchestrate different stakeholders to exchange value. Both private and public agencies can act as platform developers. The platform model integrates producers, consumers/citizens, partners, and owners. We know that for the private-sector platform economy, blockchain technology has the potential to disrupt the current

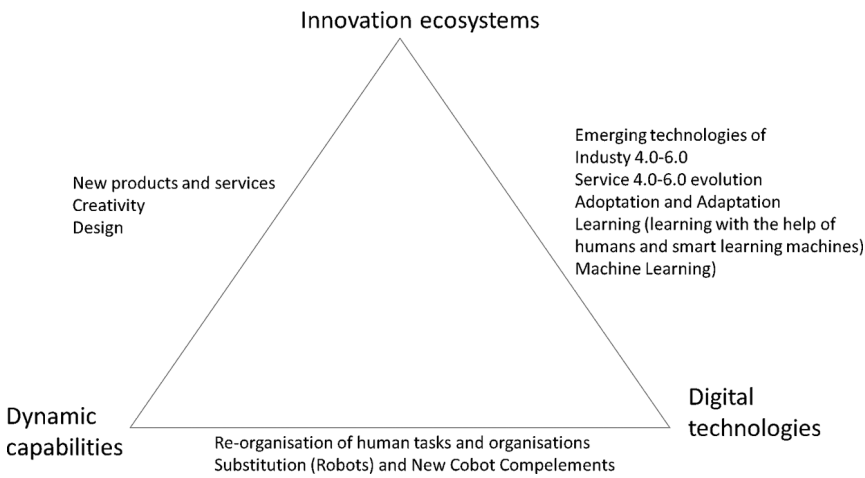

Figure 10.2 Interconnections between innovation ecosystems, dynamic capabilities, and digital technologies.

value-creation models. Matthias Walter (2017) has noted that the regulated blockchain will be the strongest driver for a trusted multi-owner economy. In the current platform economy, the power belongs to the owner of the platform. The platform owner is responsible for (1) the infrastructure, (2) governance, and (3) the business model. The platform owner orchestrates the value exchange and drives the development of the platform to lower the friction of using the platform. If we combine the platform model with a regulated blockchain technology concept, we will face a shift of power from a single owner to a multi-ownership model. In this new model, partners or stakeholders are transforming from value-adding service providers to neutral, trusted, and governance-related third parties of the decentralized owners (see Walter 2017). Blockchain solutions might also provide more decentralized systems for public information management (Kassen 2022). Decentralization and autonomous solution can change many fundamental ideas of the government and its provision of services to citizens and enterprises, and how this plays out will be an important theme for future research.

To sum up, the organization of innovation ecosystems, of public–private platforms, and of public-sector blockchain solutions still contain many outstanding issues, which we see as potentially defining for future digital transformation and public innovation.

Public procurement as a driver of innovation

Public procurement is a very literal form of a public–private relationship. It has been promoted as an effective demand-side policy instrument for leading public and private actors to implement more sustainable practices and results (e.g., Lenderink et al. 2019; Uyarra et al. 2020). This kind of planned management process can be leveraged to develop innovative practices oriented towards sustainability and create new markets for eco-friendly products and other useful services such as the development of greener markets for a circular economy. Public procurement can be studied as a design activity to increase its effectiveness as an innovation policy tool. There is a need to clarify the mechanisms by which public procurement can stimulate sustainable innovation in organizations, creating opportunities for collective innovative practices (see Ntsondé & Aggeri 2021). One promising avenue is to introduce better pre-tested public procurement mechanisms. With these kinds of procurement mechanisms, we can identify potential peripheral visions and hidden needs of stakeholders. Innovation potential can be revealed by these tools and mechanisms.

Today, in EU member states, public procurement procedures must be carried out following national procurement legislation and the procurement directives of the EU. The main purpose of procurement regulation is to increase the efficiency of the use of public funds and to enhance the competitiveness of European businesses. The modern regulation strives to secure the free movement of goods, services, capital, and labour. However, no regulation is fully perfect, and in many countries, regulations are not implemented rightly due to corruption and/or inefficient management styles. Securing transparent, efficient, and non-discriminatory tendering processes is an important institutional challenge.

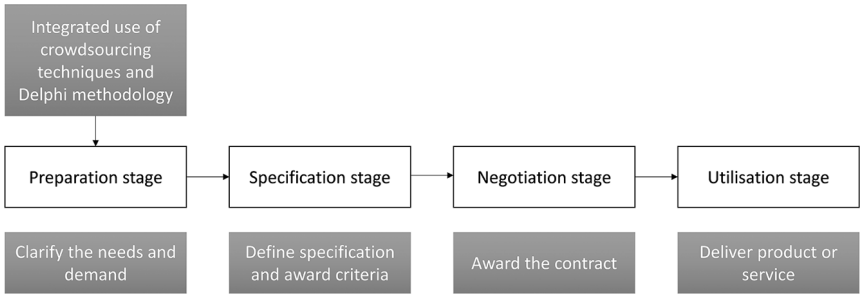

Figure 10.3 Public procurement process, crowdsourcing, and expert panel tools (modification of Witjes & Lozano 2016).

Another important future element for stimulating innovation is to make better use of the public procurement policies for public innovation management. We suggest that there is major untapped potential for better co-creation within this process. In Figure 10.3, we present one solution to improve the digital co-creation of public innovation.

First, the link between procurement and supply practices is a critical issue. The model visualized in Figure 10.3 proposes changing from a traditional public procurement process, based on product-selling business models, to a more service-oriented system. User-demand and stakeholder needs should be taken better into account already in the preparation and specification stages. Integrated uses of crowdsourcing techniques and Delphi methodology, through digital tools, would be an innovative and beneficial approach to ensuring this, as well as a good example of an *inclusive government*. By including stakeholders' input systematically early on in the process, there is increased hope the results of the utilization stage will satisfy actual needs. Another important element is to create a feedback loop so that the experiences from the utilization stage are collected systematically and used for future improvements. Most public procurement processes are not one-off, so the evaluation of one delivered procurement project must feed into the preparation stage for the next, similar, procurement project. The importance of this should not be understated. Again drawing on the Arrowian concept of LBD, increased reliance on private service providers entails a major risk for public innovation, if outsourcing and projectification curtail (in-house) organizational learning. If, however, public procurement becomes a systematic tool of experimentation from which the system – in both its public and its private constituents – *can* generate learning, it might lead the way for public innovations in the digital era.

Promoting sustainability and new social innovations

The development of social innovations for the needs of the digital transition process is likely to be one of the most interesting areas of innovation research in the near future. We may not have realized the full potential of digital technology solutions for social innovation. A new avenue awaits us in this area of innovation research.

There have been numerous studies on the transformation of the public sector and its innovation activities. Many studies have neglected one key aspect: the dissemination and adoption of management accounting practices within the public sector. There are various needs to explore (1) the manner and means of innovation diffusion, (2) the obstacles to adoption, and (3) to establish a research agenda (see, e.g., Lapsley & Wright 2004). Financial managers of public-sector agencies use various digital tools, platforms, and apps. The adoption of digital accounting innovations by public-sector organizations is largely affected by government influence. We elaborate that there is a need for a new research agenda on the diffusion of digital management accounting practices in the public sector.

Another inspiring avenue is the increased use of social impact management plans (SIMPs) to manage social issues in the public sector (Frank & Vanclay 2013) transparently and inclusively. Digitalization and management tools may be linked to SIMPs. SIMPs can be developed in partnership with regulatory agencies, investors, and the community. For example, SIMPS can be used for sustainability assessments and for promoting the green transition towards sustainability. SIMPs link assessments to ongoing management and clarify responsibilities in the management of impacts, opportunities, and risks, and address ongoing social and community issues. The community-led SIMP for potential mining explorations in the small, sparsely populated municipality of Sodankylä in Northern Finland is a good case study of the sustainability/social/local governance potential of SIMPs (Suopajärvi & Kantola 2020). We hope to see many such applications and experimentations in the coming years.

Much of recent innovation policy has been reorientated towards grand challenges, "missions", and the Sustainable Development Goals (SDGs). We have seen manufacturing companies reorient themselves due to sustainability-related technological turbulences and changing external environments (Ogbeibu et al. 2020). The SDGs, from combating climate change to increasing gender equality, are also likely to be an important driver for changes to public administration, public innovation, and digital transformation. Mitigating the emission of greenhouse gases is a driver for implementing smart cities, while climate change adaptation is a driver for satellite investments such as Destination Europe. However, the mentality of the SDGs also invites a much more fundamental shift in the organization of public innovations, as the necessity of inclusiveness directs policymakers towards much higher levels of citizen participation (Peutz et al. 2020). Even as innovation policy, for example, in the EU is reformulated towards new missions, the missions often fail to take citizen participation sufficiently on board. How digital tools might assist in "democratizing innovation with SDGs" (cf. Peutz et al. 2020) should be a major research theme for future research on public innovation and digital transformation.

Inclusiveness goes beyond living humans

Until now, the co-creation of public services and public innovation has meant the inclusion of humans living today. For most people this probably represents the natural state of things – not only are living humans the group seen as most

immediately affected by any course of public policy, but it is probably also the only group capable of systematically communicating their preferences into public processes (here we consider inputs of firms and organizations also to be transmitted through living humans).

However, several ongoing trends suggest presumption could be challenged in the future. Firstly, there are movements to ascribe rights to future generations of humans and include them in the policymaking of the present (Gonzalez-Ricoy & Rey 2019; Krznaric 2020). Secondly, there are jurisdictions around the world starting to ascribe legal rights also to nature as innovative institutional arrangements underpinning sustainability (Borras 2016; O'Donnell & Talbot-Jones 2018). Thirdly, with digital transformations, algorithms, the rapid rise of human-machine interactions, and collaborative robotics (Knudsen & Kaivo-oja 2020a, b; Lauraéus et al. 2021), and with increasing shares of machine-to-machine interactions, there is already a de facto machine participation in collaborative innovation networks (Kattel et al. 2020). Are we not soon likely to consider also the rights of robots (cf. Bennett & Daly 2020)? At least we will hypothesize here that the notion of inclusive governments could fundamentally change as the considerations of the natural world, of future generations of humans, and of machines and robots as stakeholders in public processes rise subject of both academic and public debate.

The anticipatory government

For years, it has been postulated that the world has moved into an era of VUCA (Kaivo-oja & Lauraéus 2018), i.e., with unprecedented levels of Volatility, Uncertainty, Complexity, and Ambiguity. Rarely has this been truer than since the onset of the COVID-19 pandemic with all the digital and societal transformations this has since triggered. In a VUCA-world, there can be no organizational expectation that tomorrow will look like yesterday or even today. There is no such thing as guaranteed business-as-usual (BAU).

As uncertainty grows, the necessity of foresight increases. Foresight, here, aims at anticipation, not prediction. Through envisioning multiple futures, wiser courses of action in the present are supported (Maffei et al. 2020). It might help condition policies to be more appropriate, more robust, and more flexible to changes in times and circumstances. By introducing foresight in government we can talk about anticipatory governance. Leon Fuerth, who served eight years in the Clinton Administration as national security advisor to Al Gore before becoming founder and director of the George Washington University Project of Forward Engagement, has described anticipatory governance as "*a mode of decision-making that perpetually scans the horizon" and a "scalable system of systems*" (Fuerth 2009).

Anticipatory governance in this terminology is a forward-looking endeavour, which includes participatory foresight and enables rapid policy prototyping. It thereby combines all three modes of *experimental government*, *inclusive government*, and *anticipatory government*. We can also link anticipatory governance with the current mission-focused innovation policy. Missions, such as those enabling green transition, might be defined through defining the societal grand challenges of the

future. The innovation policy reorientation shifts focus from short-term problems and priorities to long-term policy problems, based on *how they are anticipated in the present*. Digital transformations and public innovation should assist us on the road to solving these problems of tomorrow – or help us realize our societal *preferred futures* as devolved through visioning processes. Organizations better equipped at formulating their (non-BAU) preferred futures will also be better at stimulating innovation to realize them. We can consider this as innovation policy through visionary market-shaping, or see it as anticipatory institutionalism in which envisioned futures lock in particular market paths.

There is also a more hands-on interpretation of an anticipatory government, which we might conflate with the somewhat derogatory term *algorithmic governance*. With data, algorithms, and AI predictions about the future begets (Agrawal et al. 2018). The proliferation of highly adaptive algorithmic decision-making systems in both the private sector and in certain areas of public-sector services provisions has attracted much interest, and there is no shortage of literature critical towards this development (for a primer, see, e.g., Katzenbach & Ulbricht 2019). We are very aware of challenges and limitations (for example, predictive policing is a highly contentious issue), but we see it as value-neutral to remark that applications of digital tools for anticipation will be a major theme for public–private innovation for years ahead.

Important themes in this regard will be how to align data-driven anticipatory governance with citizen and stakeholder participation (cf. Maffei et al. 2020) and how to use data-driven anticipatory elements also for policy and policy futures (Kimbell 2019).

Data-driven value-creation

Nowadays we are living in the "Age of Data", with new data being produced from all industries and public bodies at an unprecedented and constantly growing rate. The term "big data" captures the exponential growth of data flows, particularly the data flowing from ubiquitous mobile phones, satellites, ground sensors, vehicles, and social media. As a result of the data revolution, there has been a great hype, which has led organizations to make substantial investments in their quest to explore how they can use their data to create value (see, e.g., Constantiou & Kallinikos 2015).

The main premise big data analytics builds on is that by analyzing very large volumes of unstructured data from multiple sources, actionable insights can be generated that can help firms and decision-makers transform their business models and gain a strategic edge over their competition (see, e.g., Chen et al. 2012; Roth et al. 2020). Being able to obtain such data-generated insight is particularly relevant for organizations that operate in dynamic and high-paced business environments. In these kinds of rapidly changing business environments (cf. VUCA) making informed decisions and taking informed action is critical (Wamba et al. 2017).

Big data is a term nowadays widely used to describe the exponential growth of data flows, particularly the data flowing from ubiquitous mobile phones, satellites,

ground sensors, vehicles, and social media. Nowadays, public-sector organizations and agencies are really meeting the challenges of the big data era. Big data can be used by the computing technologies and algorithms that harness big data for valuable insights for explorative government decision-making. In the public sector, big data typically refers to the use of non-traditional data sources and data innovations to make government solutions more responsive and effective. In Figure 10.4, we can see the spectrum of quantitative and qualitative data methods and small, pool, and big data. Data libraries and data pools are needed for this kind of analytical purpose. Typical key challenges of data analytics are deeply rooted in the use of methods. In the field of big data and data pool analyses, typical analysis tools are statistical analyses, bibliometric analyses, semantic analyses, and combined mixed-methods approaches, where qualitative and quantitative analyses are mixed. The next avenue of digital transformation is surely linked to quantitative and qualitative data analytics (see Figure 10.4).

Big data analytics can be used by governments and public agencies to improve existing services and to draw on novel datasets to drive entirely new public services. Feedback mechanisms can be improved. Also, modern policymakers are using satellite imagery, cell phone data, and more to produce alternative economic indicators for new – and real-time – policy insights. The quality of public decision-making can be improved. By applying machine learning and new digital learning tools to online and social media, governments can be more responsive to citizen sentiment, ushering in a new dimension of civic engagement. Public service delivery, policymaking, and citizen engagement can benefit from better big data analytics (see, e.g., World Bank Group 2017, p. 2).

Three components of creating value by big data are (cf. Olszak & Zurada 2020) (1) dynamic capabilities of organizations, (2) integrated process of big data resource exploration and exploitation, and (3) identification and measurement of business value-creation based on big data. Another typology of the big data variables is "the 7 Vs": Volume, Velocity, Variety, Veracity, Visualization, Variability, and Value.

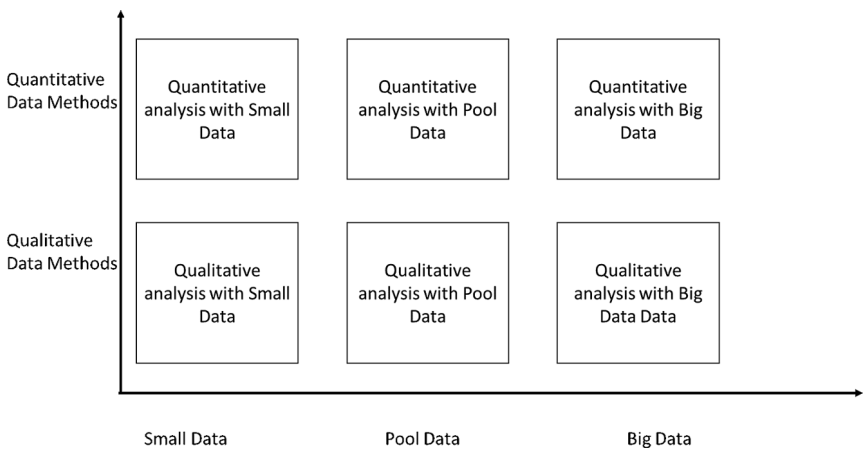

Figure 10.4 Quantitative and qualitative data methods and data size (Kaivo-oja et al. 2021).

While it might sound simple and catchy, successful management of these seven variables contain multitudes of challenges for organizational practices.

We want to highlight one key variable here. The variable of visualization has become very important in recent years, and it is difficult to understate the role of data visualizations in translating predictive analytics into actionable insights also for policymakers and public administrators. Recently, researchers have suggested a brand-new field of "visual policymaking" as a research field for the future (Gomes et al. 2021). If digital transformation shall stimulate policy changes or accelerate innovation, this is a high-priority future avenue.

Smart cities and digital twins

Smart cities have become the poster child for public-sector adoption of big data frameworks in many regions of the world (Silva et al. 2018; Löfgren & Webster 2020). The concept itself has been defined in myriads of ways, but at its core, it is about using real-time monitoring data for optimization of the performance of a city – for example, improved mobility, improved sustainability performance, or even improved quality of life. We are now also seeing the concept of digital twins (DTs) supplementing smart cities. DTs are virtual models that transmit data in and out of the virtual space, i.e., highly detailed digital models that interact with physical reality (Savolainen & Knudsen 2021). By connecting available real-time data (e.g., collected from sensors and internet of things solutions around a city) and by probabilistic prediction of future values, simulation-based DTs can front-run systems and, in real-time, present windows into the future of possible system states. This facilitates automated high-speed decision-making. The previously mentioned project of Destination Earth aims at building a full DT of Earth, which would connect enormous amounts of continuously updated satellite data with the opportunity for users to simulate various developments. It, and similar developments in other arenas than Earth observation data, will equip future policymakers with simulation-based models of possible futures beyond what has ever previously been possible. We see it as a signal of significant new opportunities for anticipatory governance, and it is likely to stimulate public innovation too. Public–private ecosystems centred on DTs are arguably one of the most interesting arenas for public administration and public innovation scholars to turn to in the 2020s.

AI and the next waves of AI revolutions

Of course, what might also really accelerate digital transformation is a new wave of AI revolution. AI is already everywhere, fuelling a multi-billion-dollar industry and radically changing how businesses operate and how people work and play. Yet as powerful as it is today, major limitations are holding back the realization of AI's true capabilities. The "three waves of AI", as described by Defense Advanced Research Projects Agency, DARPA's expert John Launchbury (Launchbury 2017), refers to the state of artificial intelligence capabilities past, present, and future (Jones 2018). We have illustrated this in Figure 10.5. The first wave was circa the

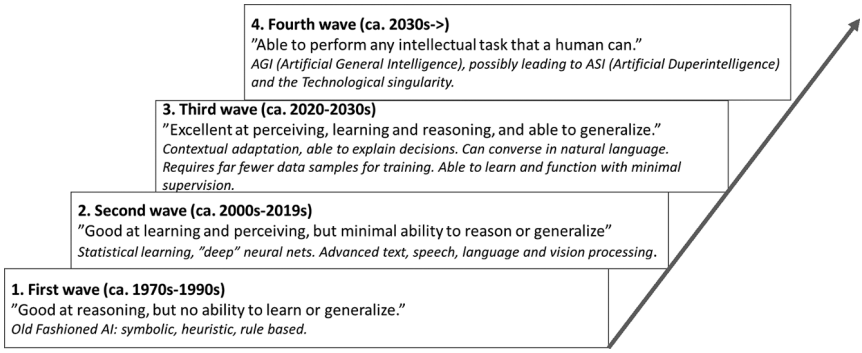

Figure 10.5 The coming revolution in Artificial Intelligence: The four waves of AI (modified from Jones 2018; Launchbury 2017).

1960s–1990s, and it has been called the GOFAI era: Good Old-Fashioned AI. AI applications of this era were good in reasoning, but they were not able to learn or generalize. The second AI era started around the 2000s, and we might be living near the end of the era today. The AI applications of this era are good at learning and perceiving, but they have minimal ability to reason or generalize. Instead, they were symbolic, heuristic, and rule-based (see Launchbury 2017; Jones 2018).

A third AI wave is expected to happen during the 2020s–2030s. AI applications of the forthcoming AI era are expected to be good in perceiving, learning and reasoning and able to generalize. Third-wave AI systems will feature very dramatic improvements, most notably in their ability for contextual adaptation. Third-wave AI will understand context and meaning, and be able to adapt accordingly. AI apps will not only recognize a cat but will also be able to explain why it's a cat, and how the AI arrived at that conclusion – a giant leap from today's "black-box" systems. These AI applications will be based on statistical learning, deep neural sets, convolutional neural networks (CNNs), and recurrent neural networks (RNNs) (see Launchbury 2017; Jones 2018). Beyond that, a fourth AI wave is expected to happen in the 2030s, and with this AI applications are expected to perform any intellectual task a human can perform.

We are currently benefiting from the Second Wave of AI, dominated by deep learning and statistical, "big data" approaches to AI. If a new area, as speculated above, is waiting just around the corner with AIs capable of learning not just from enormous sets of labelled training data, but also from descriptive, contextual models, it will have massive ramifications. This new AI era will change the business world, it will change the public sector, and it will be a game changer for both public innovation and digital transformations.

AI for good?

Indeed, it is today hard to find images of the future in which AI does not take on a more significant role. A timely question increasingly asked by researchers is therefore how to turn AI into a source for good (in current social media parlance,

#AIforGood). How can we direct the plausibly revolutionary impact of AI towards such a path that it accelerates our journey towards our own preferred futures? One relevant discussion, for example, is how AI might interact with the realization of SDGs, as the two twin transition megatrends square off during the next decades. The research to date suggests a Janus-headed possible trajectory, in which AI can be both a boon and a detriment to a more sustainable world. This is a knife's edge, which will be important for society to get right. Based on a snapshot of recent literature (see Knudsen & Kaivo-oja 2020a, b), we can here list a few key priorities for the development of sustainable AI:

- Transformation to an environment-friendly ICT sector (reduced energy use, use of renewable energy, sustainable mining of raw materials, less e-waste)
- AI for the global, greater good (*inclusive* approaches beyond AI as solutions for the chosen few)
- Tackling algorithmic bias and algorithmic coloniality (decentralized AI, algorithmic transparency, codified ethics, certifications, and regulatory oversight).

If the future trajectory of AI is a game changer for future avenues of public-sector innovation and digital transformation, few themes during the next few years should have as much public and academic attention as the ability to steer the AI trajectory towards a preferred future.

Discussion and conclusion

In the digital era, changes are happening at such a speed that it is always difficult to assess what the world will look like around the corner. This chapter has attempted to highlight some of the important arenas around which the next steps for public innovations in the digital era will happen. It is simple to note that the defining issue for future avenues of digital transformations and public innovation is the ability of the public sector to create public value from data. Within this theme rests many organizational challenges for which a strategical response, we suggest here, can be broken down into three main parts: experimentation, inclusion, and anticipation. We have shown this also in Table 10.1, which provides a short summary of the determinant logics, key themes, and key questions shaping the future.

As a final remark, we should note that this chapter obviously only covered a fragment of the important themes for the future of digital, public innovation. We find the most interesting arenas to be those for which there is still uncertainty about the outcome – the plausible or possible developments rather than just expected ones. This is one reason for certain omissions, which the reader might find would have needed attention here. However, the main purpose of our text has been to open the world up to new future research directions and provide readers engaged enough with the themes of this book to read it with some novel considerations. We hope we have succeeded with that.

Table 10.1 Summarizing key future avenues for digital transformations

	The Experimental Government	*The Inclusive Government*	*The Anticipatory Government*
Key logic	Digitalization enables experimentation, which induces innovation through LBD	Modern challenges require co-creation and public–private partnerships, which are organized digitally	Governments anticipating plausible and preferred futures can stimulate the right innovation
Key themes	Data-driven policymaking Data-driven innovation policy Transnational digital innovation hubs	The entrepreneurial state as ecosystem manager Public–private platform economy Public-sector blockchain Public procurement Social innovations Democratizing innovation Inclusion of future generations and non-human entities	Moving towards preferred futures Public value-creation with big data Visual policymaking DT public–private ecosystems AI #AIforGood
Key questions	*How should government:* • Organize experimental STI policies? • Induce national and transnational experimentation? • Integrate outcomes of experimentation and LBD into policymaking?	*How should government:* • Organize public–private platforms and ecosystems? • Induce social and sustainable innovation? • Democratize innovation through citizen participation? • Change its ideas of who to include?	*How should government:* • Strengthen the integration of foresight into policy and decision-making? • Develop value-creation capabilities from big data? • Organize DT ecosystems? • Promote visual policymaking? • Steer AI in the right direction?

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