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10 Future avenues of digital transformation

Next steps?

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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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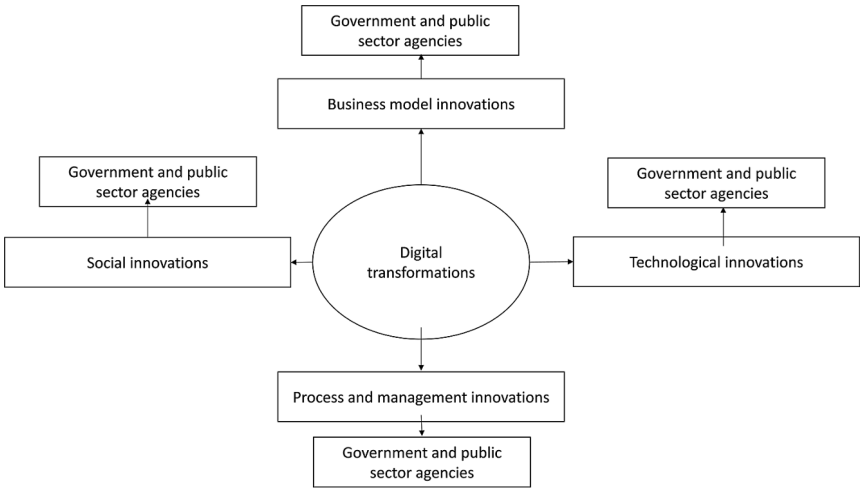

Figure 10.1 Digital transformations and impact of innovations on the government and public-sector agencies.

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

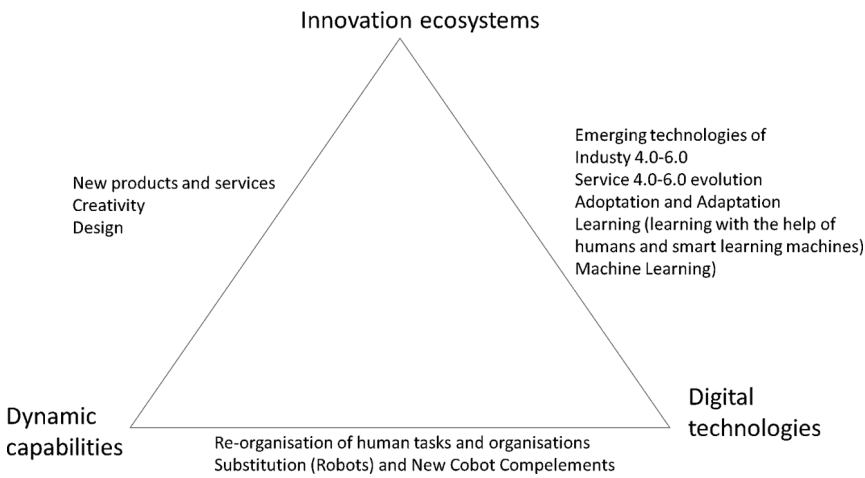

Figure 10.2 Interconnections between innovation ecosystems, dynamic capabilities, and digital technologies.

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.

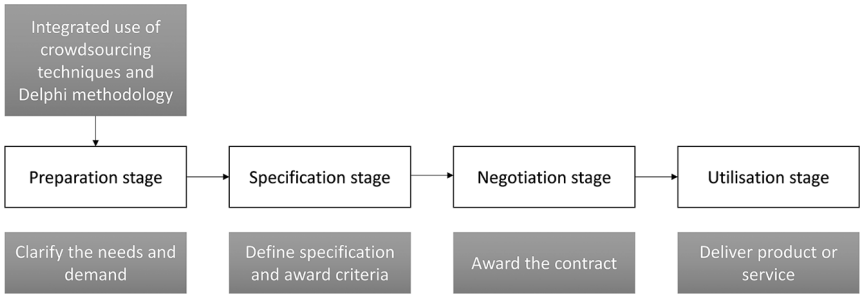

Figure 10.3 Public procurement process, crowdsourcing, and expert panel tools (modification of Witjes & Lozano 2016).

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.

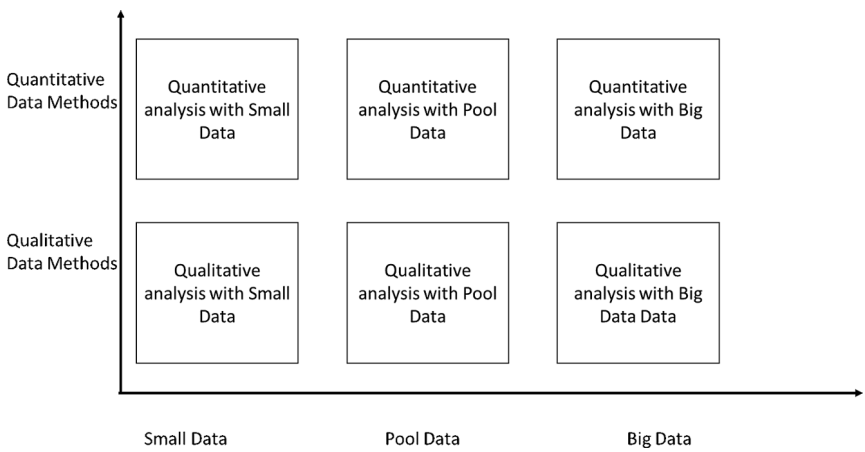

Figure 10.4 Quantitative and qualitative data methods and data size (Kaivo-oja et al. 2021).

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

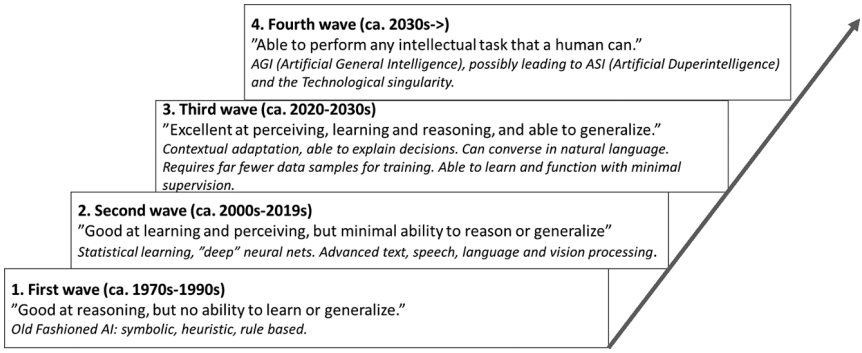

Figure 10.5 The coming revolution in Artificial Intelligence: The four waves of AI (modified from Jones 2018; Launchbury 2017).

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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