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Abstract

This research deconstructs complexity as a key challenge of intergovernmental digitalisation projects. While much of the literature acknowledges that the fundamental restructuring coupled with technical capacity that these joint projects require leads to increased complexity, little is known about how different types of complexity interact within the collaborative process. Using Klijn and Koppenjan's (2014) work on substantive, strategic, and institutional complexity, we apply complexity theory in collaborative digital environments. To do so, eight digital projects are analysed that differ by state structure and government level. Using a cross-case design with 50 semi-structured expert interviews, we find that each digitalisation project exhibits all types of complexity and that these complexities overlap. However, clear differences emerge between national and local level projects, suggesting that complexity in digitalisation processes presents different challenges for collaborative digitalisation projects across contexts.

Key Words

Collaboration, Digitalisation, Public Sector, Complexity, Europe

Introduction

Collaboration is a highly influential topic for public sector governance and innovation research, including the digitalisation of government where projects increasingly rely on collaborative work (Luna-Reyes et al., 2007). The reliance on collaboration is due to digitalisation's boundary-crossing nature, high initial financial investments tied with increasing cost pressures, bureaucratic and legal rules of accountability, staff retraining, and high rates of failure (Anthopoulos & Reddick, 2016; Mergel, 2016; Neumann et al., 2019; Torfing, 2019). As a result, digitalisation becomes a holistic process in the sense that technological components are only one of many aspects under consideration during this change (Breaugh et al., 2023; Gil-García, 2012; Gil-Garcia & Flores-Zúñiga, 2020). One salient component of collaborative digitalisation projects is their complexity (Costumato, 2021; Parker et al., 2021) as they combine characteristics that clearly distinguish them from complicated systems (cf. Klijn and Koppenjan, 2014). These include, for example, joint efforts to establish nationwide digital platforms (such as citizen registries) or to implement smart city projects.

Digital innovation represents a technical innovation, focusing on different components linked to the nature in which data is collected, stored, and utilised (Yoo et al., 2010) to create streamlined government services. Ironically, as with many collaborations, while digitalisation aims to reduce complexity, it requires both technical innovations *and* institutional innovations to reflect the environment in which they are embedded (Hinings et al., 2018; Huang et al., 2017). This fundamental restructuring paired with technical innovation leads to increased complexity within the collaboration process, yet little is known about how diverse types of complexity interact within the collaborative processes in digital innovations. While Mergel (2022) and Tangi et al. (2020) identify organisational complexity as one of the most important structural barriers to digitalisation, the concept of complexity is yet to be fully understood in this context (di Giulio & Vecchi, 2021).

In their seminal work Klijn and Koppenjan (2014) present complexity in three forms: substantive, strategic, and institutional. Substantive components refer to cognitive perceptions for problem definition in collaboration projects, strategic components refer to the effect of organisational goals and biases on (in) actions of stakeholders in the projects, while institutional components refer to prioritisation and conflicts of formal and informal rules from different networks that govern actor behaviours. To this end, the purpose of this paper is to assess how complexity emerges within the context of intergovernmental digitalisation projects, and which

factors contribute to this complexity, in particular, across different countries and levels of government.

To empirically explore this, we adopt a small N comparative case study design. This approach is particularly suited to comparing several cases without compromising on analytical depth (Nowell & Albrecht, 2018). To ensure a large degree of complexity, we take a cross-country (four countries) and multi-level (national vs. local) perspective, something that is essential for understanding the universality of our claims across conditions and called for by scholars in the field (e.g., Neumann et al., 2019). In total, eight cases are used which come from Belgium, Estonia, Germany, and the UK., one case for each level of government per country. The cases focus on the implementation of smart city technologies at the municipal level, and government platform approaches at the national level.

The structure of the paper is as follows: we begin by presenting the theoretical framework in which our empirical analysis will test. We then present the methodological framework with respect to the eight case studies as well as the coding framework used followed by the results. We conclude with a discussion of our findings and areas for future research.

Theoretical framing

In this section, Klijn and Koppenjan's (2014) framework of substantive, strategic, and institutional complexity will be used to deconstruct complexity within collaborative digital government environments, forming the theoretical basis for our empirical investigations. Complexity in this context is defined by the relationships between the elements of a system and their dynamic nature, rather than simply by the number of elements–characteristics that make them non-deterministic and thus particularly unpredictable and distinguish them from complicated systems (Klijn & Koppenjan, 2014).

Substantive Complexity

Substantive complexity relates to differences in problematisations among actors in a collaboration project. Knowledge production occurs within existing organisational routines and activities that subject the expertise-based idea to a value-based environment (Agranoff & Yildiz, 2007; Head, 2008). Substantive complexity emerges when different actors perceive both the problems and solutions differently. In these cases, it is not about information shortage, but rather, the "lack of a joint frame of reference and shared meaning among actors" (Klijn &

Koppenjan, 2014, p. 63). Individual agency of diverse actors means that these problematisations can also change (Gilpin & Miller, 2013) and selective perceptions emerge where individuals support processes from their own perspective rather than that of the whole (Dearborn & Simon, 1958; Wegrich, 2019). Because of this, different actors come to a collaborative environment with their own perspectives, which does not preclude a common goal but may mean misaligned understandings of how to achieve it (Basadur et al., 2000).

Strategic Complexity

Strategic complexity focuses on the strategies used to solve network problems, or the complexity inherent in reconciling different interests while dealing with the risk of opportunistic behaviour (Bonomi Savignon et al., 2021; Waardenburg et al., 2020a). In this case, strategic complexity emerges from having to develop one solution to a particular problem, but stakeholders have their own strategic goals (Head & Alford, 2015). The individual actors are affected by existing capabilities and personal and organisational values that guide their behaviours within a collaboration, which can lead to a lack of coordination (Klijn & Koppenjan, 2016; Raadschelders & Whetsell, 2018). When goals are not aligned across the collaborative project, strategic complexity emerges. This can occur in environments of competitiveness and limited resources with actors prioritizing the maintenance of their position over collective goal-attainment (Wegrich, 2019).

Institutional complexity

Institutional complexity is a third form of complexity. Institutions define rules that regulate behaviour (March & Olsen, 1989; Scharpf, 1997). In the public sector context, these include both the legal apparatus and institutional culture. These rules can help to regulate behaviours, but on the other hand, "if the number of rules grows, become inconsistent, opaque, and not well understood, they may generate complexity instead of predictability" (Klijn & Koppenjan, 2014, p. 64). This occurs, when actors have interaction arenas with conflicting patterns of rules, requiring stakeholders to prioritise one set of rules over the others (O'Leary & Vij, 2012). This may be exacerbated by differences between and/or fundamentally contrasting institutional logics between collaboration partners. The varying logics could lead to diverging behaviours, which are guided, to a large extent, by their own employing institution rather than that of the collaboration, therein increasing institutional complexity.

Complexity within the context of digitalisation

With the differentiation of complexity outlined in the collaboration literature, we argue that the subcomponents of complexity are not only magnified through digitalisation but also, become more interdependent. Digitalisation projects are characterised by multi-channel access to information and services, system interoperability and distributed, multi-agent systems, and cross-boundary social interactions (Dawes, 2009). These include the interdependence between technological, organisational, and institutional arrangements, as well as how IT is used by internal and front-facing users leading to relationships that are recursive and dynamic (Anthopoulos et al., 2016; Luna-Reyes & Gil-Garcia, 2011). The lack of consideration and understanding of the overlapping complexity could, in part, help to understand why IT projects end up failing or stalling (Omar et al., 2020).

The digitalisation process serves the multitude of stakeholders who are involved in the projects (Liu & Zheng, 2018; Mergel, 2018). As such, within the context of digitalisation, substantive complexity emerges as stakeholders developing collaborative digital solutions may have different perspectives on both the problems and solutions that information technology (IT) can offer. This variance in cognitive framing is based on both the collaborative environment, as well as their own understanding of digital processes and outcomes (Orlikowski & Gash. D, 1994).

Within the realm of complexity in digitalisation, strategic complexity can emerge in several ways. In some cases, actors must balance the co-design between the legislative framework which includes the legal context of the programme and country, programme goals and IT functions (Apostolou et al., 2011), for example, combining the technical and design skills of IT professionals with the traditional logic of public sector bureaucracy (Neumann et al., 2019). This can result in a diversity of actors, searching for solutions to cater to their own agendas. Furthermore, it can result in the group of actors looking to either take control of the process or change the technical solution and in doing so, change the intended outcome (Bailey & Barley, 2020). Moreover, the centralisation of digitalisation projects typically requires new organisational forms to emerge (Orlikowski, 2007). How these develop can become a point of contention, and likely overlap with institutional complexity. Finally, digitalisation projects are long-term and evolving with feedback loops from the solution and surrounding environment shaping the direction. This means that they require continuous adaptation to the needs of their

users, legislative frameworks, and programme decisions and delivery. This can create clear tensions between different stakeholders, especially those wanting to optimise IT with those handling legal compliance and service delivery dilemmas (Apostolou et al., 2011). It may also create problems with aligning short-term and long-term goals, especially if basic IT infrastructures (such as data-sharing capabilities and issues related to interoperability) are overshadowed by an immediate service need. This includes centralisation, and technical requirements related to interoperability and data sharing, cloud computing that can, at times, operate across jurisdictions (Scholl et al., 2012; Waardenburg et al., 2020a). This can lead to a lack of clear understanding of the legality of information-sharing across organisations as well as to delays in development (Waardenburg et al., 2020). In line with this, regulations need to be changed or are constantly being changed and updated as emerging IT becomes more mainstream adding both institutional and substantial complexity to the projects (McLean et al., 2021).

National-level versus local-level dynamics

Thus far we have argued that there is an interplay between different complexities in collaborative digitalisation projects, however, complexity dynamics could be different based on the level of government under analysis (for example, national vs local level).

Digitalisation projects initiated by national governments to overcome existing boundaries between organisations, administrative levels, and functional areas, face greater complexity as they involve horizontally and vertically distributed processes within and outside the organisation (Meijer, 2015; Willem & Lucidarme, 2014). Moreover, due to the exhaustive nature of the projects, there is often a clash of different preconditions, such as unequal access to human or financial resources, but also cognitive aspects, manifesting in opposing views or different rationale for change (Luna-Reyes et al., 2021). National platform projects are thus prime examples of pronounced complexities, as they involve specific agencies and ministries and often multiple levels of government while at the same time confronting the complexity of the IT itself (Luna-Reyes et al., 2007) and the capacity to adopt it (Liu & Zheng, 2018; Mergel et al., 2018; Rackwitz et al., 2021).

By contrast, local government is characterised by the interaction of various local actors, the need for internal change management, and the technical requirements that digitalisation projects entail, which all add to the complexity of local governance processes (Ruhlandt, 2018;

Scholl & Scholl, 2014). However, it is less difficult to motivate and engage partners because they have the prospect of benefitting from practical project outcomes as project performance feeds back into their immediate habitat(Neumann et al., 2019; van Raaij, 2006; Willem & Lucidarme, 2014). This is likely because partners have the prospect of benefitting from practical project outcomes as project performance feeds back into their immediate habitat (Karppi & Vakkuri, 2020). It can be argued that at the level of a local government (vis-à-vis national government), interactions are proximate and take place not only formally but also informally. In addition, both decision-makers and citizens may find it easier to establish public support and action for locally experienced problems. This is referred to in the literature as 'the proximity principle'. While local government actors are also interdependent, they have access to a more homogeneous pool of partners, as they come from similar regional contexts. It is more likely that there is a common regional identification and regular or spatial forums for personal exchanges that facilitate the creation of joint frames of reference or a "single meta-narrative" (Eppel, 2012, p. 895). Local partners are therefore potentially more aligned in preferences and understandings of what is considered appropriate behaviour than in national government projects. Based on these specifics of digitalisation projects at national versus local scales, we can infer that complexity constitutes a different challenge for digitalisation projects at the national level than for those at the local level.

From these considerations, two propositions emerge, which will be empirically examined in the remainder of this paper:

1) *Complexity in digitalisation*, in its three subcomponents of substantive, strategic and institutional complexity, takes a different form at the national level of collaborative project implementation than at the local level.

2) Government digitalisation projects at the national level face more intense complexity overall than projects at the local level.

Methodology

Research Design

To analyse complexity mechanisms across conditions, we adopt a qualitative comparative case design (Yin, 2014). We focus on inter- and intra- governmental collaboration networks on digitalisation projects, that is both, between (inter) and within (intra) public organisations. We selected cases based on several criteria. First, variance in state structures and governmental

levels had to be present, likely reflecting varying intensities of complexity. The cases had to be beyond their starting phase, collaborative in nature, and linked to the EU Single Digital Gateway (national level) or be a city of at least 50,000 that is considered a digital pioneer and implementing a smart city strategy (local level). This means that the projects are well known in the countries of study.

Our final case selection consists of eight public networks from two sets of European countries: two federal (Belgium and Germany) and two unitary (Estonia and the UK). The rationale behind this is that federal countries are inherently more prone to complexity compared to unitary state structures. This is because they have more fragmented legislative and cognitive frameworks that may be at odds with top-down government-wide initiatives. In addition (semi-)autonomous local governments are less willing to accept centralised control. Within each country, we selected a digital platform in line with the EU Single Digital Gateway, representing the national scale and a smart city network, representing the local scale (see Table 1 for case characteristics).

Table 1: *Key characteristics of the cases selected*

Country	State structure	Case	Level	In text reference
Belgium	Federal	Civil Registry	National	BE
		Smart City Policy, Antwerp	Local	ANT
Germany	Federal	Online Access Act	National	DE
		Digitalstadt Darmstadt, Darmstadt	Local	DAR
Estonia	Unitary	Employment Registry	National	EE
		Sustainable Urban Mobility Plan (SUMP), Tallinn	Local	TAL
The UK	Unitary	Government as a Platform	National	UK
		Bristol is Open (BiO), Bristol	Local	BRI

Case Characteristics

This section will outline the key characteristics of the selected cases

Civil registry, Belgium

This project aims to digitise and modernise the Belgian Civil Registry (the database where key citizen information regarding life is done) by moving from a decentralised paper-based system to a centralised digital database. It started in 2010 and was completed in 2019. There was one central coordinator for the project and participation was mandatory.

Smart City Policy, Antwerp

This project aims to implement smart city projects in a living urban lab in the city of Antwerp. The project began in 2016 and is ongoing. Two main partners are coordinating the voluntary network.

Online Access Act, Germany

The project aims to implement the Online Access Act, which requires all levels of government to provide government services (such as car registration, birth registration, and parental leave) online through a single digital gateway, or platform. . The project started in 2017 and is mandatory for government levels, it is coordinated by a central coordinating body.

Digitalstadt Darmstadt, Darmstadt

The project aims to develop Darmstadt into an experimental space for designing and testing smart city technologies and includes projects such as implementing smart traffic lights that adjust to real-time traffic. The voluntary project began in 2017 and is coordinated by an arm's length company.

Employment Registry, Estonia

The Employment Registry provides a single coherent set of employment data for each person who works in Estonia. Its goal is to enable relevant government agencies access to employee records for different processes (i.e., pensions, health, and unemployment insurance) from a single registry in compliance with the once-only principle. This mandatory project was initiated in 2013 and is still ongoing. There was one main coordinator.

Sustainable Urban Mobility Plan (SUMP), Tallinn

SUMP is a public transport initiative, aimed to improve multi-modal accessibility. The initiative aimed to incorporate an enhanced data-based decision-making framework by systematizing

mobility-related data (i.e., traffic congestion, travel times etc.). It was voluntary and ran between 2016 and 2019, with one city department providing coordination.

Government as a Platform (GaaP), UK

This project aimed at developing online tools (both citizen-facing and internal) to facilitate the adoption of streamlined digital public services across all UK ministries. It has been running since 2011, is voluntary and coordinated by the UK Cabinet Office.

Bristol is Open (BiO), Bristol

BiO is aimed at implementing smart city technologies by establishing a citywide and programmable testbed for experimentation and digital innovation. It was established in 2015, is voluntary and was a joint venture between Bristol City Council and the University of Bristol.

Methodological Approach

To empirically test our research questions, an analysis of semi-structured, coded, interviews was used. The interviewees were key actors in each of the cases and were selected via a purposeful sampling approach (Palys, 2008). They included current and former project managers and participating departments, and technological experts. This coverage of interviewees ensured a balanced assessment of the projects. Between September 2019 and March 2020, a total of 50 interviews across the eight cases were conducted. The MAXQDA software was used to code the transcribed interviews, using a deductive coding guide developed by the researchers. Regular coding meetings took place to ensure consistency between the six native-speaker coders. A coding leader also randomly checked the coding process for consistency (O'Connor & Joffe, 2020).

Results

This section reports the findings of the coding analysis, showing how substantive, strategic, and institutional complexity occur and are interrelated in collaborative digitalisation efforts at the national and local government levels. To increase the transparency of qualitative research (Nowell & Albrecht, 2018), all quotations have direct references to the interview that were undertaken (in an anonymised fashion) indicated at the end of the quote using the following label: country/city – project type– interview number.

Substantive Complexity

Substantive complexity within the *national cases* took different forms. Many of the interviewees noted a tension between legislative and practice design aspects of the projects, including different ideas of how to design the platforms themselves to make them universal (United Kingdom (UK)), how much data to collect (Estonia (EE)), who would have access to this data (EE), and legislative changes required to dissolve responsibility required for a centralised system (Belgium (BE)). Others also noted a lack of understanding (both technical and non-technical) across different departments leading to fragmentation. For example, in the UK, one interviewee noted,

> Most government departments historically think that their problem is unique and special. They couldn't possibly be like another department. Therefore, they need to do it themselves. (UK SDG 7)

Similarly, one interviewee from Estonia also noted,

> The biggest challenge from the beginning was whether all the partners perceived the need in the same way and whether they could sell the idea internally to the officials who would use the new register in the first place. So that they are not afraid of it. (EE SDG 3)

In all cases, interviewees noted that actors were "talking side by side" (BE), "being pulled in different directions" (UK) or "having to speak different languages" (EE). When they were able to align each actor's ideas and understanding, the projects were able to move forward. This problem of different alignment also revealed itself when examining the dynamics between different actors in the collaboration in terms of different priorities (BE/UK), organisational culture (BE), and openness to change (BE/UK). For example, in Belgium, when talking about the need to work closely with the judiciary to update legislative frameworks to allow for a centralised civil registry, one interviewee said,

> Yes [they] had to convince the Ministry of Justice a little bit, [to] go far into the digitalisation and centralisation. The Ministry of Justice has a vision, [and is] conservative. It is legal texts, papers and so on. If we go into a digital and centralised way of working there are many opportunities and different ways to do it. (BE SDG 6)

In terms of complexity related to digital infrastructure, several interviews noted that the starting IT conditions make it more complex, including different computer programmes (UK, Germany (DE), BE) which impacted who participated in the development, what templating languages were used (DE, UK), how individuals communicated (UK), where information is stored (BE), and the rules and regulations related to accessing the data (BE). It also impacted how the actor became involved in the projects, how they interpreted the goals of the projects and their level of engagement therein. In the UK, one interviewee noted,

> For example, government doesn't have a single email system. It doesn't have a single document or Wiki. It doesn't have a single chat system or a single source code repository. All these things exist within silos, or silos within silos. Actually, it can be really difficult to find out what is happening in another corner of government. Or even to be working on the same system for a lot of people can be quite challenging (UK SDG 7)

In Estonia, the definitions of key stakeholders became a substantive issue that needed to be reconciled to build their platform related to employment one interviewee noted,

> Very trivial things that need to have a common understanding. Who are the employees, how broad is the definition of an employee? (EE SDG 3)

Others noted that the varying nature of digitalisation leads to simultaneous changes including the alignment of technical, services, and planning (DE) and policy performance and timing of new IT services to not overlap existing IT contracts (UK), lack of trust in and understanding of the IT (BE, UK) or the inability to move beyond a narrow frame of mind (BE). For example, in the UK, with reference to improving service quality, one interviewee stated,

> Often, the conversations around complexity, we were pushing back to policy colleagues and the ministers, saying, "Do you realise you're not getting the outcome you want for this policy? That's not because the service has not been designed in a particular way, or delivered by a particular technology, it is that you have oversimplified your understanding of the system. Actually, it's quite a complex system here and you are employing quite a crude policy mechanism." (UK SDG 8)

By contrast, at the *local level,* substantive complexity emerged based on a lack of common language and understanding of the projects at hand. For example, in Antwerp (ANT), one interview noted, "everyone believes in the overall smart city project, but we really talk a

different language" (ANT SC 6). Beyond this, like the national level cases, balancing the technological and policy interests of actors (ANT, Bristol (BRI)), which often overlapped with strategic complexity was common. For example, in Tallinn (TAL), one interviewee stated,

> Mobility as an area is a complex issue, clashing different interests and world views you might even say. Bringing together these different substantive interests and perceptions was a challenge and there were certainly differing views on how to go about it. (TAL SC 1)

The struggle between IT development and performance outcomes is also evident from an interview from Antwerp, where they realised, "we are going to play with technology. The fundamental problem with something like smart city is that as we have done it, it is very technology-driven and had little to do with targets" (ANT SC 2). This clash was also seen in Bristol. In Antwerp, they also noted,

> That's a typical technology-driven thing like a smart city. If you're not working from a policy perspective or from a problem or something you want to solve, then you have a very broad [task]... You have a whole kitchen available, but … you don't know what dish you're going to make... So that was really a problem in the beginning. (ANT SC 2)

These examples show that overall, there appear to be more similarities with regards to substantive complexity at the local level compared to the national level projects, with the most common being the varying ideas and perspectives of the many actors involved in the projects. With respect to the starting conditions, the limited IT capacity was more problematic at the national level compared to the local levels, whereas the key issue at the local level was a lack of common understanding of the overarching projects and defining what exactly a 'smart city' entails.

Strategic Complexity

Numerous themes emerged regarding strategic complexity at the *national level*. First, similar to substantive complexity, the different perceptions of problems led to diverse needs and solutions for the development and design of IT (BE/UK). For example, technical solutions collided with policy and service design requirements in the UK and Germany. For example, in Germany, one interviewee noted,

So, in principle, there were those who have now pursued a more ambitious path and have really worked more in the direction of this digitisation platform for Germany and the others who then said, "No, come on, it's all far too much and far too complicated and too expensive and too complex for me, and they didn't yet have an infrastructure and architecture and so, therefore, said, "I'll only do the minimum that is required by law, I'll make myself accessible in other projects". (DE SDG 5)

This links directly to institutional complexity in so much that different services affected the internal workings of the organisations differently, for some, it required a complete re-organisation of corporate operations, for others, it was an add-on (BE and the UK). For example, in the UK case, one interviewee noted the tension between the degree of complexity and collaboration, particularly showcasing that less complex platform projects related to communication (Notify) and payment processing (Pay) were easier because of their discrete, focused and simpler, nature. They explain that,

The more complex the technical solutions, i.e., the more complex the problem they were trying to solve, the harder it was to achieve cross-departmental collaboration because they became...very definitive and prescriptive in the kind of business operation that a department had to operate. Whereas things like Notify and Pay, which are quite discrete processes at the edge of a business, were much easier to adopt. Complexity was an absolute, major factor. (UK SDG 5)

In the case of Belgium and Germany, the delegation of authority of distinct levels of government was also used. For example, in Germany,

The biggest challenge for us is actually to unite all the *Länder* with one goal for a project of this size without a "real structure" and to actually get all the participants, all the stakeholders to follow the course of the project. (DE SDG 1)

The challenge of interoperability on the technical level was reflected by an interviewee in Germany who noted,

Yes, it sounds so simple the portal network. Yes, we really have to build something that somehow makes it easy to get from A to B...But in practice, it's actually super, super hard to create a uniform look in a completely heterogeneous landscape. It's a really hard task and also takes time. (DE SDG 5)

In these cases, interviewees across all the national cases noted the difficult nature of collaboration, and how the complexity of the projects themselves exacerbated this.

Strategic complexity at the *local level* was interrelated with substantive complexity and mostly focused on the inability to align the goals of the projects, which led to the development of different solutions. In most cases, this was a clear clash between technical solutions and policy performance. For example, in Antwerp, one interview noted,

> That, for us as a research centre, things that we set up jointly, didn't go far enough and for the city often went too far, too far as in the tests that we've done are not immediately scalable to the rest of the city because it's still too exploratory, too innovative, also often still too expensive. innovation, a prototype that just costs a lot more money than if you just buy something from a company. (ANT SC 4)

In Tallinn, the broader goals were similar, but there was uncertainty on how they could be achieved including agenda-seeking and losing sight of the oscillating issues around the project. One interviewee stated,

> I'd say it's not so much that you're imposing your own agenda, to some extent it's maybe that you forget that there are other issues to deal with other than what's important to your organisation. (TAL SC 1)

In Bristol, the different solutions from the partners led to projects that were not "coming together" (BRI SC 3). In Antwerp, there was an issue of scalability versus research outcomes. A clear example of the overlap between strategic and institutional complexity was observed in the Bristol case. In this case, the two partners started to diverge in key areas of the project, including the need to adopt more strongly regulatory aspects into their IT operating systems. This need caused a strain in their relationship. As one interviewee stated,

> It's moved from, "we're developing a prototype tested," which was developed in an environment that is basically free of industrial quality standards, into an environment now where it needs to be a stable, [IT] operating system that's operated, maintained and upgraded. (BRI SC 2)

In Darmstadt, some interviewees also noticed the difficulties in coordinating joint data management.

Overall, there is a convergence of strategic complexity at both the national and local levels as different problematizations lead to different solutions. There were also similarities across both levels of government in the clash between technical and service innovation – with some actors more heavily focused on the technical aspects of the digitalisation process, while others focused on the potential policy impact. It was also clear at both levels of government that goal alignment was a critical point of contention.

Institutional complexity

Several themes related to institutional complexity emerged at the *national level*. First, in addition to technical applications, legislative changes to ministerial responsibility also needed to be developed simultaneously, often creating new forms of strategic complexity as different actors came to the table with quite different needs and IT solutions (BE, EE). It also challenged existing power structures and traditional roles in government. For example, in the UK, one interviewee noted,

> It can be, not quite adversarial, but because this idea of cross-government platforms, cross-government working challenges power structures, and in combination with digital transformation is challenging and replacing existing positions and roles, or positions and roles kind of change, there is a lot at stake. (UK SDG 7)

The structure of government was a second theme to emerge that added to institutional complexity. In the case of the UK, this was due to large ministerial autonomy and the rotating personnel typical of a Westminster and open career system.

> The complexity in government comes from the fact that it's completely obfuscated. There's no way of reading, from the list of departments, like what services are being delivered and who's delivering them, and so it makes collaborating really difficult. (UK SDG 2)

For Belgium and Germany's national projects, this was due to the federalist nature of the country and the necessity to bring together actors from various levels of government. For example, in Belgium, one interview reflected on regional differences, in noting "there was a difference in views and ways of thinking between north and south for example in the country. And small and large municipalities" (BE SDG 2). In Germany, one interview highlighted the

salience of both the technological development as well as coordination complexity across various levels of government:

> It's really the sheer size and breadth //yes// that we, we are basically on the road in the entire German administration (…) Plus the development of digital infrastructures, of course, and that across the levels of federal, state and local government, indirect administration. In width and in height, horizontally and vertically. (DAR SDG 6)

In Estonia, Belgium and Germany balancing the legislative frameworks of the countries with the goals of the project became tantamount to bringing the collaborations forward and ensuring they remained aligned. In the Estonian and Belgium cases, institutional complexity was created due to the technological and organisational changes required to implement the projects. In Estonia, for example, one interviewee noted,

> …Another thing is that you have to analyse other laws, not just the Health Insurance Act and the Taxation Act. For instance, like the Social Tax Act. The elements regarding data exchange between notaries were forgotten and left unchanged in the Taxation Act. These things, where other laws are connected, should be observed more carefully by the initiators. (TAL SDG 5)

Examining institutional complexity of collaborative projects at the *local level*, the most common theme that emerged was related to the legal rules and regulations related to procurement, the project approval process, and handling overlapping ownerships (all cases). This was further complicated by the multiple actors involved in the projects and deciding on how to create a balance between centralised and decentralised structures alongside existing authority and ownership (DAR, TAL). For example, in Darmstadt, one interviewee noted,

> We have the business enterprises. We are talking about levels, corporate advisory boards, boards of directors and CEOs. We have an ethics and technology advisory board of science, but also politically driven. (DAR SC 1)

Overall, the local cases did not appear to be highly impacted by legislative complexities compared to the national level cases; instead, the complexity that emerged was more focused on the project governance and processes as well as procurement. One exception was in Tallinn, where interviews noted that overlapping authorities (between regions) did impact the way the project was designed. At the national level, the balance between the legislative frameworks

and technical capacity was a critical area of institutional complexity. Balancing the regional differences (and powers) added to the institutional complexity, particularly in the federal countries, was also a common theme to emerge. This may be because many of the national cases involved more multilevel actors, larger budgets and scope, and core government services, which are traditionally siloed. Table 2 summarizes these findings.

Table 2: Summary of findings

Complexity/Government level	National	Local
Institutional	Diversity and formality	Homogeneity and informality
Strategic	Lack of interest and 'going it alone'	Join interest and power distribution
Substantive	Disjoint frames of reference	Mismatch between technical and service goals

Discussion

The process of government digitalisation touches every aspect of public sector organisations. Due to its boundary-spanning nature, it also forces public sector organisations to collaborate to achieve their digitalisation goals. Our paper was therefore premised on the notion that collaborative digitalisation projects that aim to unite a greater diversity of actors, while operating in highly formal environments, are more prone to complexity (Kadushin, et al., 2005; Mintzberg, 1983; Thomson and Perry, 2006). Because of this, digitalisation adds another level of complexity to the already complex task of collaboration management.

Overall, we presented two propositions. The first is that the dynamics of complexity in digitalisation would differ between national and local projects. The second was that projects at the national level would exhibit a more intense level of complexity. Our results generally showed large overlapping complexities related to introducing digital technologies into government, and this was indeed more salient at the national rather than local level. The substantive and strategic complexity was evident in the projects' struggles with managing each actor's needs and ambitions, while the institutional complexity required to engage in inter-organisational collaboration emerged as projects pushed towards the edge of legislative frameworks. Despite reporting less complexity, local projects struggled with balancing implementing IT for the sake of the technology itself compared to the sake of service

improvement. As a result of this, the findings provide evidence to support the proposed propositions. We, therefore, provide three overarching contributions to the literature.

First, complexity in digitalisation is indeed overlapping and interdependent. Within the context of the national level cases, the complexity emerged from the starting conditions, attempting to convene a variety of public organisations. In many of the cases, technical skills imbalance, coupled with unclear legislative areas regarding data development, access, and management made projects increasingly difficult to navigate. Added to this was a clear variation in the goals of the digitalisation project for each actor as well as the necessity to merge both the technical aspects of the digitalisation projects with the (re-)organisational aspects necessary for the projects to achieve their goals. These findings underscore the holistic approach necessary for governing digitalisation projects (Gil-García, 2012), meaning, that the digitalisation process must then be paired with deep institutional understandings and change management skills.

Second, national-level projects tend to show more complexity due to the horizontal and vertical collaborative arrangements, as well as the more siloed government structures. In terms of how complexity takes different forms, government departments not working closely can lead to problems with technical developments, lack of interest in collaborating, or 'doing it alone' (like in the UK). The power imbalances in the projects exacerbated this, clearly showing the problems with following individual over collective goals (Klievink and Janssen, 2009), how to operate across jurisdictions (Waardenburg et al., 2020), and how to manage frameworks of accountability (Mergel, 2018). This complexity was also particularly focused on the institutional level, and the need to organise large heterogeneity of actors at various levels of government, where authorities often overlapped, and technical knowledge, funding and power imbalances were evident. This follows stipulations regarding the complexity of horizontal and vertical networks, and the necessity for a clear coordinated approach (Meijer, 2015; Willem and Lucidarme, 2014). The projects also found themselves having to balance legislative, organisational, and technical developments simultaneously.

By contrast, at the local level, complexity did not appear to be as problematic, at least at the institutional level. In most cases, the engagement was easier as there were fewer partners and clearer responsibilities. However, the smart cities did share similar elements of the national projects especially with respect to overlapping authorities if the projects went outside general jurisdiction (i.e., Tallinn). As a result of this, the concept of the 'single meta

narrative' can be challenged (Eppel, 2012) as substantive complexity in balancing the interests of those working on the technical side of the projects, and those working on the applied side were evident. These findings thus follow the work of Karppi and Vakkuri (2020). In terms of institutional complexity, IT development was driving the process, with the legal regulations (for example, related to procurement), coming only after the IT was developed. Although the focus of this paper has been to provide empirically grounded insights into how complexity occurs rather than how it is managed, this lays the foundation for future research on counteracting public management strategies. For example, one might pursue Minzberg's(1983) suggestion of a stepwise approach to taming complexity, or Klijn and Kopenjan's (2014) emphasis on the mediating potential of network managers. The final contribution of the paper is its cross-national perspective. Indeed, finding trends in analysis that includes eight different cases, including varying political structures, levels of government, and types of projects points to a level of universality that is evident across large-scale digitalisation projects. This is quite important as up until now, the literature has been dominated by single-case studies.

Limitations

Despite our interesting findings, some limitations should be mentioned. First, as this is a study based on interview data, we rely on information that is being recalled by specific individuals and could introduce bias in our sample. While we attempted to mitigate this by interviewing several individuals involved in each of the projects (between five and eight individuals) and using documentary analysis, this can only be fully mitigated through mixed methods research designs. Relatedly, with this research, we specifically aimed to address the gap in the digitalisation literature regarding the dynamics of intra- and intergovernmental collaboration. However, since all the projects we studied relied to some extent on outsourced components, future research should explore the projects' intersectoral relationships, such as with suppliers of the technologies used. These can then be contrasted with the collaborative dynamics identified in this paper.

Second, this analysis is only a snapshot of project development and does not capture how the subcomponents interact over time. While this would have been beyond the scope of an eight-case analysis, future research should include this in its design.

Third, the cases themselves differed in terms of the projects' level of technological sophistication or national digitalisation progress, which can affect the degree of complexity

present in digitalisation as well as the expertise in managing it. Both are aspects that were beyond the scope of this design but are worth exploring in follow-up research. Similarly, future research could consider the effects of country size, tradition, or national degree of decentralisation.

Finally, due to the multi-lingual nature research design, there is a threat of inadequate semantic equivalence within the analysis. The researchers took several steps to mitigate this from the interview design phase, through to the coding and interpretation phases, for example, through several meetings, revisions, and discussions related to context and choice of working in each of the languages, but there is still a chance of linguistic misinterpretation.

Conclusion

Overall, complexity emerges from a project's cross-cutting nature which requires different actors and functions across organisational boundaries, increased security for task interdependence, and a complete re-organisation of work processes and technical requirements making digitalisation projects additionally unpredictable and complex (Asgarkhani, 2005; Dawes, 2009; Klijn & Koppenjan, 2014; Ramon Gil-Garcia et al., 2007; Ran & Qi, 2019; Uppström & Lönn, 2017). This underscores the ironic symmetry that the very problem that motivated collaboration in the first place (reducing complexity) can only be addressed by temporarily exacerbating it (increasing complexity). We also showed that digitalisation tends to amplify the interrelatedness of the different types of complexity. While awareness of this is crucial for those who are to navigate digitalisation projects, it also suggests that current trends can largely be captured by existing analytical concepts informed by complexity theory, calling into question the need to 'reinvent' public management theory in response to digital progress. Breaking down complexity into its parts thus allows for finding targeted coping mechanisms, which opens up future research that focuses on public management interventions that can be used to guide dynamics effectively.

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