

Agile development for urban digitalisation: insights from the creation of Dresden's smart city strategy

Jörg Rainer Noennig, Filipe Mello Rose, Paul Stadelhofer, Anja Jannack and Swati Kulashri

Abstract

Purpose – Digitalising cities requires new urban governance processes that account for rapidly changing environments and technological advances. In this context, agile development methods have become valuable, if not necessary. However, agile development contradicts public administration practices of risk aversion and long-term planning. The purpose of this study is to discuss practical avenues for navigating these two contradictions by adapting agile development to the needs of public sector organisations.

Design/methodology/approach – The authors review the collaborative elaboration of Dresden's smart city strategy as a critical case study. Dresden's smart city strategy was developed using agile development and quadruple-helix innovation. The year-long co-creation process involved stakeholders from various groups to conceive an integrated and sustainable vision for digitalisation-based urban development.

Findings – Despite the apparent contradictions, this study finds that key aspects of agile development are feasible for public sector innovation. Firstly, risks can be strategically managed and distributed among administration and non-administration stakeholders. Secondly, while delivering value through short iterative loops, adherence to formal processes remains possible. Informal feedback cycles can be harmoniously combined with official statements, allowing iterative progress.

Research limitations/implications – The empirical material is based on a single case study and thus risks overemphasising the general applicability of the proposed methods.

Practical implications – This paper outlines practical steps to greater agility for public administration engaged in digitalising cities. The paper conceptualises a forward and lateral momentum for the agile development of a smart city strategy that aims to reconcile formal policymaking processes with short-term loops and risk aversion with experimental value creation. This approach balanced risks, created value and enhanced the strategy's alignment with strategic frameworks, ultimately promoting innovation in the public sector.

Originality/value – This paper proposes a novel, empirically grounded conceptualisation of implementing agile methods that explicitly recognises the peculiarities of public administrations. It conceptualises the orchestrated and pragmatic use of specific agile development methods to advance the digitalisation of cities.

Keywords Agile development, Smart city development, Public-sector innovation, Strategy, Quadruple-helix

Paper type Research paper

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Received 29 September 2023
Revised 13 November 2023
Accepted 2 January 2024

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1. Introduction

During significant societal, climatic and economic shifts, public sector innovation requires the capacity to adapt to changing environments swiftly. Smart city initiatives, for instance, promise to harmonise competing goals like environmental sustainability, quality of life and economic growth (Frenchman *et al.*, 2011; The Climate Group, 2008), potentially revolutionising urban living. However, to fully use the potential of smart cities, public administrations and service providers must consider the constantly evolving technological and social environments in each project while keeping their long-term strategic goals in

mind. Agile development – or short “agility” – is an iterative and collaborative approach that explicitly aims to safeguard the capacity to react to swiftly changing circumstances without disregarding long-term ambitions through adaptability, personal collaboration and incremental delivery (Beck *et al.*, 2001; Laanti *et al.*, 2013). The notion of agile development originated in software development but has now been applied to innovation processes more broadly. Agile development focusses on flexibility and responsiveness to evolving requirements, enabling teams to provide value quickly and consistently (Bogdanova *et al.*, 2020). The advantages of agile development include the constant progress that allows satisfying customers by delivering functional output early and often, improving project transparency and visibility, promoting better team collaboration and communication, and, most importantly, the ability to respond rapidly to changing contexts (Beck *et al.*, 2001; Laanti *et al.*, 2013).

However, while the principles and practices of agile development have proven to be highly effective in the private sector, their application in the public sector has proven challenging (Mergel *et al.*, 2021; Nuottila *et al.*, 2022). This is due to two main fields of tension between agile methods and the traditional organisational logic of public administrations. Drawing on existing literature on the one hand and on the experience of practically creating and implementing a smart city strategy on the other, our examination reveals two contradictions that emerge when contrasting classical government practices with agile development methodologies. The first pertains to the divergence between the government’s long-term and formal planning, typified by due process and public procurement, and the agile approach’s emphasis on short iterative loops and close, personalised communication (Mergel *et al.*, 2021). The second contradiction centres around the conflict between risk aversion, a prevalent feature of traditional government strategies, and the experimental value delivery that lies at the core of agile development principles (Bogdanova *et al.*, 2020).

In this sense, smart city development initiatives offer a compelling case study for exploring how these fields of tension can be navigated successfully to reap the benefits of agile development methodologies. More precisely, we use the case of a particular smart city initiative to address the following research question:

RQ1. How can the tensions between agile development methodologies and traditional government practices be effectively navigated within smart city development initiatives?

This question is further broken down into the following sub-questions:

RQ1a. What strategies can be used to navigate the divergence between long-term planning and the emphasis on short iterative loops within the context of smart city development?

RQ1b. How can the conflict between risk aversion and the experimental value delivery inherent in agile development be managed to achieve successful outcomes and innovation in smart city projects?

Empirically, we use the elaboration of a smart city strategy for the city of Dresden, Germany, as a case study. The study explores the introduction of agile development in public sector innovation via a 1.5-year strategy-making process, which was embedded in the federal government’s funding priority “Model Projects Smart Cities” (MPSC). Launched in 2019 by the German Federal Government, the MPSC initiative aims to strategically assist municipalities in using digital transformation for integrated, sustainable urban development. In this process, we collaborated with a municipal IT service provider to swiftly deliver on the funding agency’s requirement to define a comprehensive smart city strategy. This process translated an initial vision of intelligent model districts into an overall urban strategy, focusing on innovative digital services and solutions for three specific city wards.

This paper draws from multiple strands of literature, contributing to the fields of management, urban development, urban governance and new public management. The

paper leverages agile development methodologies in management and organisation studies, exploring their application in the public sector context of smart city initiatives. Within urban development, the study contributes by examining the challenges of translating initial visionary concepts into actionable strategies for intelligent model districts. The paper also contributes to the discourse on urban governance and management, delving into the collaborative partnership between municipal administration and academia in formulating and implementing the smart city strategy. Additionally, the paper engages with new public management principles as it navigates the tensions between traditional government practices and the agile approach, offering insights into how these approaches can be harmonised for effective urban innovation. Overall, the paper offers a multidisciplinary contribution that bridges management practices, urban development strategies and governance models in the context of smart city implementation.

The paper is structured as follows. In the next section, we use extant literature to conceptualise two main fields of tension between agile methods and the traditional organisational logic of public administrations. The third section contextualises our action-research-based methodological and empirical case study. In the fourth section, we disentangle and analyse the processes and practices that allowed us, as action researchers, to effectively navigate the tensions between agile methods and the traditional organisational logic of public administrations. Finally, in the fifth section, we discuss and summarise our results in light of the contradictions (or rather misconceptions) between agility and innovation in public administrations.

2. Agile development in public sector innovation

The principle of *agile development* – originally from IT and software development – is increasingly used in other innovation processes, e.g. in the construction industry (Owen *et al.*, 2006) and media and financial companies (Uludağ *et al.*, 2022). Crucially, as Mergel (2016, p. 518) puts it:

Agile development is a method that involves creating, testing, and improving technology products incrementally, instead of waiting for the foolproof delivery by the end of the contract period in a traditional IT contracting agreement.

Agile development entails an iterative, step-by-step approach to development processes in which requirements and solutions are flexibly adapted in the continuous exchange between developers and customers to react quickly to changes (Beck *et al.*, 2001). In contrast to traditional “waterfall” development approaches, where plans and timelines are set at the beginning of processes and one phase must be finished before starting a new one, agility allows overlapping developments and accounts for constantly changing environments (Mergel, 2016). In a sense, agile development inverts variable and fixed aspects of project development. Rather than defining a fixed goal and negotiating on processes, timeframe and resources, agile development assumes fixed resources, processes and timeframes and negotiates the best attainable goal (Bogdanova *et al.*, 2020; Owen *et al.*, 2006).

Over the past years, the potential and usefulness of implementing agile development in public sector administrations have become increasingly apparent (Mergel, 2016). Especially in the context of urban digitalisation, it appears reasonable to apply a methodology of development that originated in the realm of software and IT (Battisti, 2020). Notably, in the context of public administrations, it improves the capacity of “responding to changing public needs in an efficient way” (Mergel *et al.*, 2021, p. 162). Methods of promoting agile development rely on advocating transparency and supporting experimentation through smaller projects. It can also mean hiring innovators, IT entrepreneurs and former employees of software companies and changing acquisition policies to favour agile processes through cultural changes in the leadership (Mergel, 2016). However, despite various strategies for using agile development in public sector innovation, fundamental differences persist regarding documentation, staff

training and experience, communication with stakeholders, defining roles and legislation (Nuottila *et al.*, 2022). We conceptualise these fundamental differences as being caused by two underlying contradictions.

The incorporation of agile development within public sector administrations is closely related to the broader concept of experimental governance, as exemplified in urban living labs (Bulkeley *et al.*, 2019; Kronsell and Mukhtar-Landgren, 2018). Notably, at the municipal level, the agile methods embraced within these experiments foster informal engagement with diverse stakeholders, circumventing predefined bureaucratic procedures (Bulkeley *et al.*, 2019). Moreover, agile practices align with research in governmental and corporate innovation laboratories, as articulated by Santarsiero *et al.* (2021). In this context, they facilitate active participant involvement and cultivate an innovative work environment (Santarsiero *et al.*, 2021, p. 87; Schiuma and Santarsiero, 2023).

2.1 Long-term planning in public administrations vs. short, iterative loops in agile development

Firstly, public administrations typically adhere to extensive planning procedures involving due process and formal public procurement. This contrasts with the agile approach's emphasis on short, iterative loops and personalised communication (Mergel *et al.*, 2021). For an agile development process, public administrations must thus balance long-term strategies and higher-level policies, integrating iterative cycles and personalised engagement. However, challenges arise due to lengthy formal procurement processes and regulatory constraints, hindering agile methods for urban development. These limitations exacerbate inefficiencies and missed opportunities, underscoring the importance of routine collaboration and communication in the development process.

To address this, Hick *et al.* (2018) stress the significance of establishing connections among diverse interest groups, a pivotal element for achieving urban digitisation agility. Public administrations must adapt their planning processes to accommodate both iterative cycles and regulatory requirements, allowing for smoother progress. Given these contradictions, Bogdanova *et al.* (2020) suggest that the introduction of agile management should be gradual, acknowledging the various external and internal constraints.

2.2 Risk aversion in public administrations vs. experimental risk-embracing agile development

The second contradiction centres on the clash between risk aversion and predictable processes that typically guide government administrations and the experimental value delivery integral to agile development principles (Bogdanova *et al.*, 2020). By its mandate and disposition, public administration and decision-making are not designed for risk-taking and experiments but rather for minimising potential threats and maximising security and predictability. While traditional administrations follow a top-down decision-making approach, agile practices are based on permanent and cyclic front-to-back communication between end-users (who eventually receive and use the product) and developers. However, relinquishing decision-making control can be challenging for conventional managers responsible for the final outcomes (Bogdanova *et al.*, 2020). The divergence in risk approaches underscores the difficulty of aligning established governmental processes with the agile mindset necessary for effective strategy development in dynamic contexts. Successful agile development implies a substantial amount of continuous communicative exchange across the involved parties, inciting managers to take “responsibility for the final product and defend[ing] the outcome, even though it might not have been developed with their explicit input” (Mergel *et al.*, 2021). This requires a shift in leadership dynamics and the ability to revise decisions and improve processes regardless of hierarchical structures. Yet, the limited motivation for informal leadership and self-management in government offices

has raised doubts regarding the feasibility of agile methods in these settings (Bogdanova *et al.*, 2020).

These contradictions can be mitigated by fostering an inclination towards continuous learning, proactivity, collaboration, teamwork, trust, mutual support and optimism (Bogdanova *et al.*, 2020). Overcoming these challenges involves engaging with local communities and external experts as well as ensuring alignment with other policies, including higher-level ones, to distribute the risks associated with experimental, agile development (Hernández and Amaral, 2022). In the following, we discuss how public administrations can navigate this tension between risk avoidance and agile development principles by embracing a more open and collaborative approach and acknowledging the potential benefits of experimentation.

3. Action research into agile smart city development: the case of Dresden's smart city strategy

3.1 The case: development of a smart city strategy for Dresden

Empirically, this paper discusses ways of introducing agile development in public sector innovation in the context of Dresden's elaboration of a smart city strategy. This strategy was developed in the context of the federal funding priority "Model Projects Smart Cities" (henceforth MPSC) from early 2022 to mid-2023. MPSC is a funding priority established by the federal government's Ministry for Housing, Urban Development and Building in 2019 with a budget of 820 million euros. It aims to support municipalities in using digital transformation for more integrated, sustainable and welfare-oriented urban development. The framework supports 73 cities and rural communities – referred to as "model cities" – in testing cross-sector digital strategies and exploring role models for distinct "Smart Cities made in Germany". All participating cities and rural communities undergo a 1.5-year strategy elaboration phase and a four-year strategy implementation phase.

In Dresden, the municipal IT service provider is formally responsible for the city's participation in the federal funding priority. Founded in 2005, the municipal IT service provider offers advisory and support services to the Dresden city administration for IT and telecommunications matters. The tasks of the municipal IT service provider include IT support, software maintenance, management of significant IT projects, consultation for city departments, digitalisation efforts, data security and supporting the city's IT and digitalisation strategy.

The project consortium led by the municipal IT service provider was tasked with crafting the strategy, aiming for a feasible, context-sensitive smart city strategy by the end of the first project phase. Given the requirements set by the federal government, the public administration had to design a strategy-making process that ensured:

- the formulation of innovative concepts and measures;
- effective engagement with all stakeholder groups; and
- sustained momentum and intrinsic dynamism for ongoing progress.

In practical terms, the main objective of the strategy creation process was to transform the initial vision of a city made up of intelligent model districts into a comprehensive smart city strategy. As per MPSC funding regulations, supported "model projects" must be exemplary and replicable to benefit all municipalities. Projects aim to transfer historical city qualities to the digital age while maintaining compact, culturally rich, human-centred cityscapes. Each model project must include smart city strategies, measures and solutions for future replication. To this end, the targeted application of agile development methods emerged as a highly promising approach.

3.2 Action research: active participation in agile strategy development

From the start of the project, the municipal IT service provider partnered with a research lab from the local technical university. The main task of the lab in the first project phase was to elaborate on the city's smart city strategy on the basis of a systematic and scientific approach. Having investigated smart cities for more than 10 years (Noennig and Schmiedgen, 2014), the lab has vast expertise in strategic urban development, integrated planning and smart city technologies (Jannack *et al.*, 2020; Stelzle *et al.*, 2017), enabling it to use an innovative approach to smart city strategy development that aims to use agile methods.

The strategy development process thus represented an opportunity to investigate the implementation of agile development in the public sector as action researchers. Action research “associates research and practice, so research informs practice, and practice informs research synergistically”. (Avison *et al.*, 1999, p. 94). As an iterative process that involves practitioners and researchers, action research yields precise – through context-dependent – results for existing organisations (Avison *et al.*, 1999). Action research requires the prior setting of conceptual and practical “interventions” that are introduced exogenously to solve problems (Waardenburg *et al.*, 2020, p. 391). In this case, agile development aims to solve the problem of elaborating a smart city strategy in a short time that is innovative, involves diverse stakeholders and creates momentum for smart city development.

Action research involves a cyclical process of identifying an issue or problem, collecting data, planning and implementing interventions and reflecting on outcomes to inform further iterations (Avison *et al.*, 1999; Waardenburg *et al.*, 2020). In the context of agile development in public sector innovation, such as smart city development, action research offers a collaborative and iterative methodology that actively involves stakeholders, fosters participatory decision-making and promotes sustainable urban transformation (Soeiro, 2021).

3.3 Main stakeholders and policy frameworks embedding the agile strategy development

In the context of implementing agile development methodologies in public administrations, it is imperative to recognise and account for the external constraints and policy frameworks that condition urban development. These external policy constraints interact with the principles of agile development and potentially pose challenges when fostering innovation in the public sector. Understanding these external policy frameworks is essential to navigate the complexities of urban development processes – such as the digitalisation efforts towards a smart city – and ensure the successful integration of innovative strategies in public administration practices.

The main external reference framework for Dresden's smart city strategy elaboration process is the *MPSC programme*, the federal funding priority in which this programme is embedded. The MPSC programme is supervised by the Coordination and Transfer Agency (“Koordinierungs- und Transferstelle”, henceforth KTS), which supports and evaluates the 73 model projects. This agency synthesises the knowledge created in the individual model projects and their implementation measures, focussing on the elaborated smart city strategies and the processes that lead to them. Since 2023, the KTS has also been the main organisation evaluating the model project's smart city strategies, representing the main deliverable of the first funding phase. In this evaluation, the KTS judges whether the individual model cities comply with the requirement of producing a smart city strategy in a collaborative, participatory way that prioritises spatial impacts of digitalisation on local and urban levels. Continued federal funding is tied to a positive evaluation by the KTS. Its verdict on Dresden's smart city strategy represents a major risk to the administration and local smart city development. Moreover, prior to the submission to the KTS and to the

federal government, the strategy had to be ratified by a simple majority of the city council. Failure to ratify the strategy also represented a main risk to the project.

The MPSC and Dresden's administration are also embedded in multiple higher-level and local policy frameworks. These include, but are not limited to, the following policy frameworks:

- *Sustainable development goals (SDGs)*: The SDGs provide international guidelines for city planning, including the goal of “Liveable Cities” (United Nations, 2015). However, the original formulation of the SDGs did not fully address the emerging trend of smart and digital cities, limiting their precise reflection of the role of digitalisation in urban development.
- *Leipzig charter*: On the European level, the Leipzig Charter, revised in 2020, aims to steer urban development towards the social and spatial qualities of the “European City” (BBSR, 2021a). While it emphasises centrality, diversity and cultural preservation, the charter does not specifically address the discourse of smart or digital cities.
- *Integrated urban development concepts (IUDCs)*: IUDCs coordinate plans for urban systems using participatory approaches and stakeholder engagement (BMVBS, 2016). However, these concepts lack a methodological focus on smart and digital cities, as they do not fully consider the advent of digitalisation and new urban technologies. While envisioning future scenarios is undoubtedly the overall goal of IUDCs, their focus is on integrating and re-framing existing concepts and strategies within a unified, larger picture [BMVBS, 2016; Deutscher Städtetag (Association of German Cities), 2015].
- *Future city (“Zukunftsstadt”) Program*: The German government's Future City program takes a visionary approach to urban development, promoting citizen engagement and participation (BMBF, 2015). Despite encouraging experiments and new forms of engagement, the program does not explicitly address digital urban challenges. However, while supporting exploratory experiments, living lab approaches and radically new forms of citizen engagement and participation, the programme did not address digital urban challenges (Noennig et al., 2016).
- *Smart city charter*: The German Smart City Charter is a key guideline for smart city initiatives, such as the MPSC programme. It outlines the federal governments of smart city development and urban digitalisation, organising key values and guiding innovation programs and research projects (BBSR, 2021b). While it aligns with key aspects of other frameworks (notably SDGs or the Leipzig Charter), its guidance on implementing smart and digital urban technologies is limited.
- *“Shaping the digital city” project*: Initiated by the German federal government, this project aims to guide municipalities in creating digital city strategies and to set the stage for an upcoming, large-scale smart city funding priority (i.e. MPSC). As a main outcome, the project issued a methodological guideline supporting urban administrations struggling with making smart city strategies – a generic development process leaning on agile approaches and participation (Jonas et al., 2022).

4. Findings: implementing agile development for a smart city strategy

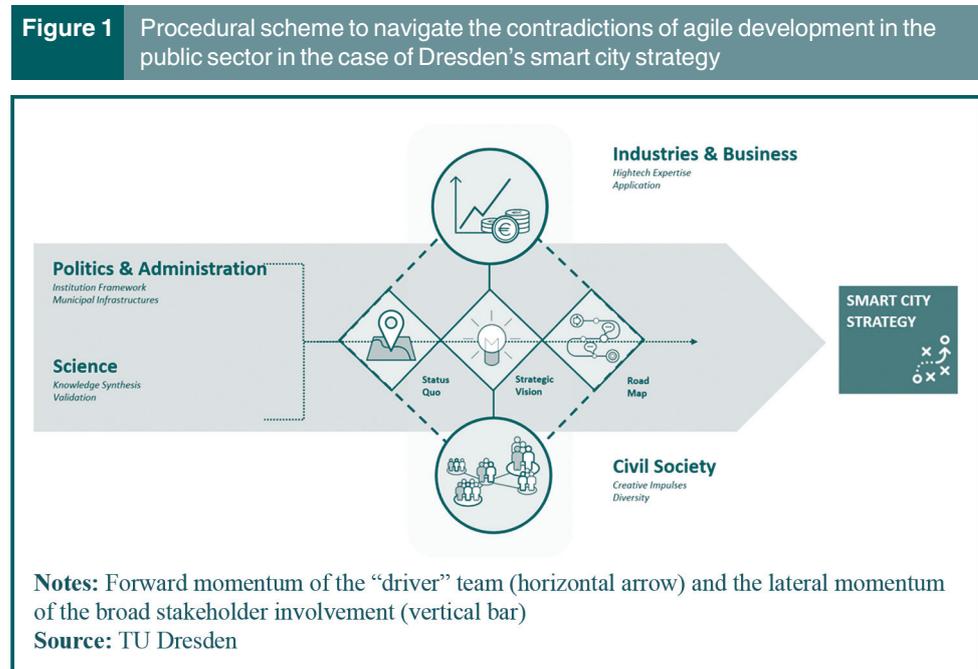
We conceptualised a framework that combined the standard steps of most strategy-making approaches (status quo analysis → future vision → implementation roadmap) with an agile development approach. This entailed forming a “driver-team” for the strategy process, bringing together key personnel from city administration and governance (the municipal IT service provider) and science (the lab from the local technical university). This “driver” team would be highly motivated to advance the project in an agile manner and willing to bear the responsibility for the experimental approach taken. This way, the “driver” team ensured a

dynamic forward momentum (represented in Figure 1 by the horizontal grey arrow), which was supported by a lateral momentum of widespread participation (represented in Figure 1 by the vertical yellow column). The widespread participation aimed to address the diversity of stakeholders identified in extant research (e.g. Mora *et al.*, 2019; Mello Rose *et al.*, 2022). These forward and lateral momentums allowed navigating the two main contradictions of implementing agile development in public administrations.

4.1 Forward momentum: navigating the contradictions between long-term planning vs. short, iterative loops

The agile development approach for the smart city strategy in Dresden was fuelled by a continuous forward momentum that resulted from the dynamic co-creation process facilitated by the “driver team”. This process dynamically evolved on the basis of frequent iterative loops and extensive involvement of a wide range of stakeholders. The latter included high-ranking civil servants, which facilitated the ongoing evaluation of the feasibility of agile practices within the context of long-term processes, such as the gradual implementation of agile methods. The development process emphasised the strategy’s living and evolving nature in alignment with agile methodologies. Initial ideas and outlines were introduced early in the process, allowing stakeholders to engage with a tangible representation of the strategy’s potential outcomes. This cyclical approach, involving problem identification, data collection, intervention and reflection, enabled collaborative work between the research team and key stakeholders in the administration. This partnership aimed to generate valuable insights and drive meaningful improvements, ensuring the strategy’s development remained responsive and adaptive. Throughout the development journey, a total of four distinct loops were undertaken, with each loop resulting in an updated version of Dresden’s smart city strategy. These loops were characterised by their co-creative nature, incorporating feedback from workshops and other uniquely designed activities.

The iterative process ensured that the strategy document evolved continuously, despite its unfinished state at any given time. As the development process progressed, the feedback loops became progressively more efficient, with shorter durations, indicating the deepening



engagement and refined co-creation process. This continuous forward momentum, rooted in agile principles, allowed the strategy to adapt, refine and improve iteratively, contributing to its holistic and dynamic nature. Crucial steps in preparing for the feedback loops involved the creation of an initial version to kick-start the process and generate early momentum for the project. This version was based on ideas that were already elaborated in the application for the MPSC funding priority. While the initial version served as a starting point for discussions with the “driving team” to plan the strategy elaboration process, close to nothing from it remained unchanged through the following four loops of co-creative revision.

The first loop aimed to gather as many ideas as possible from various stakeholders through workshop formats and interviews. This ideation phase included developing various visions and missions, which were then subjected to in-depth interviews with key decision-making stakeholders and citizens at dedicated events. Workshops in Dresden’s “Bürgerlabor” (Citizen Lab) – a facility newly implemented in the town hall for public co-creation – involving citizens and civil servants provided conceptual inputs. The input ranged from high-flying visions (“merging tradition and digitalisation”) and mission statements (“actor networking for maker culture”) for Dresden’s long-term future, but also ambitious challenges (“City Service Hubs”) and concrete project ideas (“Open Data Access”) to be tackled in the short run. The workshops also produced a “Smart City Radar,” which offered an overview of smart city projects and themes in Dresden. High-flying visions, mission statements, ambitious challenges and concrete project ideas were generated during these workshops and included in the strategy process. The “Smart City Radar” served as a knowledge base for creating a unified vision and action plan and will be useful during the implementation phase. Presentations at events, including Silicon Saxony Day, engaged various public audiences in the initial strategy ideas. At the end of this loop, we had a first version of the strategy with abundant ideas and propositions, which, however, still lacked focus and was not embedded in the wider institutional context (i.e. from multiple higher-level and other local policy frameworks).

The second loop began with the first large “reflection workshop” that brought together numerous members of the public administration to comment on the strategy version that resulted from the first phase. This loop also involved engaging with responsible handlers at the KTS to consider their requirements within the funding priority MPSC. We also closely analysed policy documents such as Dresden’s Integrated Urban Development Concept and the Smart City Charter during this loop. Towards the end of this loop, the different guiding principles, high-flying visions and mission statements for Dresden’s long-term future were consolidated with the analysis of the two policy documents and the collected comments to form a new version of the strategy that served as the basis for the third loop.

During the third loop, an online participation survey collected feedback from stakeholders on different strategy aspects. A second “reflection workshop” included administration stakeholders, presented the version of the strategy resulting from the first two loops and explained how the participants were incorporated. A participatory workshop called the “Future Tram” allowed citizens to express priorities for a Smart City Dresden while riding public trams. More policy documents, like the SDGs and Leipzig Charter, were integrated during this stage, expanding the strategy’s scope. This new, advanced version of the smart city strategy was discussed with industry representatives at an industry meeting (“Wirtschaftsstammtisch Nachhaltigkeit”) and reflected upon with researchers from the Leibniz Institute of Ecological Urban and Regional Development in an online workshop.

The fourth loop capitalised on bureaucratic requirements of obligatory consultation of different sectors of the administration (“Ämterumlauf”) to enhance the strategy and engage various administration sectors. While this process is often a pure formality, direct communication and joint meetings were used to address issues collaboratively, which reduced risks of outright rejection and thus prevented delays in the delivery of the strategy.

Our stakeholder engagement approach extended to multiple levels of public administration through personal interviews with top-level decision-makers, workshops and an online questionnaire. By engaging civil servants at different levels, including the city's major and the adjunct majors, we facilitated the shift towards more experimental approaches. Decision-makers were encouraged to participate in agile development processes, providing them with first-hand experience of the benefits and challenges associated with iterative and experimental strategies. This not only enhanced their understanding but also facilitated buy-in for such strategies. Simultaneously, subordinate implementers were empowered to contribute with their insights and expertise, fostering a collaborative environment conducive to risk-taking and innovation. We also carried out three working meetings with the KTS to safeguard the acceptance of the final result by the institution tasked with evaluating the strategy for the federal government. With the KTS' timely feedback, the risk of a possible refusal of the final strategy was significantly reduced, enabling the greater use of experimental, agile methods.

The involvement of citizens and civil society actors was integral throughout the strategy development process. Various formats, such as public events like the "Lange Nacht der Wissenschaften" (Long Night of Science) and the innovative "Future Tram", engaged citizens and solicited their opinions (Holmer and Noennig 2017, 2018). This comprehensive engagement approach ensured that insights from citizens and stakeholders were harnessed effectively. Organised civil society groups were also engaged, enriching the stakeholder landscape by integrating social and environmental considerations into the strategy. Collaborations with non-governmental organisations and advocacy groups enabled alignment with broader societal goals. Furthermore, involving businesses ensured that private sector expertise and innovative solutions were leveraged to address digital urban challenges effectively. The comprehensive analysis of smart city challenges and demands through participatory campaigns (Future Tram, online survey) drew an informative picture of the overall attitude of Dresden's citizenship towards smart city themes. The online survey with more than 600 replies showed that a mainly positive connotation exists within the population towards a smart city. At the same time, it was found that fears of surveillance and technocracy exist but are not dominating. Visionary concepts co-created in participation workshops such as "Digital Service Points" or "Dresden as a testbed for innovative climate-protecting solutions" earned high agreement.

While the WISSENARCHITEKTUR lab took the lead role in the strategy development process, researchers from other institutions were also involved through an online questionnaire, a workshop and the "Lange Nacht der Wissenschaften" (Long Night of Science). This collaboration aimed to integrate research findings into the strategy development process, enabling a better understanding of the potential risks and benefits of smart city development. The collaboration also facilitated a connection between theoretical knowledge and practical implementation, ultimately enhancing the quality of the strategy.

Industry representatives were engaged through various events, including Silicon Saxony Day, Future Sax Road Show and a joint workshop with sustainability-oriented companies. Despite low participation, an online questionnaire was also made available.

Our commitment to tailored approaches allowed us to engage diverse audiences effectively, such as through participatory strategy workshops that brought together experts from urban politics, administration, science and civil society. By collaborating with these experts, we co-created initial ideas and inputs that were later augmented through public participation campaigns and expert talks with representatives from the science and business sectors.

Across all formats, we critically examined existing measures and thematic approaches relevant to the smart city context, evaluating their potential integration into the strategy and model project. This comprehensive engagement strategy contributed to managing

contradictions effectively and ensuring the successful implementation of the smart city strategy while fostering a culture of innovation and adaptability within the public administration. This way, Dresden's smart city strategy development exemplifies the successful management of the contradictory relation between risk aversion and experimental value creation by involving many stakeholders and promoting cross-sectoral dialogue, ensuring a holistic and adaptive approach (Noennig *et al.*, 2016).

5. Discussion, conclusion and future research

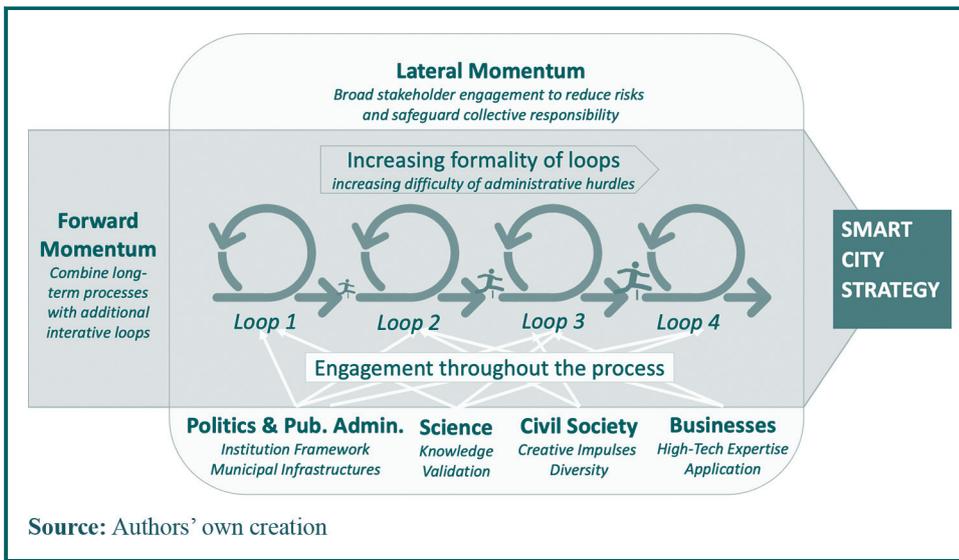
The agile development process undertaken for Dresden's smart city strategy addressed the contradictions and challenges highlighted in the theoretical framework for public sector agile development (Mergel, 2016). The process effectively managed the inherent tensions between long-term planning practices in public administrations and the short, iterative loops of agile development. Additionally, it navigated the clash between prevalent risk aversion in public administrations and agile development's experimental, risk-embracing nature. In this sense, it has not only theoretical implications but also offers insights for applied management and policy-making practices.

At a theoretical level, the agile development process in Dresden effectively addressed the theoretical contradiction between public administrations' risk aversion and the experimental risk-embracing principles of agile development. The process found that the clash between a "traditional" risk-averse public sector and the experimental nature of agile practices was less pronounced due to practices of continuous learning, collaboration, teamwork, trust, mutual support and optimism. Moreover, the empirical material from action research showed that engaging with local communities and external experts while generally aligning with higher-level policies allows managing the risks precisely with experimental, agile development. By embracing an open and collaborative approach, the strategy development process in Dresden demonstrated the potential benefits of experimentation, allowing for more adaptive and innovative strategies that effectively navigated the tension between risk avoidance and agile development principles. In this sense, our empirical investigation finds that public-sector risk aversion does not represent an unsurpassable obstacle to the experimental nature of agile development.

At a managerial and policy-making level, the smart city strategy development process in Dresden – carried out over a comparably short period – demonstrated the successful integration of iterative cycles and long-term planning in public administration. The strategy process balanced these seemingly conflicting approaches by (1) adapting planning processes to accommodate iterative cycles and regulatory requirements and (2) creating an informal "network" of workshop participants willing to contribute to the strategy throughout the entire process (see Figure 3). The involvement of diverse stakeholders, including high-ranking civil servants, citizens, businesses, researchers and organised civil society, facilitated routine collaboration and communication. This approach enabled the development of an adaptive strategy aligned with strategic frameworks and external policy documents, overcoming potential challenges posed by lengthy procurement processes and regulatory constraints.

In practical terms, implementing agile development for public sector innovation also tentatively proposes the combination of a forward and a lateral momentum. A continuous forward momentum was enabled through four iterative feedback loops that motivated stakeholders (through a feeling of continuous progress, albeit occasionally small) and allowed them to control risks while experimentally creating value. Moreover, each loop allowed the stakeholder to continuously evaluate the applicability of agile practices within the long-term development process. Incorporating the cyclical process of problem identification, data collection, intervention and reflection, our collaborative efforts with stakeholders generated knowledge and drove tangible improvements. The lateral momentum introduced through the quadruple-helix innovation model further enriched

Figure 3 Summary of the forward and lateral momentum that helped implement agile development within a public administration



stakeholder engagement across sectors. As expected from the literature (e.g. [Holmer and Noennig, 2018](#); [Mello Rose et al., 2022](#)), collaborations among public administrations, academia, industry and civil society fostered cross-sectoral dialogue and collaboration. This approach aligned with previous research emphasising the importance of engaging different stakeholder groups, particularly civil society, to enhance the legitimacy and success of smart city initiatives ([Stelzle et al., 2017](#); [Stelzle and Noennig, 2019](#)).

In conclusion, the smart city strategy development process in Dresden effectively addressed the contradictions outlined in the theoretical framework of agile development in the public sector. Through iterative feedback loops and stakeholder involvement, the strategy managed to integrate long-term planning with short, iterative loops, as well as reconcile risk aversion with experimental value delivery. By embracing a dynamic and collaborative approach, the strategy development process exemplified the potential for agile development to be successfully applied within the context of public administrations, resulting in an adaptive and inclusive smart city strategy aligned with internal and external requirements.

While the agile development process for the smart city strategy in Dresden demonstrated successful management of contradictions and challenges, certain limitations warrant consideration for future research. Firstly, the specific context of Dresden and its administrative structure may only be partially transferable to other cities with different characteristics and challenges. This includes the availability of a dedicated driver team that brings the needed scientific expertise regarding smart city development as well as procedural capacities regarding agile practices. Further research must explore how agile development processes could be adapted and tailored to diverse urban contexts. Also, despite the comprehensive stakeholder involvement, there could still be marginalised voices or perspectives that needed to be adequately represented in the strategy development process. Lastly, the long-term impact and sustainability of the developed smart city strategy remain to be seen. Continuous evaluation and monitoring of the strategy's implementation and outcomes are necessary to assess its effectiveness in achieving its intended goals and adapting to emerging challenges and opportunities.

Acknowledgement

We gratefully acknowledge the pivotal role played by the German federal government's funding priority, 'Modellprojekte Smart Cities,' and, in particular, Dresden's model project, in enabling the research presented in this paper. Our gratitude also extends to the journal editor and the anonymous reviewers for their valuable insights and constructive feedback, significantly contributing to improving our work. It is essential to highlight that, despite the crucial external support and feedback received, any remaining errors or shortcomings in the content are the authors' sole responsibility. We affirm that no conflict of interest is associated with this research.

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