Systemic innovation strategies of smart cities: governance and implementation strategies of four pioneer SC initiatives

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Abstract

In this paper, the governance and implementation strategies of four pioneer smart city (SC) initiatives are examined in a comparative case study. Drawing on different sources of information (e.g. expert interviews, analysis of SC strategy reports), the history of the individual SC initiative in terms of organisation, instruments, project portfolios, as well as perceived drivers and barriers are analysed and compared with the existing literature. As a result, 4 different generic strategy types are identified: i) the agile type, which focuses on the solution of identified problems without developing a broader organisation and strategy framework, ii) the anchor strategy, in which cities deploy all technologies for a pressing stand-alone application (e.g. smart mobility) and then extend or integrate other applications or fields as needed, iii) the framework strategy, in which cities coordinate and reorganise SC developments in an initiative via a strategy formulation process and the foundation of an SC organisation and finally iv) a platforms strategy, in which cities focus on the development of a IoT and data management platform architecture first, in order to deliver a range of new applications and services. The identified strategies are compared and discussed in terms of how they contribute to urban transition. The paper concludes with a discussion of potential path dependencies and the contributions to the smart city literature.

Keywords

SC Strategy typology, agile strategy, anchor strategy, framework strategy, platform strategy

1. Introduction

Challenges such as the digitalisation of public administration, urbanisation, climate change and the ongoing transformation of energy and mobility infrastructure systems require us to rethink the current approach to urban development. In recent years, the Smart City (SC) concept gained importance in practice as well as in academic research (Angelidou and Mora, 2019; Mora et al., 2017). Driven by developments in information and communication technologies (ICTs) – for instance, enhanced broadband connectivity, various sensor technologies, the Internet of Things (IoT), smart grids, smart meters, and the diffusion of e-mobility – new possibilities for coordination and management of fragmented urban sub-systems opened up (Carvalho, 2014).

While digital solutions with the smart city concept in mind have already been implemented, the smart city concept itself still consists of a plurality of contested meanings and approaches that are oftentimes contradictory (Mora et al., 2019). One camp of thinkers has found the smart city wheel, which outlines different areas of development, a useful framework for applied contexts. Addressing SC implementation challenges using an integrated and inter-departmental development approach with a network of partners and with the support of digital technologies might best help to address urban challenges (Musiolik et al., 2020).

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In the current interrelated digital-, energy- and mobility transitions, many European cities moved from sectoral transformation approaches (like focusing solely on energy) towards more systemic and integrative governance, taking the smart city concept into account. Many Smart City Initiatives (SCI) have been founded in which digital experiments and pilot projects are complemented with further coordination and management activities such as developing visions and roadmaps for the transformation, establishing cross-sectoral or departmental steering groups, communication and marketing, or developing an overcharging digital infrastructure (Musiolik et al 2020). These activities might accelerate the transition process of cities, since a joint governance and management strategy is applied to energy, mobility, and housing issues with the help of ICT (Mora et al., 2019). However, the number of successfully realised digital SC projects is still low (van Winden and van den Buuse, 2017). There appears to be a large gap between policy visions and implementation (Hartemink 2016). Especially since one third of medium-sized and large cities are expected to define their SC roadmaps within the next few years, research of the governance of SC implementation is of key importance (Manville et al., 2014).

This paper focusses primarily on typologies for SC implementation. It identifies and typical implementation strategies currently applied in European smart city initiatives and contributes to the overall questions of innovation strategies and (digital) transition governance.

2. Literature Review: Smart City Implementation

2.1. Smart City Concept

There have been attempts to further categorise approaches and paths of SC implementation in the smart city literature. Overarching principles have been identified with the help of literature reviews, by conducting case studies of leading smart cities, and finally, through the various guideline reports published by SC stakeholders (grey literature).

Mora et al. (2019) for example started from an analysis of the SC academic literature and identified five different development paths: i) an experimental path, where SC are used as testbeds for the development of IoT solutions, ii) the ubiquitous path of the Korean experience of a top down technology and industry policy approach, iii) the corporate path, in which urban areas become smart when they deploy platform of digital solutions provided by ICT firms, iv) a European path, were smart cities are developed and financially supported to foster a low-carbon economy, and v) a holistic path where digital technologies are assembled in a local context taking collective intelligence, participatory governance and community led urban development and an open and user driven innovation process into account.

Mora et al. (2019) then derived from these paths four dichotomies of how SC development could be approached: 1) a technology-led or holistic strategy, 2) a double or quadruple-helix model of collaboration, 3) a top-down or bottom-up approach, and finally, 4) mono-dimensional or integrated intervention logic. The dichotomies "…generate divergent hypothesis on what principles drive smart city development and the strategies assembled to enable it" (ibid.). In fact, they are mainly concerned with the governance approach of smart city implementation and discuss their dichotomies with the following management logics in mind: 1) Technology-led approaches voice a technology-push model of thinking while holistic strategies pronounce a logic of citizen pull and a need to incorporate the needs of the citizen in the already existing sociotechnical system, 2) differentiate the model of collaboration and the governance of the innovation process, 3) the role of the city administration and of the citizen in decision making and implementation, and finally, 4) the intervention logic of single (e.g. just mobility) or more integrated areas of activity (like V2G) should be key in the implementation.

Others, however, have identified further variations of these principles of smart city implementation. These variants have been derived from case studies of leading SCs and are often suggested as blueprints or development paths for followers. Lee et al. (2014) compare the strategies of San Francisco and Seoul. Komnininos (2011) analyse different case studies and delineate three approaches to smart city development. These variants are based on the idea that local communities should combine their intellectual capital with ICT. Angelidou (2014) analyses the incorporation of key domains of technology advancement, human and social capital development, the development of a pro-business environment and the networking in the ongoing implementation strategies of four leading smart cities.

She concludes that technological development is of no use if it does not promote the development of human and social capital in terms of innovation networking and knowledge generation. Technology underpins the development of knowledge and decision making in cities and vice versa. Kaczorowski and Swarat (2018) differentiate a "public private partnership approach" in which cities work together in an alliance in a rather closed innovation process with influential multinational companies, a "city elite approach" in which established networks of politicians, administration, utilities, and science implement the SC in a top-down manner and finally a so called "city society approach" in which the city administration develops and implements the SC together with its citizens (Kaczorowski and Swarat, 2018).

Finally, many types of SC stakeholders have published guideline reports on how to implement SC (in the grey literature). These reports often start from empirical experience of front runner cities and take into account the view of technology developers, consultants or intermediary organisations active in the field of smart cities. Often, they propose a step-by-step approach that describes the design and implementation process of smart city development by a roadmap or a phase model including in which a starting point and the goals are determined; projects are identified, selected, and implemented; best practices and success factors are outlined; and finally, tools for monitoring solutions are introduced. Berger (2018) serves as a good example showing different best practices and approach SC development by first focusing on one or two specific areas of the smart city wheel before taking a more integrated, systemic approach to the solutions. Machina research (2017) discuss technology and infrastructure related meta strategies and suggest i) an 'anchor' route, in which the city adds working applications in series, ii) a 'platform' route, in which the city focuses on deploying infrastructure first so that a number of applications can be compiled later, and iii) a 'beta city' route, in which the city continues to experiment with multiple applications without a finalised plan for how to bring these pilots to full operational deployment (ibid; Green, 2016). Musiolik et al. (2020) conceptualise SC implementation through a model and differentiated SC development in a pilot project phase in which project management is key, an institutionalisation phase in which organisational development of smart city specific structures takes place, and a consolidation phase in which the long-term urban transition is realised.

To conclude, most of the identified principles and paths are concerned with the overall management logic and governance principles of smart city implementation. They are to a certain degree normative, influenced by the ongoing conceptual discussions and mainly derived from case studies of leading smart cities.

2.2. Summary and Research Questions

The concept of 'Smart City' is still fluid, scarcely formalised and, to some degree, subject to different ideological interpretations (Hartemink, 2016). A shared definition in addition to a consolidated understanding of the strategic options to implement SC does not exist, though the concept is implemented in many different European cities. Due to the existing gap between policy visions and implementation, there is thus a need to move towards more explanatory typologies to better understand how smart city implementations are guided.

Current research on smart city implementation, however, can only partly fill this gap. Most of the identified principles and paths of smart city implementation – within some sort of meta-level discussion – are again to a certain degree shaped by the ongoing conceptual discussions. In addition, they are rather descriptive, have some overlap, and it is rather unclear how these key principles are combined in real strategies. While these principles indicate potential challenges and trade-offs of smart city strategy formulation, the literature at micro- and meso level moves a step forward and concretises elements and dimension of SC implementation.

SC implementation can in a first dimension be differentiated in terms of coordination, organisation, and strategic development. While some cities operate with the existing personnel, processes, and administrative structures, others identify a need for organisational and strategic renewal. Key elements are therefore SC visions or strategies, which are developed in addition to new positions, such as chief digital officers, or steering and coordination committees. The second dimension is made up of the level of technological implementation and integration. The deployment of digital technologies can be a core

element of smart cities. However, implementation processes may very terms of depth of the deployment and integration of technologies, data, and the necessary infrastructure for new platform architectures. This includes the technological development and integration in single applications of the smart city wheel, but also coordination and integration between different fields and different spatial levels of the city (buildings, street, districts, whole city).

Taking these two dimensions into account allows for a more rooted analysis and depiction of strategy options of smart cities. In addition, it might allow further investigations on how technology and organisational development interrelate and it might explain smart city implementations in terms of viable strategies, overall impacts on city systems and paths for further strategic (re-)developments. Therefore, in this paper we would like to answer the following research questions:

- What kinds of organisational and technological strategies are deployed to implement SC?
- What kind of strength and weaknesses do these strategies have? What are potential strategic re-developments and paths?

3. Methods

Our research on SC implementation strategies builds on a pre-study in which we prepared and conducted the case study selection and a main study in which four smart city initiatives have been analysed in terms of the strategy type they applied. Case studies were conducted on Pully, Amsterdam, Vienna, and Santander.

4. Typology of implementation strategies

4.1. Technology and organisational development in the case studies

SC implementation can be differentiated in the first dimension in terms of organisational and strategic development and coordination. While Pully operates with the existing personnel, processes and administrative structures and does not implement any coordinative strategy due to costs and potential loss of flexibility and freedom of innovation, Vienna had identified a need for organisational and strategic renewal and built up i) smart city specific organisational structure including interdepartmental coordinative bodies, committees for strategy development as well as for the operative implementation and management and ii) strategy documents called smart city framework strategy. Projects and activities are therefore selected according to the established strategy and the implementation process is reviewed within a monitoring process. This process should detect if the goals of the framework strategy are achieved, or an adaption of the strategy is needed. However, it recognises that smaller cities tend to find it easier to network across departments and cooperate between different players, even without a formal smart city strategy.

The second dimension comprises the level of technological implementation and integration. The deployment of digital technologies is a key element of smart cities and the level of deployment and integration of technologies varies between our case studies. In Amsterdam, Santander, Vienna, and Pully smart city processes mostly started with pilot projects in the field of smart energy, smart mobility, or the replacement of analogue administrative processes (smart government). Amsterdam and Santander developed partial fully functional standalone application while Vienna and Pully did not have such focused approaches on technological innovation. These developments in Santander and Amsterdam include further decisions and activities in terms of data generation and deployment for certain decision or management processes. They also include well-defined selections of fenders, accompanying technologies such as APIs, transmission technologies, and take into account the already existing infrastructures, formats, and potential future extensions in terms of integration of applications and services. While most of pilot projects were located in specific areas of the smart city wheel, in the case of Amsterdam they are neither scaled up nor complemented with further developments in terms integration of further data sources, applications or platform infrastructures (van Winden and van den Buuse, 2017). While Amsterdam is strong in technological development and integration in single applications such as smart energy, Santander goes a step further and coordinates and integrates between different smart city fields and different spatial levels of the city by complementing IoT platforms with

an overarching platform architecture for data management. These first results show that SCI vary in terms of organisational development and technology implementation, although they have the same aim of implementing the smart city concepts.

4.2. Typology of SC implementation strategies

By differentiating these dimensions in the two values of "low" and "high" four key strategies of SC implementation can be derived (see Figure 1).

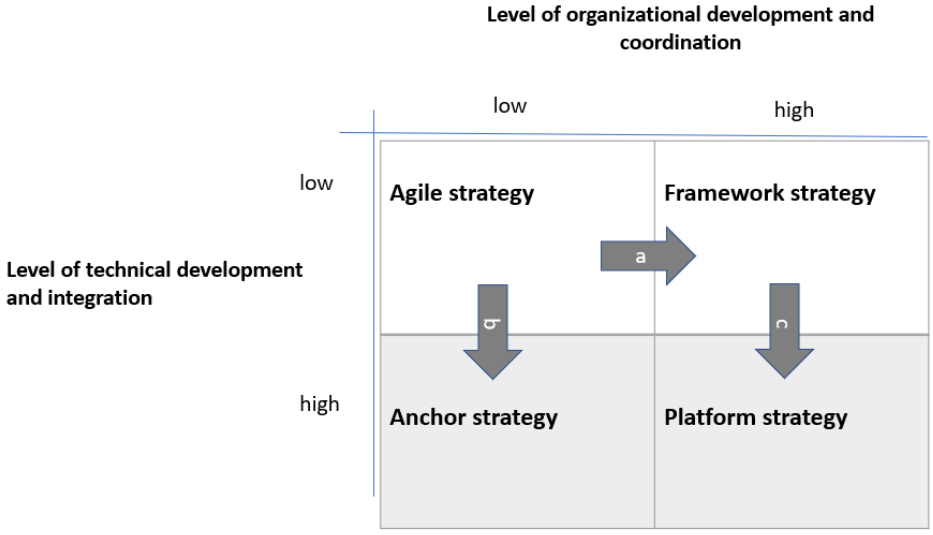

Figure 1: Typology of implementation strategies of Smart Cities

The **agile strategy** is characterised by both, a low level of technical integration and a low level organisational and strategic development. The Pully case study represents this type. Innovative projects are proactively initiated and implemented by various actors. There is no overarching organisational structure or strategy for project selection or -coordination, and often no monitoring of smart city implementation takes place. The focus is on implementing pilot projects, so-called "quick wins," for marketing reasons in addition to learning and know-how development. Freedom, agility, and the ability to innovate are seen as more important than coordination and integration. This approach is based on the assumption that smart cities are not implemented by following a master plan but by a step-by-step approach and by making small changes in the cities through different projects. In terms of strengths and weaknesses, it allows for a high degree of freedom to test new technologies and services and involves the broader public to help increase acceptance and legitimacy of smart city development. Different applications and vendors can be tested without a final plan for technological and infrastructural integration into a new systems architecture. However, scaling up and going beyond pilot projects might be challenging, as a long-term plan and strategy is lacking.

The **framework strategy** is related to the agile type. While technology development and coordination are low, the level of strategy and organisational development is advanced in this strategy type. Cities coordinate and often reorganise SC developments in an initiative via a planning and strategy formulation process and the foundation of an SC organisation. While technologies are tested in pilot projects, the focus of the initiative is on the implementation of citizen-oriented projects and the careful deployment of technologies. As a result, there might be no plan for fully operational integration of technologies. Moreover, a smart city strategy or a programme that encourages innovation and perhaps implements a monitoring system to control the long-term developments are key. Projects are then selected, funded and implemented according to the strategy. Using the monitoring system, the success of the entire smart city initiative is then assessed, and the strategy adjusted if necessary.

The anchor strategy type can be described by a high level of technology integration but low level of strategy and organisational development. Parts of an anchor strategy can be found in the Pully and

Amsterdam case studies. Cities develop a technological solution for a specific standalone application (e.g. smart mobility), usually in response to an urgent need (e.g. traffic congestion in the city) for which there is a digital solution. This digital solution "anchors" all subsequent investments in technology in other fields of action. Implementation of the initial technology is therefore driven by the initial use-case. If the technology works, it might be expanded to other fields of the smart city wheel. This, however, means that new projects and solutions must fit in the already existing technological setting and that the innovation management modus have a trial and error component. Organisational and strategical development of the smart city initiative is not demanded as only specific departments and processes are key. In terms of strengths and weaknesses it was reported that an anchor strategy is a straightforward way to achieve a fully digital solutions in single applications, which also provide concrete solutions and gains. However, the dependence on specific vendors and technologies as well as the integration of further solutions and services might be challenging.

Finally, the platform strategy is the most advanced type in terms of technology integration and strategic and organisational development. The Santander case represents this type. Such smart cities focus on investments in infrastructures and a comprehensive smart city platform encompassing existing datasets, applications, and services. The core idea of this approach is that specific services and solutions can only be created by combining different processes, applications, and data sets in a single platform. This means that the platform's performance and benefits depend not only on a specific technological architecture but also on mainstreaming of different processes such as data collection and management, as well as an adoption of planning and decision-making process in all parts of the city administrations. This means that next to the implementation of a smart city organisation, all departments have a need of reorganisation. In addition to that, the implementation management is structured by the needs of the overall architecture (the management platform). A major strength of this approach is explicit activation of synergies between different smart city fields, data sets and the explicit provision of new services and solutions. A major weakness are the high upfront investments, technology, and vendor dependences as well as the tendency of losing track of the citizen needs. Finally, the approach heavily depends on coordination and design skills of those responsible for the smart city and that investment decisions have to be made despite the lack of technological standardisation.

5. Discussion and Conclusion

While the SC concept is fluid and much of the literature remains in a conceptual place, many cities and municipalities have already operationalised the concept. In this paper we take an applied perspective and focus on the "how" of smart cities rather than the "what" and have a look on smart city implementation strategies. We showed that in four studied examples, organisational and technological dimensions were of importance for SC implementation and that four strategy types can be identified: i) the agile type, which focuses on the solution of identified problems without developing a broader organisation and strategy framework, ii) the anchor strategy, in which cities deploy all technologies for a pressing stand-alone application (e.g. smart mobility) and then extend or integrate other applications or fields as needed, iii) the framework strategy, in which cities coordinate and reorganise SC developments in an initiative via a strategy formulation process and the foundation of an SC organisation and finally iv) a platforms strategy, in which cities focus on the development of a IoT and data management platform architecture first, in order to deliver a range of new applications and services.

These strategies have different strength and weaknesses in terms of flexibilities, costs, dependence and created services and solutions, and are situated in contexts where cities have actively decided to engage with the SC concept. With our proposed typology, our primary aim is to provide an explanatory tool to classify current SCIs and map out potential SC implementation routes. The four strategy types, therefore, may offer some orientation around different pathways a city may choose to follow, should they make the decision to engage with smart cities.

One should note that while certain progression paths from one strategy type to another are easier to follow, cities must decide depending on their own competencies, capacities and priorities which strategy type their mission most closely aligns with and whether other strategy types are even desirable. It follows then, that any strategy type can lead to either highly desirable or highly undesirable results in their implementation without a deliberative and reflexive process leading up to certain path of

implementation. With our proposed typology we, therefore, neither suggested that all SC will move in the direction of implementing SC platform automatically nor do we expect that implementation of this type always will lead to positive outcomes in the respective smart cities.

While the SC concept is fluid and without a uniform theoretical background to explain SC development, our contribution to the SC literature are threefold. First, the digital urban transformation might evolve around different paths in which organisational and technology innovation and development are key dimensions which jointly evolve and are interrelated i.e. the development in one dimension might accelerate or impede the development in the other dimension. Second, reflections on the directionality of path development and considerations of whether contradictions or path dependencies are emerging are pivotal. The implementation strategies identified influence dependencies and especially the build-up of key architectures in terms of IoT or data and smart city management platforms might influence further development. Third, we point to the potential trade-offs cities may face in the SC implementation, such as the trade-off between control through a platform but also dependence on the developed technological infrastructure, and the flexibility to switch paths easily whilst having less control over the types of innovations that emerge. The agile- or framework strategy as 'wait and see' strategies, might be an option here but they come at cost of innovation leadership, availability of new services and shaping the transition towards smart cities. Nevertheless, further research on SC implementation strategies is needed. Through further assessments of currently implemented SCI, we are curious to see which implementation pathways cities choose to follow and how these different paths shape the urban transformation in practice.

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