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Jocelyn Cranefield

Jan Pries-Heje

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Cities worldwide are engaging in smart city digital transformation. However, delivering sustainable improvements while pursuing high-level transformational goals is highly complex. Based on interviews with smart city leaders, we identify eight challenges to sustaining and scaling-up smart city transformation. These challenges are underpinned by a clash between traditional institutional city logic and emerging smart city logic. We describe three boundary management strategies for addressing this clash and the associated challenges, and provide a framework to help smart city leaders select appropriate boundary management strategies.[1,2]

Jocelyn Cranefield
Victoria University of Wellington (New Zealand)

Jan Pries-Heje
Roskilde University (Denmark)

The Clash Between Smart City Logic and Traditional Institutional Logic

Smart cities use diverse applications of new technology, big data and the Internet of Things (IoT) to create benefits for their citizens and to improve sustainability and resilience.[3] With two thirds of the world's population expected to be living in cities by 2050,[4] and growing urgency to address environmental concerns, interest in smart cities is growing rapidly. The global market for smart city technologies and services is forecast to be worth between $873.7 billion[5] and $2,036.10 billion[6] by 2026. There is no doubt that smart cities are a key topic of the future that every business and IT leader and manager, whether in the public or private sector, needs to understand.

The drive toward smart cities is linked with an ambitious and multifaceted digital transformation agenda. Smart cities typically aim to solve entangled problems of urbanization

1 Kristine Dery is the accepting senior editor for this article.

2 The authors thank Kristine Dery and the reviewers for their valuable feedback and guidance throughout the review process. We also gratefully acknowledge the input of the smart city leaders who took part in this study.

3 The smart city has also been defined as a system of interdependent systems connecting people, institutions, technology, organization, built environment and physical infrastructure. For a full discussion see Zheng, C., Yuan, J., Zhu, L., Zhang, Y. and Shao, Q. "From Digital to Sustainable: A Scientometric Review of Smart City Literature between 1990 and 2019," *Journal of Cleaner Production* (258), June 2020, 120689.

4 The United Nations Development Programme (2017) estimates that 6.5 billion people will be living in cities by 2050.

5 *Smart Cities Market by Focus Area, Smart Transportation, Smart Buildings, Smart Utilities, Smart Citizen Services (2022-2026)*, MarketsandMarkets Research Private Limited, 2022, available at https://www.marketsandmarkets.com/Market-Reports/smart-cities-market-542.html.

6 *Smart Cities Market Size, Trends, Covid Impact and Forecasts (2022–27)*, Mordor Intelligence, 2022, available at https://www.mordorintelligence.com/industry-reports/smart-cities-market.

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that span multiple domains. Their desired outcomes include reductions in emissions and improvements in transport, energy efficiency, security and emergency services, waste and water management, city management, economic development, public health, informed public participation and environmental sustainability.[7] A typical goal of a smart city digital transformation is to increase people's quality of life while reducing the environmental impact of urban activities.[8] In pursuit of these diverse smart city goals, those implementing the necessary technologies must work across organizational boundaries and build networks and partnerships with citizens, industry, academia and other cities to co-create and co-fund transformation.

Digital transformation creates "unprecedented disruptions in society, industry and organizations"[9] and smart city digital transformation is no exception. The smart city agenda is underpinned by a radically new institutional logic of how a city operates, how it delivers benefits to city stakeholders, how it facilitates decision-making that involves its citizens, and how it uses technology and data. Smart cities take an integrated view of how a city's services work and provide benefits. For example, smart street lamps not only provide lighting but also gather data to contribute to the city's transportation solutions, citizen safety and air pollution management.

A fundamental attribute of the new logic is that data helps drive city-level improvements through rational and adaptive responses. For example, by revealing high-level patterns of what is really happening in a city, analysis of data from sensors may challenge the assumptions underlying a city's policies relating to building zones, energy use, alcohol policy and parking. This in turn may require new policy solutions. Smart city logic also emphasizes innovation, discovery, agility and co-operation.[10]

Although these attributes of smart city logic offer great potential, they create a powerful clash with the institutional logic[11] that underpins how traditional cities operate. According to traditional bureaucratic logic, city services are delivered through functional divisions that are accountable for different budgets and benefits. This traditional logic means, for example, that smart street lamps become a complex problem. Moreover, the incentives embedded in traditional logic favor stability, budget presentation and risk reduction more than innovation and agility.

For leaders of smart city initiatives, the clash of new and traditional logics presents a considerable hurdle on top of the challenge of transforming a city to gain widespread benefits from the use of advanced IT and data. Motivated by this problem, we set out to understand the digital leadership work that is involved in smart city digital transformations. Our study was guided by two questions:

1. What challenges do leaders face when embarking on smart city digital transformations?
2. How do they address these challenges?

We focused on the digital leadership work of individuals who have played key roles in leading smart city transformation programs across 12 cities in Europe, North America and the Pacific. In total, we conducted 21 in-depth interviews with 18 leaders in two rounds (2018-19 and 2021). Participants included four CIOs, five program managers, four innovation leads, three lead consultants, a technical lead and a mayor. (See the Appendix for details of the interviewees and our research method.) These leaders had overseen smart city pilot projects and were

7 See Höjer, M. and Wangel, J. "Smart Sustainable Cities: Definition and Challenges," *ICT Innovations for Sustainability*, Springer, 2015, pp. 333-349.

8 See Belli, L., Cilfone, A., Davoli, L., Ferrari, G., Adorni, P., Di Nocera, Dall'Olio A., Pellegrini, C., Mordacci, M. and Bertolotti, E. "IoT-Enabled Smart Sustainable Cities: Challenges and Approaches," Smart Cities (3:3), September 2020, pp. 1039-1071.

9 See Feroz, A. K., Zo, H. and Chiravuri, A. "Digital Transformation and Environmental Sustainability: A Review and Research Agenda," *Sustainability* (13:3), February 2021, Article 1530.

10 According to Pierce et al, eight typical institutional logics may coexist to shape the organization of smart cities: innovation, classical market, bureaucratic, equality, environmentalist, predatory, commons, and co-creation. Innovation logic and bureaucratic logic are particularly conflicting. For more information, see Pierce, P., Ricciardi, F. and Zardini, A. "Smart Cities as Organizational Fields: A Framework for Mapping Sustainability-Enabling Configurations," *Sustainability* (9:9), August 2017, Article 1506.

11 Institutional logics are the systems of values, beliefs and norms through which people, groups and organizations make sense of, evaluate and organize their activities. For more information, see Haveman, H. A. and Gualtieri, G. "Institutional Logics," in *Oxford Research Encyclopedia of Business and Management*, September 2017, available at https://oxfordre.com/business/view/10.1093/acrefore/9780190224851.001.0001/acrefore-9780190224851-e-137.

undertaking larger-scale digital transformation programs that would fundamentally impact their cities' business-as-usual and involved multiple third parties. The smart city programs were all "brownfield" initiatives, with smart city technologies and their benefits layered on top of existing city systems and infrastructure. Our findings reported in this article are based on the challenges faced by these key informants and how they addressed these challenges.

Challenges of Smart City Digital Transformation

Our interviewees' smart city programs began with pilot projects that aimed to produce valuable results quickly and generate buy-in. However, the resulting quick wins typically resulted in nonsustainable outcomes. We found that smart city leaders faced eight key challenges, described below, to scaling up smart city digital transformations and building on the early benefits of pilot projects. These challenges were interdependent and mutually reinforcing.

Challenge 1: Misalignment of Municipal Structures and Systems with Smart City Goals

All participants reported that their city's administrative structures and systems presented challenges to achieving smart city goals. Silos are a feature of many organizations but, as reported by Kris[12] (a city CIO), they are "massively exaggerated" and provide "a collection of quite disparate activities united only by location" (Ted, an innovation lead). Nina, also a city CIO, said that efforts to improve service delivery were often perceived as "a disturbance to the main focus."

Traditional city budgeting is based around allocating costs and ownership to business or service divisions. This causes problems in delivering integrated services. Carl, a program manager, told us that his city was rolling out street lamps with built-in charging stations for electric cars and video cameras for monitoring public safety. The initiative cut across three business divisions and was hindered by a lack of ownership: "Nobody owns it because there's no owner for integration functions. And the same goes for funding. … The municipality is definitely not organized to facilitate smart cities."

Similar issues arose for recognizing benefits. Diana (also a program manager) reported that her city installed food grinders to reduce waste. The cost fell to the housing department, but the benefits were realized by the waste management department, which caused both friction and complexity. She said: "It's hard to lift people's eyes up to that greater value offering, because we are still working in our silos."

Furthermore, the procurement cycles of service divisions were not aligned, with disparate renewal dates making it hard to shift toward integrated solutions. As Carl explained, incremental budgeting systems also created a challenge: "You get your money if you're NOT more efficient. But if you ARE [more] efficient [at delivering services] … you're going to lose your budget. So, there's no incentive to be better at what you're doing."

These budget issues, combined with the ownership issue, made it hard for smart city leaders to secure funding to scale up benefits. When funding from pilots ran out and vendors exited from technology trials, leaders typically found themselves competing for funds from a general taxpayer-funded pool and searching for innovative funding solutions. Moreover, the few study participants who had dedicated smart city funding saw this as insufficient to achieve substantial digital transformation.

Challenge 2: Restrictive Data Arrangements

In many cities, the data generated by smart city pilots was held in cloud solutions owned by third parties. Deploying these solutions helped cities achieve rapid results that were evidenced by data. However, cities did not always own this data. Moreover, the data in vendor ecosystems could not be readily integrated with other city data. Nina explained:

> *"We've been … working with small pilot projects … to show this is a smart thing to do … [but the] provider has the whole ecosystem of data. … They [the provider] split up the centers, they get the data into their own cloud somewhere, and maybe show them in an app or on the web or*

12 In attributing the quotes from our study participants, we use the pseudonyms shown in the Appendix. On first mention, the participant's role is also given.

something. But it's an ecosystem that lives parallel to the municipality."

In Ted's city, the vertical procurement model for parking sensors meant that parking data went to users' apps without allowing the city to store, process or view the data.

The challenge of externally held data was mirrored internally. Smart city data was held across multiple systems in multiple formats and with different conventions and restrictions around its use. Ted said that departments in his city used data in very different ways and that "the perceived specialness" of each department's data made it hard for stakeholders to agree on any unified solution. He said there was "effectively a cities data market operating with the departments as entities in that market." Restrictions on the use of the city's internal data presented a major challenge to digital transformation.

Challenge 3: Legal, Regulatory and Security Challenges

The scope of the smart city pilots was highly focused, and they were short-term projects and/or undertaken on a proof-of-concept basis. Hence, they did not need to comply with business-as-usual policy requirements. However, when cities needed to scale up the pilots, leaders faced a multitude of legal regulatory, security and privacy challenges. These challenges were complex, time-consuming and difficult to resolve. Ted described how a citizen safety pilot in his city had used machine learning to analyze the video feed from street cameras. The pilot had shown that citizen safety could be effectively monitored by an AI-based system. Moreover, this system had proven to be more effective at protecting citizen privacy than the existing use of volunteers to monitor the video feed. However, since the AI-based monitoring system could not be rolled out without a major legislative change, it did not proceed. Victoria, a program manager, and other participants told similar stories.

The geographic boundaries of cities' governance mandates presented a further challenge to scalability: One participant headed up a smart city initiative in a metropolitan region with multiple contiguous cities. The ambitious nature of the smart city digital transformation goals made it hard for any one city to succeed alone, but it was hard to collaborate on achieving higher-level metropolitan area goals when there were 40 police services, 40 ambulance services and 40 ERP systems.

Challenge 4: Lack of an Innovation Culture in City Administration

The technology providers and personnel involved in smart city initiatives need to be innovative and agile but, by their very nature, city administrations are highly stable, consistent and focus on the long term. These characteristics don't foster innovation or risk-taking. Participants reported that city administrations have cultures that are risk averse and resistant to innovation, making progress toward transformative goals difficult. The impact of the entrenched institutional culture was significant, as emphasized by Carl: "it's the culture that is by far the most difficult to create. And that's the thing everybody underestimates."

Fostering an innovation culture in a traditional city administration needs to be undertaken with care, and it is crucial to building the *right kind* of innovation culture. One participant described how a nearby smart city project had adopted a disruptive innovation mindset. This created an "us and them" culture that led the smart city program to stall. In contrast, another city established an independent smart city unit within the city architect's department, which fostered a constructive innovation culture that was seen as conductive to engaging the municipality in smart city digital transformation.

Challenge 5: Resistance to Using Data to Drive Value

Smart city initiatives aim to deliver benefits by analyzing data from sensors and IoT devices embedded in city infrastructure. However, interviewees revealed that their cities often resisted using this data or took a piecemeal approach and were uncertain about how to move forward with data use. For example, Carl's city was using automated data-driven decision models for transport and water management, but the data gathered was rarely used to drive decisions, even if there was an identified opportunity to create efficiencies. For example, predictive analytics could determine the optimum locations

to send a scanning car to identify citizens' parking offenses, but the city resisted using this approach because its existing policy for policing parking was based around the equity of geographic coverage.

Unsurprisingly, cities had a particular concern about how to ethically use citizens' personal data in their decisions. This placed many areas of smart city transformation in the "too hard" basket. Nina told us that her city had decided to avoid using data about people entirely: "We usually put data together because we want to help a citizen, but do they want to be helped in that way, and who should decide? ... And it's been questioned whether that's ethical. … So … we're trying to stay on the safe side, working with safe data, like building data … nonperson data."

Challenge 6: Gaps in the Capability and Knowledge Needed for Smart City Digital Transformation

Digital transformation inevitably creates a demand for new knowledge, and this is magnified in a smart city context. Fiona, a program manager, likened leading a smart city initiative to "flying an airplane while building it." Participants emphasized that a lack of specialized knowledge, skills and capability created a major challenge to smart city digital transformation. They faced gaps in the knowledge needed to inform technology-related decisions, determine how to embed smart city initiatives in city services and processes, manage IoT datasets and integrate data from smart city-wide area networks with municipal data sets. A further challenge was working out how to guide investments in smart city technology given its rapid rate of change. These knowledge gaps were seen not as a disincentive but rather as a stimulating and perennial aspect of smart city digital transformation. Nonetheless, they placed major demands on leaders and exposed a significant divide between the capabilities of cities and those of their external partners.

Lack of knowledge was a particular issue for smaller cities, where resources to develop knowledge were most constrained. Nina noted, "We're all looking for somebody bigger than us to learn from." This constraint often affected everyone involved in smart city digital transformation, making it necessary to work with many different consultants and gain access to their diversified knowledge.

Managers of city services often lacked understanding regarding how smart city technologies could help them improve service delivery, which increased their resistance to initiatives. Smart city leaders therefore needed to anticipate "the sort of knowledge acquisition" that business owners needed before they would engage with initiatives (Leonard, innovation lead). Conversely, smart city leaders often lacked a good understanding of city services and operations, as noted by Nina: "The people who actually know something about the core service that [the city] delivers do not know anything about the technical possibilities, and I don't really know much about what they really do out there with citizens. So, bridging those things is [an issue]."

Challenge 7: Engaging Citizens

Smart cities both service their citizens and are funded by them. It is therefore critical to engage with citizens and communities about smart city initiatives. Though the smart city leaders in our study did not directly oversee citizen engagement, they were strongly dependent on the quality and depth of citizen engagement. Many noted that their cities struggled in this area. In all the cities of our interviewees, there was a double-layered structure comprising the public administration and the elected politicians. For politicians, the involvement of citizens is crucial, not only to justify smart city investments but also because they generally want to be reelected. Hans and Nina (the mayor and CIO of a large town) told us that engaging citizens was relatively easy, but it was often the "Tordenskjold's soldiers"[13] who engaged—the same group of people feeling compelled to repeatedly show up. Typically, these people were early retirees and those with older children, whereas people with young families rarely found the time to engage. Participants emphasized that it was important to engage with a broad base of citizens to engender

13 Tordenskjold was a Danish/Norwegian navy officer. During a war in the Swedish city of Marstrand, he had his men move in secrecy from one position to another as he was walking the Marstrand commander through his positions, thus convincing the commander that his strength was much greater than it actually was.

social license,[14] co-create solutions, identify biases and address knowledge gaps. Without such engagement, it is hard to make informed decisions about smart city digital transformation. For example, one city's transport systems were optimized around rush-hour commuter data because the city lacked an understanding of the travel needs of children and non rush-hour commuters.

Challenge 8: City Politics

Unsurprisingly, city politics also present challenges to smart city digital transformation. This is a key challenge that differentiates smart city initiatives from corporate IT initiatives. The leaders in our study spoke of having faced diverse political challenges. Nina described the process of transformation as being like "a [game of] ping pong" between the wishes of politicians and the opportunities identified by the smart city program. Sometimes, however, city politics enabled smart city initiatives. Victoria recounted how her city being chosen as one of the top 100 resilient cities helped create political momentum for building an innovation unit under the city architect.

More often, though, politics created challenges that required push-back from smart city leaders. Ted noted that politicians can be more responsive to the concerns of pressure groups than to insights from large data sets. He had faced feedback from city councilors saying: "We've been told this by our community. Why isn't your data showing [it to] us?" This led to, "a long conversation about empirical data and experience-based narratives vs. the dispassionate footprint of systems and the limitations of both forms of data."

Another smart city leader faced criticism when a vocal political leader questioned whether she was engaging in a "proper" smart city transformation. This political intervention potentially affected access to resources and created undesirable pressure to do what other cities were doing. Other leaders reported challenges in gaining buy-in from conservative governing bodies in their region. The political agendas of elected city officials were also seen as presenting a potential challenge for the smart city's future use of data in decision-making. Carl noted that: "Politics are about emotion. … You can analyze everything, but for politicians it wouldn't be beneficial if everything [was] transparent based on our data, because then they won't have a function anymore."

Smart City Leaders Must Manage the Boundary Between Traditional and Smart City Logics

To understand how smart city leaders tackle the eight challenges of smart city digital transformation, we draw on the concepts of boundary spanning and boundary work. People who are boundary spanners[15] span different contexts and typically work to interconnect the cultures and norms of these contexts. By doing this, they build new understandings, foster innovation and gain resources. Boundary spanners therefore need strong relational competencies, innovative capacities, and skills in managing complexity and interdependencies that are drawn from a base of broad experience and transdisciplinary knowledge.[16]

Our study clearly showed that smart city leaders are expert boundary spanners. In their day-to-day work, they span multiple structural, cultural and domain-based boundaries. These include the boundaries between:

- A city's functional silos
- Communities of practice (e.g., between city planners, policy makers, data analysts and security experts) with their distinct bodies of knowledge, ways of working and professional values
- The municipality and its citizens,[17] external vendors, consultants, experts, governing bodies and networks
- Their smart city and other smart cities.

Without a doubt, the key boundary that smart city leaders need to negotiate is that

14 Social license is the ongoing acceptance of an organization's standard business practices and operating procedures by its employees, stakeholders and the general public.

15 See Levina, N. and Vaast E. "The Emergence of Boundary Spanning Competence in Practice: Implications for Implementation and Use of Information Systems," *MIS Quarterly* (24:2), June 2005, pp. 335-363.

16 See Williams, P. "The Competent Boundary Spanner," *Public Administration* (80:1), 2002, pp. 103-124.

17 The majority of our study participants did not work directly with citizens.

between traditional institutional city logic and the emerging smart city logic. This boundary (i.e., the clash between the two logics) is at the root of many of the challenges identified above. On one side of the boundary is the traditional city logic that values and incentivizes tradition, stability, silo-based budget allocation, distributed ownership of service delivery, budget preservation and risk-aversion. On the other side is the emerging smart city logic that values digitalization, innovation, agility, integrated ownership of services and benefits, rational responses to data-driven insights, new forms of collaboration and planetary-level goals. An additional complication is that smart city logic is not as stable or coherent as traditional city logic. The former can combine potentially competing institutional logics, including environmental, technology, market, innovation, equality, predatory, common and co-creation logics.[18] From the perspective of traditional city logic, smart city logic presents immense challenges.

An example of this clash of logics was provided by Carl. In his city, a scanning patrol car had identified previously unknown patterns of parking infringements. According to smart city logic, this data could be used in a predictive way to route the car to optimal ticketing locations, disincentivizing car use and generating revenue. However, no change was made to the ticketing system because the existing routing system (rotating the car evenly among locations) was based on the principle of equitable treatment of citizens.

Similar clashes of logic can occur in allocating smart city benefits, attributing costs, incentivizing savings, managing privacy, using data in decision-making and defining the role of policy in smart city transformation. It is therefore essential that smart city leaders understand the boundary clashes between traditional city and smart city logics and find ways to address them in their work. As Nina stated, there is a constant imperative "to figure out how to add value … without slowing down the project."

18 See Pierce, P., Ricciardi, F. and Zardini, A., op. cit., August 2017.

Three Boundary Management Strategies for Smart City Digital Transformation

We use the lens of boundary work to understand how smart city leaders address the challenges of digital transformation. Boundary work is the work that boundary spanners do to manage boundaries in pursuit of their goals. This lens is valuable because smart city leaders span so many boundaries in their daily work. Their position as "super" boundary spanners puts them in a unique position to exploit these boundaries in different ways to address the challenges and promote smart city digital transformation.

Effective boundary work requires knowing when to employ three different boundary management strategies: 1) boundary bridging; 2) boundary buffering; and 3) boundary building, reinforcing and defending.[19] Boundary spanners are best known for their use of the boundary bridging strategy—i.e., establishing connections across boundaries to foster knowledge transfer and creation, and/or to obtain resources and support.[20] In some situations, however, boundary spanners need to tackle boundaries in a more defensive way. They do this either through a boundary buffering strategy, which protects one side by disengaging from the other, or a boundary building, reinforcing and defending strategy, which exploits and remodels boundaries to overcome differences. We found that smart city leaders use all three of these boundary management strategies in their work, switching between them to tackle the barriers to transformation.

1. The Boundary Bridging Strategy Generates Buy-in, Resources and Knowledge

Boundary bridging was the most frequent boundary management strategy used by our study participants. Bridging is an engagement

19 See: 1) Faraj, S. and Yan, A. "Boundary Work in Knowledge Teams," *Journal of Applied Psychology* (94:3), June 2009, pp. 604-617; and 2) Kislov, R. "Selective Permeability of Boundaries in a Knowledge Brokering Team," *Public Administration* (96:4), August 2018, pp. 817-836.

20 For a good study of the boundary bridging strategy, see Lindgren, R., Andersson, M. and Henfridsson, O. "Multi-Contextuality in Boundary-Spanning Practices," *Information Systems Journal* (18:6), November 2008, pp. 641-661.

strategy in which smart city leaders work across boundaries to connect others, generate buy-in and goodwill and create knowledge. This boundary management strategy is useful when there is task uncertainty, and/or when external groups have valuable resources. As explained later, it is also useful when the level of threat to the smart city initiative is low.

Smart city leaders in our study used an internally focused bridging strategy (bridging between the departments of a city) to connect smart city digital transformation to traditional city logic while leveraging the existing structures and resources of departments. They also used internal bridging to build new knowledge and foster mindsets that were conducive to innovation, so that movements away from traditional city logic would be driven from within. Externally focused boundary bridging (bridging between the city and external entities) helped smart city leaders gain resources and knowledge that the city could not provide. This type of bridging promoted innovation and expanded the know-how needed to move toward smart city goals.

As described below, smart city leaders used boundary bridging strategies for two key purposes: to 1) gain buy-in, support and resources; and 2) to create new knowledge.

Boundary Bridging to Gain Buy-in, Support and Resources. Although smart city leaders must provide a clear sense of purpose and direction to guide smart city digital transformation, they also need to secure resources and gain support. Our study participants adopted a wide range of bridging activities to achieve this end. They brokered supply and demand for smart city solutions, matching the needs of city service owners to smart city solutions, and connecting internal stakeholders to external innovators, experts and suppliers. They identified existing divisional budgetary commitments on which to piggyback smart city initiatives and fostered networks of champions across different functional divisions. To build distributed ownership of smart city initiatives, they ran idea-generation workshops with key people from across their cities' divisional boundaries.

Diana said that she focused on "trying to pick the champions … leveraging the people with influence or passion or skills at different levels of the organization and pulling them together." Carl worked "to create champions on different levels, on [the] product level, people that DO something." Leaders helped champions succeed by brokering and shaping vendor agreements (e.g., to avoid restrictive data arrangements, by providing data for them to demonstrate value), and by providing social recognition. Carl said, "We brand [business owners] as a champion, we put them on a pedestal." He engaged a copywriter to help champions promote their ideas for digital transformation in staff forums.

To foster a shared vision across boundaries, smart city leaders engaged in frequent storytelling, translating and interpreting. They customized stories about potential smart city benefits to suit different needs. Nina said, "I see it as my role to try and give [business owners] some idea of [what they could do] … What would fit into your picture of the ideal way forward for your area?" Fiona noted, "I think of myself as kind of a storyteller, or translator of the different technical community executives." This was time-consuming, but critical, high-value work.

Leaders also fostered new cross-organizational conversations that aligned with smart city logic. Diana noted: "When the organization might not hear the messaging very clearly, if you can get a small group of people together across an organizational group who all understand it and all can talk the talk, then they go back to their places and they start spinning that story. So, we're kind of working by infiltration, and that has been very successful."

These boundary bridging activities required skills in communication, relationships and persuasion. Kris worked to "win people over one story at a time," while Leonard spoke of working to "fade in the knowledge and then [build] the want for them to be able to change."

Gaining buy-in, shared ownership and resources through bridging helped move projects and strategic conversations forward. By increasing buy-in and ownership, bridging made it easier for leaders to coordinate diverse stakeholder activities in pursuit of the smart city vision. Kris explained: "you've got to be able to coordinate these many different stakeholders in a way that, to the extent you can, everybody's on the same page and marching to the same drumbeat."

In combination, these bridging activities helped smart city leaders to tackle three of the challenges: misalignment of municipal structures and systems, lack of an innovation culture, and engaging citizens. For example, Jana (a consultant) led the development of a display center that showcased emerging smart city solutions and fostered the co-creation of ideas by citizens, vendors and business owners. This center acted as a bridge between citizens, the city's business unit stakeholders and technology vendors, and led to the co-design of a high-tech venue for city events. Unexpectedly, it also helped foster an emergent innovation culture within the city administration.

Smart city leaders also bridged interorganizational boundaries to address the funding, policy and resource barriers inherent to traditional city institutional logic. They helped set up new funding models via public-private partnerships and worked on cross-city solutions to create economies of scale. For example, the region in which Nina's city is located set up a shared IoT server to help with data integration. This was something her city could neither afford to do nor did they have the skills to do it.

Boundary Bridging to Create New Knowledge. Smart city leaders also used boundary bridging to build their own knowledge and address their cities' knowledge deficits. They continually sought knowledge from internal and external experts, and from technology vendors and networks. Kris noted, "I've got to be really clued into what's going on, what the vendor space is doing, really aware of … stuff that's working around the world. ... A leader in this space needs to be knowledgeable of the technology, the global phenomena and… the needs of our community." Leonard said he built up "buckets" of knowledge for future use: "[I'm] knowledge gathering the whole time. So, you're grabbing something and putting it in all your different buckets as you go along, and you may not use something for 12 months. But you know what's in the bucket ready for when you need it."

To build knowledge, leaders also drew on relationships with smart city innovators in a dispersed network of practice. Valerie (a program manager) explained: "There are innovators in various organizations around the country … who [are] kindred spirits, and you network with those people, and those are the people that you tend to tack on to make things happen; … because they have a similar attitude, it's almost like you can speak shorthand with each other."

Nina's city partnered with other local cities in a public digitalization network that aimed to specify, develop and govern digital solutions made by and for public bodies—in collaboration with vendors but without vendor lock-in. This bridging management strategy focused on addressing the challenges of restricted access to data and using data to drive value.

To deliver integrated benefits, smart city leaders need to understand how a city's silo-based operations connect with each other. Leonard's smart city program touched nearly 80 different business areas. He had to work to "understand all the interconnections between those [areas] … in order to shift it forward." This required him to make "deep dives" into different areas, identify other boundary spanners, and connect up people from different silos to help co-create solutions.

Boundary bridging was also used to create new city-level strategy. One smart city leader arranged to be seconded to the city's strategy division. This was a highly strategic bridging move, designed to co-create a new development strategy for the city that would be better aligned with smart city goals and logic. He was also working with executives to develop a positional approach to decision-making to facilitate transformation despite inevitable knowledge gaps. He said: "Rather than trying to reach a solution, what we've tried to do is put ourselves in the best position possible to make the next decision."

Smart city leaders addressed the knowledge-deficit issue by engaging experts, consultants and startups to help their cities innovate and build knowledge. Recognizing the risk of knowledge leaving when these engagements ceased, they fostered knowledge transfer through internal bridging activities.

2. The Boundary Buffering Strategy Promotes and Protects Smart City Progress

Smart city leaders used boundary buffering as a short-term defensive strategy to prevent traditional city bureaucracy from interfering

with smart city initiatives. Boundary buffering is a protective strategy that isolates groups from each other to lessen the impact of boundaries and protect the smart city from external demands. As such, this strategy mitigates uncertainty and disruption. In situations of task uncertainty, boundary buffering can help meet budget and schedule requirements.[21] Buffering helped leaders disengage from problems and protect smart city progress when there was a higher level of threat. For example, participants commonly reported using "side paths" to speed things up and circumvent resistance from traditional city bureaucracy—i.e., they used buffering to disable opposition to their smart city initiatives.

Workarounds were a common response to the barriers presented by traditional city logic. Valerie said that when she encountered sustained resistance she would *"find another way that causes no friction and has the same result."* Nina's city decided to avoid using personal data in its smart city program. Ted disengaged from groups whose promotion of disruptive innovation was seen as a threat to the co-creation of innovation.

Buffering was also used to address political barriers. One leader disengaged from conservative neighboring city councils while lobbying a governing body to mandate intercity collaboration on a digital initiative. This then trickled down to the cities concerned.

Another boundary buffering tactic was agreeing to shoulder risk if a project owned by a service division failed. This tactic buffered smart city projects from the risk-averse business-as-usual environment and reduced the exposure of service division managers.

The decision of whether to choose a buffering strategy (such as taking a side path) requires careful consideration of trade-offs vs. benefits. Leonard explained that "[it's about] starting to assess the risk element and [saying] ok, well if we can't go this way, what are all alternatives around it. … You don't want to degrade the outcome or the value that you're trying to deliver."

3. The Boundary Building, Reinforcing and Defending Strategy Protects the Future of Smart City Transformation

Although boundary buffering is useful as a short-term defensive strategy to protect smart city progress, smart city leaders also need to employ more long-term and future-oriented strategies focused on building, strengthening and defending the boundaries of smart city initiatives. The boundary building, reinforcing and defending strategy enables groups to distinguish themselves from others, strengthen their internal identity and cohesion[22] and achieve advantages vis-à-vis other groups.[23]

Smart city leaders in our study built, reinforced and defended smart city boundaries in several ways. For example, they worked to co-create new governance structures that cut across silos to better support smart city logic. Ted stated that the smart city is best viewed as a new governance approach that will "always be slightly misaligned with the structures that are there to deliver it." Some cities also established dedicated innovation units to help attract external funding and future-proof requirements.

Leaders also created mandatory data-sharing requirements for business owners who entered into vendor agreements, thus ensuring that broader long-term value would accrue to the smart city. Without such an agreement a business unit could not deem its project to be a smart city initiative and would thus not receive the associated technical support and kudos. Similarly, leaders required business units that generated data relevant to smart city goals to meet strict new privacy requirements to future-proof data use. This required some service divisions to modify their existing processes and practices so the city could secure the benefits of a connected anonymous dataset about citizens' behavior and needs. The public digitalization network in Nina's region developed data standards for member cities and their vendors. This facilitated intercity data sharing, countered restrictive vendor data arrangements and provided more data from which each city could create value. It also helped to reduce resistance to smart city initiatives.

Another boundary reinforcing strategy was sharing lessons learned. These lessons highlighted losses that had arisen from resistance to smart city projects. Study participants also spoke of times when they had to push, pull or

21 See Faraj, S. and Yan, A., op. cit., June 2009.

22 See Faraj, S. and Yan, A., op. cit., June 2009.

23 See Langley, A., Lindberg, K., Mørk, B. E., Nicolini, D., Raviola, E. and Walter, L. "Boundary Work among Groups, Occupations, and Organizations: From Cartography to Process," Academy of Management Annals (13:2), July 2019, pp. 704-736.

fight with city administrators in pursuit of smart city goals. To tackle complex legal, regulatory and security challenges, Kris reported "pushing" on legal and security experts in order to create "headaches" so they would help create solutions aligned with smart city digital transformation goals. Leaders also had to "push" for agreement to establish cross-city data schemas to support cross-platform use and modularity.

At times, the work of building and defending boundaries became almost like warfare. Carl stressed that it is important to "go to war" when battles are worth it to achieve key smart city objectives. Battles reinforce the boundary of logics by insisting that smart city logic should prevail when it matters most. Nonetheless, battles need to be selective. As Carl explained, they place strain on energy, time and relationships, and "need to be won." Nina, Carl and Kris all said they carefully considered which battles to engage in. Where possible, they avoided going to war by creating friction and using boundary bridging to seek a common consensus.

The building, reinforcing and defending boundary management strategy is critical to scaling up and sustaining smart city digital transformation because it actively challenges the cultural and organizational barriers that impede transformation. It also forces change in the structures that impede smart city progress and ensures that structures better align with smart city logic and the vision for transformation.

Recommended Framework for Choosing a Boundary Management Strategy

We found that smart city leaders adeptly combine the different boundary management strategies and shift between them when addressing the eight identified challenges. Sometimes, they need to bridge one boundary while buffering or reinforcing another. Moreover, they need to apply different strategies to different boundaries at different times, depending on whether the goal is to combat resistance, build support, knowledge and resources, or shore up gains by building new institutional structures and norms.

For example, in tackling the challenge of the reluctance to use data to inform decisions, the leaders in our study buffered their smart city programs against pockets of intense resistance. At the same time, they used the boundary bridging strategy with selected service-line owners to foster champions, gain resources, build trust and generate an understanding of potential benefits. They also used boundary building to shore up benefits and institutionalize data sharing and use by building new cross-divisional governance structures, data standards and policies, aligning procurement cycles and mandating data-sharing requirements in vendor contracts. To do this, they needed to engage in extensive boundary bridging work with technical, legal and regulatory experts, and with other cities and government bodies, illustrating that different boundary management strategies work in complementary ways. Thus, addressing each of the challenges requires a combination of boundary management strategies.

Table 1 provides examples of how smart city leaders used different boundary management strategies to address the eight challenges of smart city transformation. The blue background shows where we found many examples in our data set. The red background shows common boundary management approaches where the most significant effort is needed.

Leaders must determine which boundary management strategy is most appropriate in a particular situation—is it better to bridge, buffer or build, reinforce and defend? Our analysis identified two contextual dimensions that are important in guiding leaders' decisions about which strategy to adopt: 1) the level of threat that a challenge presents to sustaining smart city digital transformation, and 2) the time orientation of the desired outcome. Figure 1 shows a synthesis of this analysis, highlighting when different boundary management strategies are useful. The vertical axis shows the level of threat that is presented by a particular challenge. The horizontal axis shows the time orientation of the desired outcome.

Boundary bridging strategies, aimed at generating support, resources and knowledge, make up much of the core work of smart city leaders. These strategies (shown at the bottom of Figure 1) are useful when boundary-related challenges create barriers but present a low level of direct threat. Examples include:

Table 1: Boundary Management Strategies for Addressing Smart City Digital Transformation Challenges

Challenge	Bridging		Buffering	Building/Defending
	for Support	for Knowledge		
1. Misalignment of Municipal Structures and Systems	Storytelling and translating to gain buy-in and ownership *City 5's leader outlined how digitalization could address business pain points*	Doing deep dives into service delivery processes and opportunities *Leaders in Cities 2,3,4 and 7 did deep dives with business owners*	Designing workarounds *City 5 used contractors to show how the waste department could make savings by using bin sensors*	Building cross-silo governance frameworks; Creating a unifying strategic framework *City 7 created a strategic framework that required divisions to link their plans to digital transformation goals*
2. Restrictive Data Arrangements	Networking with other cities to find common ground *City 3 worked with nearby cities to agree on data sharing needs for emergency services*	Exploring solutions with cross-city communities *City 2 joined a data hub to collaborate on sharing traffic and climate data*	Making interim data-sharing agreements *City 2 created projects with surrounding cities to buffer against resistance in the city*	Creating new data sharing and architecture requirements *City 12 joined a multicity network that built an open-source IoT data architecture, creating pressure on vendors and encouraging city-level opt-in*
3. Legal, Regulatory and Security	Building relationships with legal and security experts *City 3's leader met regularly with the heads of legal and security*	Doing deep dives with experts to unpack issues and plan solutions *City 9's leader met privacy officials to explore how to use AI without compromising privacy*	Positioning strategic initiatives as pilots or infrastructure projects *City 12 piloted street cameras while deciding whether to use facial recognition technology*	Creating "headaches" for experts to gain their help in creating solutions *City 9 coded regulations into its planning processes to improve collaboration and speed up consent*
4. Lack of an Innovation Culture	Identifying and rewarding champions *City 1 assigned copywriters to help champions promote innovation*	Seconding business unit staff to the smart city team and vice versa *City 11 seconded staff to projects*	Shouldering risk; Disengaging *City 9 disengaged from groups that promoted disruptive innovation*	Creating an independent innovation unit *City 12 created an innovation unit that attracted external funding, increasing the demand for innovation*
5. Resistance to Using Data to Drive Value	Storytelling and translating to gain buy-in and ownership *City 9 ran training sessions for the business to build digital consciousness*	Doing deep dives into the city's "business as usual" *City 2's leader collaborated with the legal department to determine how personal data could be used*	Focusing on low-resistance areas to gain wins *City 2 decided to avoid working with data about people*	Setting data sharing requirements for business units' vendor contracts; Initiating a common modular data schema; Telling lessons-learned stories *City 9 set up a data governance group and mandated open and shared data.*

Table 1 (Continuation): Boundary Management Strategies for Addressing Smart City Digital Transformation Challenges

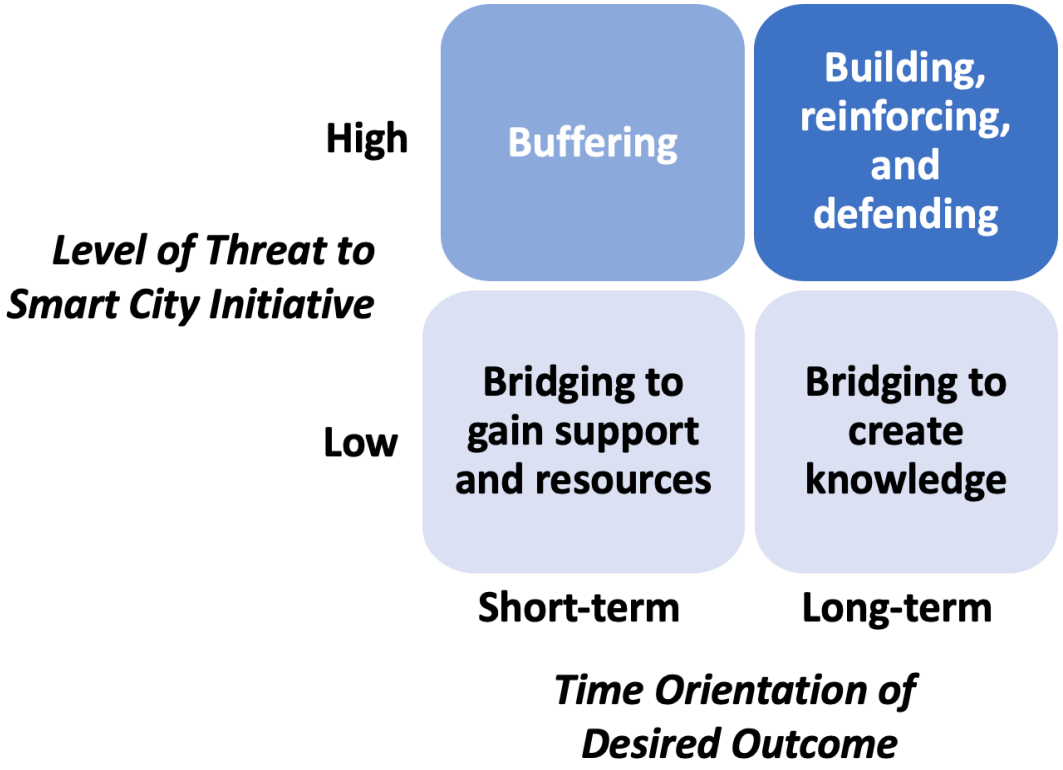
Challenge	Bridging		Buffering	Building/Defending
	for Support	for Knowledge		
6. Gaps in Capability and Knowledge	Building relationships with vendors and other cities *City 5 worked with contiguous cities to establish shared needs and opportunities*	Building rich external networks *City 3 drew on a multi-expert network to develop IoT capability and standards*	Not applicable	Not applicable
7. Engaging Citizens	Building a co-creation space; Running public workshops *City 8 opened a public space to showcase and co-create innovation*	Crowdsourcing and hackathons *Cities 3 and 9 ran hackathons for citizens to work with city data; City 8 crowdsourced ideas for a smart theater*	Inviting specified focus groups to counteract dominant voices *City 9 invited women outside the central business district to discuss their travel needs*	Not applicable
8. City Politics	Meeting councilors to explain smart city benefits *City 5's program manager met councilors to show how the smart city could help economic recovery*	Gathering and analyzing new data *City 9 gathered data about alcohol use to check the veracity of reported alcohol harm issues*	Working with umbrella groups to create trickle-down *City 9 set up public-private partnerships in areas with low political stakes, using sound and smell sensors*	Challenging claims of pressure groups through the presentation of quantitative data *City 9 used data to counter political pressure for unnecessary restrictions*

- Where managers of city services are reluctant to own a smart city project but can be brought on board
- Where a smart city initiative lacks funding but can be piggy-backed onto a departmental budgetary commitment
- Where there is a lack of knowledge about solutions.

Boundary bridging to gain support and resources (bottom left) is an important short-term strategy focused on building common ground and securing goodwill and resources, without which smart city progress would be impeded. Boundary bridging to create knowledge (bottom right) has a longer-term orientation. Its focus is on creating the knowledge that is needed to inform transformation and help leaders build the smart city foundations (such as new strategy and policy, technology investment plans, governance systems and data schemas).

The two defensive strategies shown at the top of Figure 1—boundary buffering, and building, reinforcing and defending boundaries—are suitable when there are roadblocks to smart city digital transformation and there is a higher level of threat to sustaining transformation. Boundary buffering (top left) is a short-term defensive strategy that involves disengagement and using workarounds to circumvent challenges and maintain progress. For example, after Ted saw a smart city initiative fail due to a disruptive innovation mindset, he disengaged from advocates of disruptive innovation, buffering his program from divisiveness while also fostering a constructive innovation culture through boundary bridging. Boundary buffering is

Figure 1: Consider Time Orientation and Threat Level When Deciding Which Boundary Management Strategy to Adopt



successful for protecting smart city projects and buying time to make progress.

In contrast, the building, reinforcing and defending boundary management strategy (top right) challenges and changes the fundamental structures that threaten smart city digital transformation. Its aim is to improve the sustainability of smart city initiatives. This strategy is suitable when there is a challenge that creates a threat to smart city digital transformation or would undermine its sustainability, and when a solution with a long-term orientation is needed. (For example, if the reluctance of business units to share and use data as the basis for decision-making is not compatible with smart city logic and risks impeding its goals.)

In the cities we studied, boundary-building involved mandating new requirements for vendor data sharing, internal data sharing and data formats, and building new data schemas and data governance structures. These structures were grounded firmly in smart city logic and helped to create a strong layer of cross-boundary integration. As more boundary-building work occurs, and a smart city's foundational boundaries are strengthened, there is reduced need for boundary buffering. Thus, the boundary buffering strategy is likely to be more necessary in the early stages of smart city digital transformation.

Figure 1 provides a framework that smart city leaders can use to decide which boundary management strategy is most appropriate. They should consider both the level of threat that a challenge poses to sustaining smart city digital transformation and the time orientation of the desired outcome—whether the goal is short-term progress or more sustainable long-term transformation. At a more granular level, Table 1 can help leaders evaluate which strategy will be most suitable for tackling a particular challenge. For example, intensive boundary building and defending work will be necessary to address challenges 1,2,3 and 5, while bridging

for knowledge is the key boundary management strategy needed to address challenges 6,7 and 8.

It is of course important to consider the unique context of each city and the stage of smart city digital transformation it has reached. The emphasis on boundary work is likely to change over the life of a smart city initiative. A leader may start with a short-term boundary bridging strategy for support and resources and then move to boundary bridging for knowledge creation. As threats to the smart city initiative arise, the leader will need to use boundary buffering to defend the initiative. Later, the emphasis is likely to be on building new boundaries and reinforcing existing ones to remove threats, embed smart city logic and make progress sustainable.

Smart city leaders therefore need to evaluate which boundary (or boundaries) should be managed in a particular situation as well as how to manage those boundaries. This requires a deep understanding of the boundaries that impact digital transformation in a city's particular context and an awareness of the potential for these boundaries to be turned into opportunity structures.

It is important to note that boundaries have a dual nature. In our study, we found that, on the one hand, boundaries between city departments and the smart city program caused significant friction that hindered smart city progress. Yet, on the other hand, these same boundaries were exploited in a highly productive way by smart city leaders to create resources, knowledge and innovation. This was achieved through boundary bridging strategies that connected diverse knowledge and experience, which converted the friction between boundaries into positive energy. Dieser[24] has described the dual nature of boundaries as follows:

> *"In their very essence, boundaries constitute difference, which threatens identity. At the same time, this difference (of culture, of language, of norms, etc.) is the primary space where learning and innovation happens—on an individual, organizational, and strategic level. Only if we 'play at the edge,' 'reach across the aisle,' or 'expose ourselves to the unknown,' we can transcend existing paradigms, mindsets and behavioral patterns."*

At its essence, smart city leadership requires playing across the edge, reaching across the aisle and exposing oneself to the unknown, to transcend traditional paradigms and co-create a transformational future city.

Concluding Comments

Our study found that smart city leaders face eight significant challenges when leading smart city digital transformation programs. These challenges have their roots in the fundamental clash between the emerging logic of smart cities and the traditional institutional logic that underpins how city bureaucracies operate. We also found that the core work of smart city leaders involves boundary work and that as expert boundary spanners they are well placed to address the challenges and the clash of logics. Their work involves spanning multiple structural, cultural and domain-based boundaries, which provides them with a deep understanding of the many cultures, traditions, practices, mindsets and values involved. By managing these boundaries, they can translate between perspectives, identify common ground, secure resources, manage resistance and build the collective cross-boundary knowledge and structures that are necessary for sustainable smart city transformation.

We identified three key boundary management strategies that smart city leaders use to address the challenges of smart city digital transformation: 1) boundary bridging (both for resources and knowledge), 2) boundary buffering, and 3) boundary building, reinforcing and defending. Leaders often need to use all three strategies over time and need to determine which strategy is best suited at a particular point in time to a specific situation and challenge.

We have provided a framework, depicted in Figure 1, that enables smart city leaders to decide which boundary management strategy to use, based on the level of threat to the smart city initiative and the time horizon of the outcome. Different boundary management strategies will be needed over time, as solutions to the

24 Deiser, R. *Digital Transformation Challenges in Large and Complex Organizations*, Centre for the Future of Organization, November 2018, p. 20, available at https://futureorg.org/wp-content/themes/futureorg/assets/Digital-Transformation-article-28-pages-2.pdf.

challenges emerge and/or the level of threat changes. At a more granular level, leaders can draw on the information listed in Table 1, which details the actions taken within each boundary management strategy by the cities in our study to address each of the challenges. The table also highlights the most commonly used strategies and the strategies that require the most effort.

Because we studied the smart city experiences of just 12 cities, not all our findings can be generalized to all cities. Nonetheless, the findings suggest that boundary management is central to smart city leadership and is a critical leadership competency for smart city digital transformation. Smart city leaders draw on diverse skill sets when managing boundaries, at different times acting as relationship builder, storyteller, translator, solution engineer and knowledge-builder.[25] Most critically, they need skills to determine which boundaries are critical in a particular situation, and which boundary management strategy is most appropriate—whether to bridge, buffer or build and defend boundaries. The dual nature of boundaries, as both barriers and opportunities, makes this a challenging and rewarding task.

Appendix: Research Method

To answer our research questions (What challenges do leaders face when embarking on smart city digital transformations and how do they address these challenges?), we followed an interpretive case study approach based on in-depth interviews with informants from multiple cities. Using this approach meant that we did not develop an a priori theoretical model or framework to frame the study.

We collected data from informants in two rounds, one in 2018-2019 and one in 2021. In the first round, we interviewed a cross-section of people with smart city digital leadership roles in cities from different global regions and of varying sizes and densities, with the goal of identifying common themes and concerns. To identify potential informants, we combined an online search of publicly available LinkedIn profiles (looking for the term "smart city" in job titles) with online searches of smart city programs. We identified leaders of smart city programs aiming to generate value for citizens by using the latest smart city technologies, and selected potential participants who were at least three years into their smart city program and whose smart city pilots had been completed. None of the cities had a single role dedicated to smart city leadership, but each city made it clear who was responsible.

We approached those selected by email and invited them to participate. In Round 1 we interviewed 12 leaders of ten smart city programs in Australia, Denmark New Zealand, the Netherlands and the U.S. All confirmed they were playing a leadership role in smart city digital transformation. Ten were city employees (CIOs, program managers and innovation leads) with leadership roles in smart city delivery. To increase rigor, we included several new participants in the second round. We interviewed nine leaders, five of whom were from additional cities, to confirm our emerging findings and gain more breadth of understanding. Given that the smart city is a new phenomenon, it was unsurprising that all leaders interviewed had experience in only one smart city program. To gain a broader perspective we also included a consultant who had worked with leaders from several high-profile smart cities, and the mayor of a (smaller) European city who had played an important leadership role in that city's digital transformation.

The table below provides details of the participants. We interviewed some participants just in Round 1, others just in Round 2 and some in both rounds. Note: when referring to participants in this article we used the pseudonyms given in the table to preserve their anonymity.

As per the interpretive case study approach, we sought to understand the leadership experiences of participants from their personal perspectives by conducting in-depth semi-structured interviews lasting up to 90 minutes. In the first round of interviews, we asked participants about what was distinctive about smart city leadership, the challenges to sustaining their city's smart city vision, how they addressed the challenges and the benefits achieved, such as using data to generate insights and inform decisions. During the interviews, we asked participants to share stories about specific events.

25 Pries-Heje, Jan, and Jocelyn Cranefield. "Moving Beyond Showcasing the Five Faces of Leadership in Smart City Transformation." *Proceedings of the European Conference on Information Systems*. 2019.

Study Participants

Pseudonym	Role	City No.	City Classification (using OECD definition)[26]	Interviewed in
Carl	Program manager	1	Metropolitan area (500,000-1.5 million) contiguous with large metropolitan area (2.7 million)	Round 1
Nina	CIO	2	Large town (15,000-20,000)	Rounds 1 and 2
Hans	Mayor	2	Large town (15,000-20,000)	Rounds 1 and 2
Kris	CIO	3	Small city/urban area (50,000-200,000) in a metropolitan area (1.7 million)	Round 1
Kris	Consultant	Several	Many cities, small and large	Round 2
Fiona	Program manager	4	Metropolitan area (500,000-1.5 million) contiguous with large metropolitan area (2.5 million)	Round 1
Valerie	Program manager	5	City (medium-sized urban area population 200,000-500,000)	Round 1
Luke	Consultant	6	Large metropolitan area (Over 1.5 million)	Round 1
Leonard	Innovation lead	7	City (medium-sized urban area population 200,000-500,000	Round 1
Diana	Program manager	8	City (medium-sized urban area population 200,000-500,000)	Round 1
Jana	Consultant	8	City (medium-sized urban area population 200,000-500,000)	Round 2
Kate	Innovation lead	9	City (medium-sized urban area population 200,000-500,000)	Round 1
Ted	Innovation lead	9	City (medium-sized urban area population 200,000-500,000)	Rounds 1 and 2
Talia	CIO	10	Small city/urban area (50,000-200,000) in a metropolitan area	Round 1
Mitzi	Innovation lead	11	Small city/urban area (50,000-200,000) in a metropolitan area	Round 2
Mark	CIO	11	Small city/urban area (50,000-200,000) in a metropolitan area	Round 2
Victoria	Program manager	12	Small city/urban area (50,000-200,000) in a metropolitan area	Round 2
Vernon	Technical lead	12	Small city/urban area (50,000-200,000) in a metropolitan area	Round 2

The interviews were transcribed and sent back to participants to be checked.

The transcripts were loaded into the qualitative analysis program NVivo and coded using an iterative and inductive approach to analysis, known as grounded theory. In the initial coding we identified 29 reported challenges and 42 leadership activities. Using an iterative and

26 OECD definitions: large metropolitan areas have a population of 1.5 million or more, metropolitan areas have a population of 500,000 to 1.5 million, medium-size urban areas have a population of 200,000 to 500,000, and small urban areas have a population between 50,000 and 200,000.

dialectical process we merged these to develop high-level categories linked to different aspects of leadership. Our data clearly showed that the smart city leaders were performing multiple unofficial roles requiring many skills.

We returned to the literature before embarking on a second, deductive round of coding. The identified leadership activities had clear synergies with research on boundary-spanning work, so we analyzed the leadership work using the theoretical lens of boundary work. We assigned the reported leadership activities to three categories of boundary work: boundary spanning; boundary buffering; and boundary building, reinforcing and defending, and revisited the data to identify the boundaries involved. Drawing on the theory of institutional logics we identified a fundamental boundary that was faced by the leaders in their day-to-day work: the boundary between the emergent logic of smart cities and the traditional institutional logic of city bureaucracy. This boundary was the root of the reported challenges and managing it is a key focus of leadership work in driving smart city digital transformation. Awareness of this boundary informed our analysis of how leaders used different boundary management strategies to foster smart city digital transformation and address the related barriers.

In the second round of data-gathering interviews (2021), we focused specifically on understanding the clash between smart city logic and traditional city logic, whether participants had experienced the eight challenges we had identified, the nature of boundary work that they engaged in and how this work helped to address the challenges.

A final round of deductive analysis helped us add richness to our understanding of how smart city leaders used different boundary management strategies to foster smart city digital transformation and mitigate the related barriers. This detailed analysis also resulted in Table 1, which provides examples of how smart city leaders used the three boundary management strategies to address the eight challenges.

About the Authors

Jocelyn Cranefield

Jocelyn Cranefield (jocelyn.cranefield@vuw.ac.nz) is an associate professor of information systems at Victoria University of Wellington, New Zealand, and director of the Master of Professional Business Analysis program. Her research interests center around understanding and responding to the organizational and societal issues associated with digital change and innovation, to help inform future action. Specifically, Jocelyn studies the challenges arising from digital transformation, working with AI-based technologies, knowledge transfer, sustainability and managing well-being and productivity.

Jan Pries-Heje

Jan Pries-Heje (janph@ruc.dk) is professor of information systems at Roskilde University, Denmark. He leads the Sustainable Digitalization Research Group and is the director of studies for the Executive Master's in Project Management and Organizational Change. His research focuses on designing and building innovative solutions to managerial and organizational IT problems. He has recently researched digitalization and digital transformation with several Danish municipalities. Jan is the editor-in-chief of *IFIP Select*, and a senior editor for *Journal of the Association for Information Systems*. He was named an IFIP Fellow in 2021 and was knighted by Queen Margrethe II of Denmark in 2020.

