Investigating the current approach to developing data governance in the Canadian smart city

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Smart cities have grown in prevalence as cities take advantage of big data and connected technologies to address the issues of sustainable urban development in the face of their growing urban populations. Data governance is necessary to smart cities to ensure integrity, accessibility, and accountability of data. There is also a growing concern about having proper data governance to protect citizens' digital rights and democracy. Though these concerns are pressing, there is a gap in understanding the data governance strategies of city governments and the roles that they play in developing those strategies. Additionally, literature on smart cities often focuses on data privacy and security instead of discussing data governance comprehensively and does not discuss the role of the city. This thesis aims to address this gap by understanding the current state of data governance of proposed Canadian smart cities, through identifying their data governance decisions and classifying them into the roles they are adopting. The Smart Cities Challenge in Canada presented an opportunity to study proposed smart cities for their data governance decisions and the role of the city through content analysis, using concepts from Khatri and Brown's (2010) data governance framework and Bayat and Kawalek's (2018) model of data governance city roles. The analysis found that the proposed Canadian smart cities are planning to develop their smart city projects and data governance using an approach driven by open and collaborative principles. This open and collaborative approach adopted by the Canadian smart cities prioritizes data governance activities that address the data access, data principles, and data lifecycle decision domains, in conjunction to the cities taking on roles that emphasize transparency, co-creation, and high stakeholder involvement. Openness and collaboration are discussed to be critical to the success of smart cities, as they can drive mechanisms to help address the challenges of trust and achieve and maintain democratic accountability. This open and collaborative state of smart city data governance also supports a transformation of the smart city discourse, moving away from vendor-driven and citizen-driven smart cities and towards government-driven smart cities. The study outlines considerations for the proposed Canadian smart cities and their stakeholders to act on the gaps in their data governance strategies as identified in the results. Future smart cities are recommended to proactively use an open and collaborative approach in developing their smart city plans and data governance strategies.

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List of Abbreviations

5M: $5 Million Prize Category

10M: $10 Million Prize Category

50M: $50 Million Prize Category

BK: Bayat and Kawalek's (2018) data governance modes model

DA: Data Access (DG decision domain)

DCA: Data is considered as (BK aspect)

DG: Khatri and Brown's (2010) data governance framework

DL: Data Lifecycle (DG decision domain)

DP: Data Principles (DG decision domain)

DQ: Data Quality (DG decision domain)

GI: Government Involvement (BK aspect)

GDPR: General Data Protection Regulation

ICT: information and communications technologies

IT: information technology

MD: Metadata (DG decision domain)

MO: Motivation (BK aspect)

OF: Organizational Form (BK aspect)

PIA: Privacy Impact Assessment

PIPEDA: Personal Information Protection and Electronic Documents Act

PPIA: Preliminary Privacy Impact Assessment

PRA: Preliminary Rationale Analysis

SCC: Smart Cities Challenge

SI: Stakeholder Involvement (BK aspect)

Chapter 1
Introduction

1.1 The rise of smart cities

Over half of the world's population now lives in urban areas, and in Canada, over 82 percent of the Canadian population lives in medium to large cities (Press, 2017; Winter, 2018). This rise of urbanization and urban populations has put a central focus on urban development and governance at the international scale, namely the United Nations (UN). This can be seen in the Sustainable Development Goals (SDGs) set in 2015 by the UN, specifically Goal 11, which is to make cities inclusive, safe, resilient, and sustainable (United Nations, 2015). The UN also adopted the New Urban Agenda (NUA) in 2016 at the Habitat III conference, which outlines the global standards of achievement in sustainable urban development (Habitat III, 2016).

Concurrently, there has been a rise of information and communication technologies (ICT) and big data analytics, which has brought about the application of these innovative technologies to cities to address the issues related to sustainable urban development and growing urban populations (Perera, Zaslavsky, Christen, & Georgakopoulos, 2013; Trindade et al., 2017). City governments are investing in and innovating with ICT and the vast amounts of data they are collecting for new insights and solutions to address problems of urbanization, such as traffic congestion, air pollution, resource management, and waste management, to name a few (Perera et al., 2013; Chourabi et al., 2012; Angelidou et al., 2018). By doing so, these cities have evolved to become "smart cities": cities that innovate and use data and connected technologies to draw new insights and enable city governments to provide better infrastructure and services for their community, resolve local problems, and enhance quality of life (Chourabi et al., 2012; Batty et al., 2012).

Since IBM and CISCO first coined the term "smart city", the smart technology market for cities has expanded as a business plan and as an urban model, responding more to the push of technology than the pull of demand, creating products for monitoring and managing city environments, and enabling the smart city (Paroutis et al., 2014; Angelidou, 2015; Rosati & Conti, 2016). In recent years, there has been an evolution in smart city development to focus more on the existing and real challenges of the city and the experiences of citizens, becoming less of a vendor-oriented and top-down approach, and instead taking on a collaborative and experimental approach, by engaging in both commercial and public agendas of data governance (Barns, 2018; Calzada, 2018). Smart cities have been shifting to a bottom-up approach, embracing citizen participation, co-creation, and citizens as decision-makers as drivers of their smart city strategy while still utilizing data driven solutions (Simonofski, Asensio, Smedt, & Snoeck, 2017; Calzada, 2018).

1.2 Importance of data governance

With the ever-growing amount of information and high rates of data collection made possible by the ICT and the digital infrastructures that smart cities are built upon, a greater importance is being placed on data governance in enterprises and governmental institutions to ensure the integrity and accessibility of data (Correia & Agua, 2021; Abraham, Schneider, & vom Brocke, 2019). Concerns about data governance have been made more pressing in the light of data breaches like of Yahoo and LinkedIn, compromising the privacy of billions of users, and improper use of data such as in the Facebook/Cambridge Analytica scandal (Correia & Agua, 2021; Artyushina, 2020). These events and the backlash of the Sidewalk Labs smart city project in Toronto concerning inadequate and privatized data governance policies showcase the need to have proper data governance to prevent the undermining of citizens' digital rights and the subversion of democracy (Calzada, 2019; Artyushina, 2020).

Data governance refers to a framework of decisions that must be made by an organization for effective management and utilization of its data assets, and the roles and accountabilities involved in the decision-making process (Khatri & Brown, 2010; Abraham et al., 2019). Although most literature on data governance is focused on its impact in corporate governance and data administration and not specifically on city governments, the same knowledge can be applied to cities (and smart cities), as they are organizations that handle increasing quantities of data collected through the implementation of new and innovative connected technologies. Through the discussion and adoption of data governance policies, city authorities can demonstrate that they will take on the responsibility of properly handling their citizens' data, protecting their digital rights, and ensuring responsible use of data (Calzada, 2019). This way, cities build and establish trust with their citizens, partners, and other stakeholders, which is critical for future smart city development, implementation of big data analytics such as artificial intelligence, and expansion of city digital infrastructure for public benefit (Calzada, 2019).

The discussion of data governance in smart city literature is often focused on specific issues under the purview of data governance: privacy and security are among the most popular concerns (van Zoonen, 2016; Bannerman & Orasch, 2020; Eckhoff & Wagner, 2018; Gharaibeh et al., 2017; Martinez-Balleste, Perez-Martinez & Solanas, 2013; Zhang et al., 2017). Research on data governance of smart cities appears to be inundated with discussions of popular concerns and is not balanced with other areas of data governance decision-making. There is not much literature that discusses data governance comprehensively or holistically (Abraham et al., 2019). In addition, the role of the city in data governance of smart cities is not well discussed, compared to the role of the citizen in the smart city (Calzada, 2018; Taylor & Richter, 2016; Simonofski et al, 2017; Cardullo & Kitchin, 2018).

1.3 Goals and objectives

This thesis aims to fill the research gap regarding data governance of smart cities, by exploring real world examples of data governance strategies and policies of proposed Canadian smart cities. By assessing what is being used and proposed in the real world through content analysis of the Smart Cities Challenge finalist proposals, this research investigates and determines the state of data governance in Canadian smart cities, and to understand the role of the city in the data governance of these smart city initiatives. In collecting and sorting data governance activities and descriptions of the role of the city, the frequency and application of an activity or concept is assessed against existing data governance models. This will evaluate the prevalence of data governance in a municipal setting and the role of the city in developing that data governance. Through understanding the data governance activities and roles adopted by developing and aspirational smart cities, this research will contribute to the knowledge base of data governance in the public sector and reveal policy implications for current and future smart city initiatives moving forward. To achieve these goals, the following research question will be answered:

> **Research Question:** What is the current state of data governance for proposed smart cities in Canada?

Broadly, the objectives of this research are to understand how the smart city data governance strategies of Canadian smart cities, as interpreted from the Smart Cities Challenge finalist proposals, fit within existing models and frameworks taken from data governance literature. The two main objectives are listed below:

i. identify the data governance decisions that Canadian smart cities are making using the Data Governance Framework by Khatri and Brown (2010)

ii. classify Canadian smart cities according to the roles they play in governing their data in their smart city projects and initiatives using the Data Governance Modes from the House Model by Bayat and Kawalek (2018)

1.4 Thesis structure

This thesis investigates the current state of data governance of proposed smart cities in Canada. The structure of the thesis is as follows:

Chapter 1 introduces the research topics of smart cities and data governance and outlines the research goals and objectives.

Chapter 2 conducts a review of literature on smart cities, data governance, and data governance of smart cities. It presents examples of research on smart cities in Canada, and reviews current issues of smart cities in literature. It explores existing data governance models and frameworks, including the two used for the analysis in this thesis. It introduces the Smart Cities Challenge in detail.

Chapter 3 describes the methodology that was used to extract data from the Smart Cities Challenge finalist proposals, and the analysis that was conducted on the data using the two data governance models.

Chapter 4 reviews the results of the analysis, organized by the main characteristics of the models, and describes the finalists' data governance strategies in detail.

Chapter 5 determines how the guides of the challenge may have influenced the results, and then assesses how real-world examples and existing theory may have led to the open and collaborative approach found in the results.

Chapter 6 concludes this thesis with a summary of the findings, discusses the limitations and wider impacts of this study, and presents thoughts on future research on the data governance of smart cities.

Chapter 2
Literature review

2.1 Smart cities

There are many different definitions and interpretations of the concept of smart cities (Chourabi et al., 2012; Albino, Berardi, & Dangelico, 2015). In practice and academia, there has not been a clear and consistent definition for smart cities, but this term has often been used to describe cities that are trying to find innovative ways driven by ICT to monitor and manage the problems that come from sustainable urban development in a time of rapid urban growth (Chourabi et al., 2012). Chourabi et al. (2012) noted that smart cities could be seen as a labelling phenomenon but also identified important trends in the conceptualization of smart cities, such as the emphasis on improvement in sustainability and livability. From their review of working definitions of the smart city, the authors determined and discussed 8 groups of factors that contributed towards a smart city initiative’s success: management and organization, technology, governance, policy, people and communities, the economy, built infrastructure, and the natural environment (Chourabi et al., 2012). They identified technology, organization, and policy as more influential core factors, compared to the other factors, such as people and communities (Chourabi et al., 2012).

In their in-depth analysis of literature on smart cities, Albino, Berardi, and Dangelico (2015) acknowledged the growing popularity of the concept of smart cities, stating that the smart city is beyond just the application of technologies to cities, and that the people and communities involved in and impacted by smart cities are also important. The authors found several common characteristics between the definitions of smart cities, namely that smart cities used ICT to help improve city operations to enhance quality of life (Batty et al., 2012), but also that the definitions were evolving to include the qualities of people and communities, which had initially been missing (Albino et al., 2015). Between the two papers, it was agreed that the concept of smart cities was just as multifaceted as its implementation, and developing ways to understand and assess the performance of smart cities was important to the future of smart cities and their development (Chourabi et al., 2012; Albino et al., 2015).

2.1.1 Applications of smart cities

Research in smart cities has shown that there are many ways to classify their application domains, which include taxonomies based on factors such as critical infrastructure components and services or smartness in relation to urban life (Albino et al., 2015; Sanchez-Corcuera et al., 2019). The classification can be a taxonomy of narrow domains, such as in the 2017 review by Gharaibeh et al. on smart lighting, smart traffic management, smart grid, smart emergency, and smart health, or it can be a taxonomy of two broad domains based on the decisive and enabling role of ICT in the function of city systems, "hard" domains and "soft" domains (Neirotti et al., 2014; Sanchez-Corcuera et al., 2019). Hard domains include buildings, energy grids, natural resources, energy and water management, waste management, environment, transport, mobility, and logistics, while soft domains include education and culture, social inclusion and welfare, public administration and government, and economy; domains such as healthcare and public safety sit in the between hard and soft (Neirotti et al., 2014). The classifications of smart city applications can be very similar across different authors, but Sanchez-Corcuera et al. (2019) warned that the definitions of some domains of these taxonomies can be limiting for those applications that fall into more than a single category. The authors themselves proposed a taxonomy with fewer, broader categories, based on an existing theoretical taxonomy: business-related domains, citizen-related domains, environment-based domains, and government-related domains (Sanchez-Corcuera et al., 2019).

Many cities have applied the smart city idea in pursuit of sustainable urban development, and this has led to many smart city applications related to environmental sustainability (Angelidou et al., 2018). As investigated by Angelidou et al. (2018), examples of these applications include sharing data of sustainable mobility, monitoring air quality, measuring tree population and health, and optimizing waste and resource management. These smart city applications demonstrate the synergy between the smart city approach and sustainable urban development, as the focus on sustainability and the environment are a part of many definitions and application taxonomies in reviews in other academic literature (Angelidou et al., 2018; Neirotti et al., 2014; Albino et al., 2015; Sanchez-Corcuera et al., 2019).

The evolution of smart city applications is influenced by the local context, which can be assessed by four key groups of factors: structural factors (such as size and demographic density), economic development, technology development, and environmental-friendly policies (Neirotti et al., 2014). Through their assessment, Neirotti et al. (2014) noted that the evolution of the smart city should have complementary focuses on technology and people, and that it is important to take citizen vulnerability, resilience, financial sustainability, and social inclusion into account in the city- and policy-planning of smart cities.

2.1.2 Smart city discourse

The smart city discourse is diverse and multidisciplinary, having grown to cover many different topics of interest within the academic community (Hartt, Zwick, & Webb, 2021). The main purpose of the following sections is to give a brief overview of some of the main concerns and issues among scholarship, and then discuss some of the themes in greater detail. To begin, literature in recent years has identified three common criticisms from across academic and non-academic material: technological solution-ism, profit-driven urbanism, and panoptic surveillance (Hartt et al., 2021). Technological solution-ism is the belief that technology, data, and algorithms are expected to solve any problems with the right optimization, to the point of over-reliance, forgetting to define the problem or consider people-centered policy solutions in favour of technological fixes (Hartt et al., 2021). Profit-driven urbanism is criticized for how it diminishes the role of democracy in urban institutions and creates public-private conflicts in the name of economic growth, as vendors treat governments as markets for new smart technologies while collecting and monetizing public data and data belonging to citizens, selling them back to cities and citizens (Hartt et al., 2021). Panoptic surveillance is the surveillance of city residents in the digital panopticons as created by smart city technologies, criticized for the risk to the right of privacy and how it can open a pathway to surveillance states (Hartt et al., 2021). The authors conclude with some thoughts on how a review of societal values and more critical discussion is needed as the deployment of smart city technology accelerates (Hartt et al., 2021). The authors remind readers to see both the promises and perils of smart cities, but also that people make cities smart, not technology alone, and that truly smart cities require engaged, informed, and empowered residents (Hartt et al., 2021).

Robinson and Biggar (2021), in the chapter following Hartt, Zwick, and Webb in the same book, also list some themes of smart city literature. They identify early literature to focus on exploring the definitions of a smart city and questioning what “smart” actually means, and later how the premise of “smartness” is being challenged as technocentric (Robinson & Biggar, 2021). The authors list some of the benefits of applying new tech solutions to urban problems that have been identified, but then introduce some of the challenges of smart cities, such as the rise of surveillance capitalism, concerns regarding data governance, ownership, and privacy, and economic and social exclusion (Robinson & Biggar, 2021). As questions are raised about these challenges, the authors observe the open smart city framework by Lauriault et al. (2018), which focuses on open, accessible, inclusive, participatory smart city planning, contrasting the majority of smart city projects which are closed, proprietary, and focused on efficiency and innovation (Robinson & Biggar, 2021). The authors also note the concerns in scholarship that smart cities may be accelerating neoliberal agendas, the rise of alternative smart city thinking to innovate for public good rather than profit, and that government-centered smart cities may be a new trend (Robinson & Biggar, 2021).

2.1.2.1 Privacy and security of smart cities

Of the challenges that befall smart city development, privacy and security are two of the major challenges discussed in literature due to their critical impact on smart city development and acceptance, and they are often discussed together as they are closely related (Eckhoff & Wagner, 2018).

Van Zoonen determined in her 2016 paper that people have many concerns about privacy in smart cities and created a framework to help identify privacy concerns among people in smart cities. These concerns involve what data is being collected, how they perceive the data is being used, and who is collecting the data, which is the city in this framework (van Zoonen, 2016). The first dimension of the framework assesses concern based on the kinds of data that people are worried about: data is classified as personal or impersonal, with personal data being personally identifiable data (van Zoonen, 2016). The second dimension assesses the concern based on the purpose data is used for: data could be used for service or surveillance purposes, with people generally being more concerned about surveillance (van Zoonen, 2016). The author describes that people have a moderate level of concern about data for service purposes, are highly sensitive about personal data for surveillance purposes, and have some concerns for both impersonal data used for surveillance purposes and service purposes (van Zoonen, 2016). The concerns for the latter are because data can be analyzed and enhanced to identify individual citizens, known as re-identification, and could result in activities like profiling (van Zoonen, 2016). In her research, van Zoonen (2016) found that the choice of smart technologies and the usage of particular or combinations of data and analytic tools are crucial factors to understand people's privacy concerns in smart cities, not just the two dimensions of data and purpose of use. The author acknowledges that citizens are often ignored as partners in the development of smart city projects, but their input is important as they are the ones to live with the outcomes (van Zoonen, 2016).

In an older paper, Martinez-Balleste, Perez-Martinez, and Solanas (2013) proposed a model to understand the privacy of citizens, as it is endangered by smart city technology and their ability to gather unprecedented amount of information, and propose solutions as to how each dimension of privacy can be preserved. The model presented five dimensions of citizens' privacy that can be breached in the context of smart cities and their services: identity privacy, query privacy, location privacy, footprint privacy, and owner privacy (Martinez-Balleste et al., 2013). Identity privacy relates to the risks of disclosing and correlating identity with activities but is preventable by permitting geographically distributed pseudonymizers (Martinez-Balleste et al., 2013). Query privacy is related to the preservation of queries made by citizens to services, which risks profiling, but can be resolved with private information retrieval tools and trusted third parties (Martinez-Balleste et al., 2013). Location privacy is about preserving the privacy of the physical location of residents and can largely be avoided with masking and cloaking real locations (Martinez-Balleste et al., 2013). Footprint privacy refers to the control of information that can be retrieved or inferred from microdata sets, obtained from a variety of sources but accessible by third parties, and so statistical disclosure control techniques may be needed or deleting identifying information altogether (Martinez-Balleste et al., 2013). Owner privacy regards the computation of queries across databases from different entities which can be resolved by controlling the queries to control the information (Martinez-Balleste et al., 2013). The authors acknowledged that while their off-the-shelf solutions are feasible, their success depends on secure storage and transfer of data (Martinez-Balleste et al., 2013). The authors believed that real smart cities count on their citizens, and that their privacy must be protected to be successful (Martinez-Balleste et al., 2013).

Zhang et al. (2017) believed that the security and privacy concerns regarding smart cities are due to the technologies collecting a wide range of privacy-sensitive information on people, as they also control city services and can influence people's lives. The smart city should be able to defend its data from unauthorized access, disclosure, disruption, modification, inspection, and annihilation, or otherwise residents may refrain from accepting the smart city (Zhang at al., 2017). The authors identified three main security and privacy challenges of smart city applications: privacy leakage, secure information processing, and dependability in control (Zhang at al., 2017). Privacy leakage is the disclosure of privacy-sensitive information to untrusted or unauthorized entities (Zhang at al., 2017). Although some privacy can be preserved with off-the-shelf solutions as proposed by Martinez-Balleste et al. (2013), because data are so diverse and may require different privacy measures, it can be challenging to develop protection that balances privacy and efficiency (Zhang et al., 2017). Secure data storage and processing is a challenge that exists in untrusted cloud servers, and while encryption is a solution, the computational overhead poses another challenge on efficiency (Zhang at al., 2017). Securing data sharing and access control is another challenging aspect due to the need to define access policy and privacy-preserving data sharing among collaborators (Zhang at al., 2017). Dependability in control is the third challenge as the smart city relies on control and feedback systems that are attractive targets for attackers, such as with denial-of-service, spoofing, and malicious data injection attacks, which would disrupt urban governance (Zhang at al., 2017). Dependability of control is a priority for smart cities, but efficient and fast detection of malicious attacks is challenging and requires collaboration between various stakeholders (Zhang at al., 2017). The authors presented some solutions in the context of smart city healthcare, transportation, and the energy grid, and discuss some open research directions (Zhang at al., 2017).

In their paper on the applications, technologies, challengers, and solutions of privacy in the smart city, Eckhoff and Wagner (2018) created taxonomies to systematize and understand these areas. The authors classified 9 key areas of smart city applications and 9 categories of technologies, but they define 5 types of privacy that are different from the model of privacies proposed by Martinez-Balleste et al. (2013; Eckhoff & Wagner, 2018). Their taxonomy for privacy includes privacy of location, state of body and mind, behaviour and action, social life, and media (Eckhoff & Wagner, 2018). The authors also develop taxonomies for attackers and data sources used by attackers, and they create taxonomies for process-oriented privacy protection (7 strategies), versus data-oriented privacy protection (10 strategies) (Eckhoff & Wagner, 2018). Eckhoff and Wagner (2018) note that security and privacy are closely related, and that effective privacy protection is almost impossible without security, before presenting an overview of three security challenges that strongly resembles those described by Zhang et al. (2017): system security and access control, protocol and network security, and information leakage. The authors explore the privacy issues and some solutions to existing smart city technologies, finding that privacy protection and information on privacy policies is scarce even today (Eckhoff & Wagner, 2018). They call for the improvement of privacy in future smart cities through the optimization of the privacy design process, the use of joint or composable privacy technologies, designing for privacy architecture patterns and standards, incentivize and enforce privacy-friendliness, consider user-centric privacy, understand the trade-off between privacy and utility, and improve privacy awareness (Eckhoff & Wagner, 2018). The authors argue that smart cities need to follow privacy-by-design principles from the start of smart city development as retro-fitting privacy is bound to fail (Eckhoff & Wagner, 2018).

2.1.2.2 Citizen participation in smart cities

In addition to the challenges of privacy and security, smart city literature is also increasingly concerned about the meaningful participation of citizens in smart cities, writing critically of so-called citizen-centric smart city development and the different roles of citizens when participating in smart cities.

Cardullo and Kitchin (2018) examined the framing of citizens and their roles in smart cities, looking at Dublin's smart city initiatives and adapting Arnstein's ladder of participation to create a framework that they called a "scaffold of smart citizen participation". The authors observed that smart cities were previously criticized for being overly technocratic and top-down in orientation, and developers of smart city technologies responded to these critiques by repositioning their smart city initiatives as citizen- or community-centric, but the authors argued that this is just rebranding (Cardullo & Kitchin, 2018). The authors introduced their framework to measure smart citizen inclusion, participation, and empowerment in such smart cities, identifying the form and level of participation from Arnstein's ladder of participation, and additionally the role, citizen involvement, political discourse/framing, and modality (Cardullo & Kitchin, 2018). The authors found that there are numerous roles for citizens to play in the smart city, and citizens can experience different forms of empowerment and participation at the same time (Cardullo & Kitchin, 2018). The scaffold framework builds understanding as to who is involved and in what capacity, helping to show how neoliberal ideals of "citizen-centric" smart city approaches have been reducing citizens from political subjects to weaker socio-economic and legal positions (Cardullo & Kitchin, 2018). Neoliberal citizenship means that citizen participation provides feedback but is not meant to challenge or replace the fundamental political rationalities shaping an issue or plan (Cardullo & Kitchin, 2018). Citizens in the rebranded "citizen-centric" smart cities are treated as consumers and testers to smart city technologies, the authors are concerned that these "citizen-centric" smart cities appear to be largely tokenistic, with city administrations and corporations still owning and controlling urban governance and services (Cardullo & Kitchin, 2018). An improved version of smart citizenship is already being reconceptualized in Barcelona, where the city is transforming to be actually more citizen-centric, seeking to "re-politicize the smart city and to shift its creation and control away from private interests and the state toward grassroots, civic movements and social innovation" (Cardullo & Kitchin, 2018).

In a separate analysis not based on Arnstein's ladder of participation, Simonofski et al. (2017) proposed a framework based on their literature review that summarizes the means to enable citizen participation in a smart city with three means of participation: citizens as democratic participants, citizens as co-creators, and citizens as ICT users. As democratic participants, citizens can learn about technical problems, help prioritize projects, reflect on unpopular policies with administrators, make points in non-confrontational settings and help find compromises (Simonfski et al., 2017). As co-creators, citizens can actively participate in various stages of the production process such as in requirements engineering, and not be confined as passive consumers (Simonfski et al., 2017). As ICT users, citizens are proactively using the city's ICT infrastructure that is at their service, such as with citizen science or the use of open data (Simonfski et al., 2017). This framework means to evaluate smart city strategy on how they enable citizen participation, with specific criteria to ensure that the framework is not instrumentally used by smart cities as a simple checklist (Simonfski et al., 2017). Simonofski et al. (2017) stated that the essential role of citizens has been neglected and that smart cities often do not meet their objectives if citizens are not involved in their design. The authors discuss how their framework can help reveal new means to enable citizen participation by comparing best practises across smart cities (Simonofski et al., 2017). They make a similar analysis to Cardullo and Kitchin (2018) on the risk for tokenistic and instrumental participation of citizens, expressing that instrumental participation should be avoided and that citizens should be involved in more meaningful democratic processes when participating in a smart city (Simonofski et al., 2017).

2.1.2.3 Changes in the smart city discourse

As the role of the citizen in the smart city changes, so does the discourse of the smart city, shifting from discussions of top-down, vendor-driven, tech-oriented smart cities to bottom-up, community-driven, citizen-oriented smart cities, and introducing alternative narratives of smart city development.

The idea of this transition from a "smart city 1.0" to "smart city 2.0" approach has been discussed in relation to the criticisms of the initial technocratic smart cities and the growing open data and open government movements (Barns, 2018). Barns (2018) explored this alongside the emerging concepts of smart city governance and their influence on investing in new platforms or interfaces for city data. The skepticism of the smart city as a "vendor-oriented vision of ICT-led urban growth" and the question of city governments' capacity to support partnerships with data stakeholders has provoked a shift away from that vision, known as "smart cities 1.0" (Barns, 2018). Barns (2018) described a growing interest in "smart cities 2.0", which emphasizes a role for city government in providing the data infrastructure for the curation and management of data assets to support its strategic priorities. Barns (2018) explained how smart cities must evolve their governance models and organizational frameworks and transform how they work internally and together with outside partners and citizens. Part of that is because smart city investments to date have been primarily commercial with commercial agendas, unable to guarantee "resilient, socially mobile, vibrant and healthy cities" (Barns, 2018). To align investment of data-driven services to strategic priorities, governments have drawn on the principles of the open-source software movement and the government-as-a-platform framework to facilitate access to government data and encourage digital innovations (Barns, 2018). Wider transitions in digital era governance provide the context for investments in urban data platforms, which demonstrates the shift from smart cities 1.0 to 2.0 (Barns, 2018). From her analysis, Barns (2018) found that urban data platforms such as dashboards are criticized for cultivating a top-down technocratic vision of smart cities, but they should instead aim to support the role of governments in cultivating partnerships with stakeholders and the smart cities 2.0 approach.

Simonofski et al. (2017) also briefly mentions a change in approaches to innovation in smart cities, from the traditional, top-down approach that often “fails to design a strategy that fits the citizens' expectations” and tends to underestimate the creative potential of bottom-up approaches. The bottom-up approach takes advantage of citizens' input on their needs and ideas in order to answer existing challenges (Simonofski et al., 2017). The authors noted that although citizens' input in the bottom-up approach is favourable, it should not be the only path to smart city strategy, as the input of experts and experienced decision makers is also valuable (Simonofski et al., 2017).

Calzada (2018) introduced a new paradigm called the experimental city as a counter and a transition away from the traditional top-down hegemonic approach to smart cities. The departure from the traditional smart city is marked by cities like Barcelona that have been trying to strategically overcome the side effects of the techno-deterministic emphasis on smart cities through policies to restore privacy and empower citizens (Calzada, 2018). The experimental city is characterized by the awareness of the technopolitics of data for citizens, potential alternative economics for city policies, citizen engagement as a democratic practice, multi-stakeholder schemes as a pervasive governance logic, and living lab initiatives as sites devised to design, test, and learn from social and technical innovation in real time (Calzada, 2018). Calzada (2018) claimed that experimental cities consider smart citizens as decision-makers rather than data providers as seen in the top-down market-based approach to the traditional smart city, and he presented ten conceptual transitions to compare the paradigms. In his paper, Calzada (2018) examined Barcelona's transition from the traditional smart city to his experimental city paradigm and found that because citizens are increasingly considered decision-makers rather than data providers, smartness may not necessarily be appealing to cities seeking to take back control of citizens' data and other digital rights through bottom-up democratic mechanisms.

2.1.3 Smart cities in Canada

Many cities all around the world have successfully started smart city initiatives and tried to transform into a smart city (Sanchez-Corcuera et al., 2019). In Canada, initiatives for smart city development have been supported by the federal government and Canadian non-profit organizations in their investments in research on open smart cities and innovative smart city approaches.

Natural Resources Canada funded a collaborative research project led by Open North to assess the state of smart cities in Canada, represented by the smart city initiatives of Edmonton, Guelph, Montreal, and Ottawa, and to evaluate the openness in the development and governance of smart cities, following open standards and tenets (Bloom, Lauriault, & Landry, 2018). In a related paper, the same authors defined open smart cities to have five characteristics: first, that the governance is ethical, accountable, and transparent; second, that the open smart city is participatory, collaborative, and responsive; third, that the data and technologies used are fit for purpose and adhere to open standards; fourth, that data management and data governance for public interest is the norm; and fifth, that data and technology are not a quick solution to the systemic issues of cities (Lauriault, Bloom, & Landry, 2018). Another paper by the non-profits Open North and Evergreen discussed in a similar vein the importance of openness in the concept of the smart city in Canada, articulating eight core principles for designing open smart cities: user-centered, open by default, tech-driven, resource optimization, accountable and transparent, participatory, inclusive, resilient, and adaptive (Sodhi, Flatt, & Landry, 2018). The Province of Ontario has also supported research in another discussion paper by Evergreen and Code for Canada, on how to move mid-sized cities to being smarter, identifying nine insights for action: identify needs first, technology second; design for inclusion; let community in; look outside for new solutions; think beyond city boundaries; enable and empower public servants; invest in the fundamentals; integrate to implement; brand to build buy-in (Gladstone et al., 2018). These papers contain some of the most prominent commentary and scholarship in Canada examining smart cities, particularly in relation to privacy (Bannerman & Orasch, 2020).

A notable smart city project in Toronto that captured local and international attention of the public, media, and academics alike was the failed Sidewalk Labs smart city plan for the city's waterfront. Since its inception in 2017, the Sidewalk Labs smart city project in Toronto became the topic of discussion in both media and academic literature for a variety of reasons, including but not limited to initial concerns of a Google/Alphabet takeover, issues with data ownership and privacy and surveillance, the tearing down of democracy, a lack of transparency, and a lack of meaningful citizen engagement and participation

(Morozov, 2017; Bliss, 2018; Artyushina, 2020; Johnson et al., 2020; Spicer & Zwick, 2021). Even after the announcement of its abandonment due to economic uncertainty, the Sidewalk Labs Toronto smart city project has been reviewed and discussed for its critical contributions to smart city development discourse and data governance discourse (Johnson et al., 2020; Artyushina, 2020; Spicer & Zwick, 2021). Johnson et al. (2020) noticed a top-down planning approach from Sidewalk Labs, Waterfront Toronto, and the City that was a reversal of more typical municipal processes where citizens are involved in meaningful ways from the beginning. Artyushina (2020) warned against the potential corruption of data governance initiatives like the Urban Data Trust proposed by Sidewalk Labs, as she argues that the pursuit of economic rent of data and the privatization of urban governance transformed the civic principles of a data trust. Spicer and Zwick (2021) discussed the overall capacity of Sidewalk Labs for community building and city governance, outlining the lack of adequate protection for data and privacy, and highlighted several gaps, ambiguities, and criticisms of Sidewalk Lab's data governance processes and lack of government oversight mechanisms that ultimately led to public backlash and the project's downfall.

Other literature on Canadian smart cities has been focused on citizen participation and privacy. It has been found that active citizen participation is critical to achieving the goals of smart city development, which include social equity, environmental sustainability, and economic development (Ghose & Johnson, 2020). The role of citizen participation and engagement in smart cities has changed with the shift of responsibility for social service provision from state to citizen volunteers and community organizations, but ultimately the role of the citizen is to be the smart city's main beneficiary (Ghose & Johnson, 2020). In the Canadian smart city context, many different challenges arise from citizen participation, including defining "the public" in terms of engagement, issues in co-production of data between citizens and governments, and different levels of inclusion of citizens in smart city projects (Ghose & Johnson, 2020). In an empirical study of the finalist proposals of the Smart Cities Challenge hosted by Infrastructure Canada, Johnson, Acedo, and Robinson (2020) analyzed the types of citizen participation used to support proposal development and found that most of the proposals used traditional engagement methods, notably citizen meetings, round tables, town halls, and workshops. In addition to the traditional methods, transactional forms of citizen engagement like mobile apps and social media were also used although to a lesser extent, and with less variety (Johnson et al., 2020). The authors noted that transactional forms of citizen engagement may have reduced meaning or contributive value and may have shallower reach and impact compared to traditional methods (Johnson et al., 2020). Their study showed that the process of developing smart city plans still takes a traditional citizen engagement approach, with little change to how citizens and government interact (Johnson et al., 2020).

Bannerman and Orasch (2020) surveyed Canadians for their concerns on smart city privacy and found that there was a strong level of concern regarding the privacy issues surrounding smart cities. The intended purpose and use of data influences Canadians' attitudes to data collection, with strong opposition to sale of personal data and use of personal data for targeted advertising and behaviour modification, while data collection for public uses such as transit and city planning is not as strongly opposed (Bannerman & Orasch, 2020). This verifies van Zoonen's (2016) framework, as using personal data for service was more acceptable while surveillance was highly concerning. The authors also found that many Canadians desire broader protection and control over personal data in both private and public contexts, which is often not currently available, including the ability to opt out, view, correct, download, and delete their data (Bannerman & Orasch, 2020). Notably, the authors found that nominal consent such as agreeing to fine print is not sufficient for many survey participants when their data was collected for private use (Bannerman & Orasch, 2020). Observing the Sidewalk Labs project, the authors commented that some corporate-led smart city projects do not begin with a citizen-focused approach to data policy development and may instead respond to concerns from experts and community organizations, although in a delayed and piecemeal fashion (Bannerman & Orasch, 2020). Canadians are wary of smart cities and the collection and use of their personal data more broadly, and Bannerman and Orasch (2020) suggested that municipalities reconsider business-led smart city projects or others motivated by profit, as they may not fit with the desires of Canadians for the collection and use of personal data. Instead, the authors recommend that municipalities engage with citizens about smart city initiatives and data governance to understand their desires and gain their support (Bannerman & Orasch, 2020).

Robinson and Biggar (2021) explore how the Smart Cities Challenge (SCC) differs from typical vendor-driven smart city development. The authors establish that the prevailing attitude on government innovation is that governments impede technological progress, limited to only being facilitators to the private sector, and not being innovators themselves (Robinson & Biggar, 2021). Governments are understood to be inflexible, risk-adverse, and present barriers such as procurements laws and data privacy standards (Robinson & Biggar, 2021). Earlier theory on public sector innovation was informed by private sector innovation theory, believing that competition created incentive for the public sector to innovate; however, the authors challenge the techno-optimistic narrative by identifying an alternative view suggesting that innovation in the public sector is not always inherently market oriented, and that the key driver to public innovation is collaboration, not competition (Robinson & Biggar, 2021). Robinson and Biggar (2021) introduce a more current theory of collaborative innovation for the public sector, in which a variety of stakeholders, often in a network format, bring in diverse experiences and knowledge mix to contribute to the process of public innovation. They also discuss municipal innovation competitions, which can contribute knowledge and expertise to the development of urban technology, accelerate governance strategies, and leverage partnerships, even though innovation capacity may be limited due to repeated or similar ideas created in unrealistic time constraints (Robinson & Biggar, 2021).

In this context, the authors present four ways that distinguish the approach of the SCC from other smart cities projects: first, the SCC is government-driven, starting with governments innovating and deciding which issues to prioritize and what kinds of technology would align with their priorities, instead of a vendor-driven approach; second, communities define the priorities for government, and then technology and data solutions could be found to help address them; third, an open approach to application submissions that allowed communities to check in on their local government; and fourth, the community solutions network embedded collaborative innovation, supporting applicants, disrupting excessive competition, and distributing knowledge and resources (Robinson & Biggar, 2021). The SCC shows that public sector innovation emerges in different guises, even combining competition and collaboration to spur innovation when previously they were seen as independent drivers of innovation (Robinson & Biggar, 2021).

2.2 Data governance

The concept of data governance comes from studies in IT governance, information systems, and information management, and has been discussed by practitioners (the Data Management Association International) as the exercise of authority and control over the management of data (Al-Ruithe et al., 2018; Abraham et al., 2019). Data governance aims to implement a data agenda, maximize the value of data assets in an organization, and manage data-related risks (Abraham et al., 2019). It has become increasingly important to enterprises and governmental institutions, as effective data governance can address challenges such as confidentiality, integrity, quality, and availability of customers' data, and bring benefits including reducing operational friction and protecting the needs of data stakeholders (Abraham et al., 2019; Al-Ruithe et al., 2018). To adapt the working definitions of data governance as proposed by several authors, data governance is a framework of decisions for managing data as a strategic asset, specifying the decision rights and accountabilities for an organization's decision-making about its data (Abraham et al., 2019; Khatri & Brown, 2010).

Literature reviews of data governance have revealed that publications tend to discuss specific decision domains of data governance, such as data quality or data lifecycle, or are comprised of smaller, more limited reviews that focus on narrowly defined areas of data governance, such as the agile capabilities of data governance (Abraham et al., 2019). Al-Ruithe et al.'s (2018) literature review is among the latter, as the authors focused on reviewing literature of data governance in cloud computing, which they described as "in its infancy". However, Al-Ruithe et al. (2018) presented an analysis of state-of-the-art data governance, where it emerged that data governance was initially used to establish accountabilities from IT governance, especially for data quality management. The authors also found a push for designing effective data governance frameworks, where scholarship argued that they would provide many benefits to organizations, such as supporting compliance and legal efforts and building better relationships with customers and partners (Al-Ruithe et al., 2018). Al-Ruithe et al. (2018) noted that very few data governance frameworks could be found, mainly those developed by industry associations, but in other literature, they extracted definitions for 20 of the most important critical success factors for effective data governance, such as developing a communication plan and accountability.

Many studies use data governance and information governance interchangeably, such as the review by Abraham et al. (2019) or Khatri and Brown's (2010) defining paper. However, Merkus et al. (2019), among some other authors, distinguish data governance from information governance. In their 2019 paper, Merkus et al. sought to provide a coherent set of definitions for data governance and information governance in relation with data and information as underlying concepts. In their exploration of existing definitions in the literature, they determined that data are "recorded representations of signals from the real world", and information is "data formed with a goal" (Merkus et al., 2019). Similarly, they presented data governance as the "establishing of management of data in an organization assuring quality and access during its lifecycle to be accountable for data assets", while information governance was the "establishing of management of information in an organization assuring quality and access during its lifecycle to be accountable for information assets" (Merkus et al., 2019). The authors also presented a definition of "meaning", as "human understanding having usage and context" (Merkus et al., 2019). It is important to note that Merkus et al. (2019) concluded that they regard data governance and information governance as the same. Information is formed out of data, both can be explicitly stored in systems, both are considered valuable assets and objects of accounting and governance, both lifecycle processes are similar and share the same management activities, and their governance is also similar, to establish management in an organization in order to be accountable (Merkus et al., 2019).

Most literature that defines data governance differentiates it from data management (Khatri & Brown, 2010; Alhassan et al., 2016; Alhassan et al., 2018; Al-Ruithe et al., 2018; Abraham et al., 2019; Merkus et al., 2019). These authors make this distinction clear because researchers and practitioners are often confused between data governance and data management (Al-Ruithe et al., 2018). Khatri and Brown (2010) and Alhassan et al. (2016; 2018) distinguished between the activities for data governance and data management by first differentiating between governance and management, where governance refers to "the decisions that must be made and who makes these decisions in order to ensure effective management and use of resources", whereas management refers to making and implementing decisions. Data governance is therefore a high-level planning and control over data management; data governance establishes data management (Al-Ruithe et al., 2018; Merkus et al., 2019). Abraham et al. (2019) expanded that by saying that "data governance refers to what decisions must be made and who makes those decisions, whereas data management is about making those decisions as part of the day-to-day execution of data governance policies".

2.2.1 Frameworks of data governance

Data governance is a framework of decisions for managing data as a strategic asset, specifying the decision rights and accountabilities for an organization's decision-making about its data (Abraham et al., 2019; Khatri & Brown, 2010). As previously noted by Al-Ruithe et al. (2018), there are very few data governance frameworks despite researchers' call for their need, and the few are mainly developed by organizations in the industry. The authors briefly outline the frameworks by Cloud Security Alliance, DGI, and IBM (Al-Ruithe et al., 2018). The data governance framework published by Cloud Security Alliance consists of goals and structure, where goals were divided into formal IT and business goals and functional goals, and structure was divided into locus of control, organizational form, and roles and committees (Al-Ruithe et al., 2018). DGI's data governance framework had 10 components that could be divided into 3 areas: people and organizational bodies, rules and rules of engagement, and processes; they described that a data governance framework could be developed from various related items such as programs, stages, decision domains, universal objects, and components (Al-Ruithe et al., 2018). IBM's framework for data governance is a cycle of 14 steps, 4 of which are labelled optional tracks, and was presented in the perspective of a vendor data governance software provider, establishing that a data governance needs software support and clearly defined business and IT problems (Al-Ruithe et al., 2018).

Niemi (2011) reviewed literature on ways to organize data governance with the future research objective of designing a generic data governance framework for globally operating companies. The author expected to draw on the theoretical ideas and the practice-oriented requirements described in two other papers (Niemi, 2011). The first paper he found introduced a comprehensive framework with data governance divided into Goals and Structure, where the Goals were further divided into Formal business or IT goals and Functional goals, and the Structure was divided into Locus of control, Organizational Form, and Roles & Committees (Niemi, 2011); this appears to be the original framework that Al-Ruithe et al. (2018) found published in 2012 by Cloud Security Alliance mentioned earlier. The second paper Niemi (2011) found presented foundational requirements for data governance: it must be legitimate, spans control over data in all areas of business, spans control over data process, has adequate funding, have administrative visibility, ensure that senior management is involved, and ensure that members have skills and organizational positions for respect and attention. Niemi's proposed outcome of a generic data governance framework could not be found.

Other proposed data governance frameworks in literature in more recent years focus on cloud computing, big data, and artificial intelligence. Al-Ruithe et al. (2018), following their systematic literature review, compared six common dimensions of data governance between traditional non-cloud and cloud paradigm, and defined four additional key dimensions of data governance for cloud computing. The six common dimensions that they identified are: data governance function (master activities), data governance structure (roles and responsibilities), organizational (participation and commitment of staff and management), technical (technological capability), environmental (external environmental factors like government legislation), and measuring and monitoring tool (ensuring that data meets business rules for quality and reliability) (Al-Ruithe et al., 2018). The four new dimensions they introduced are: cloud deployment model, service delivery model, cloud actors, and service level agreement (Al-Ruithe et al., 2018). Their comparison of the six common dimensions in the cloud and non-cloud paradigms showed that there is a loss of control and governance for those dimensions in cloud computing, as it becomes the responsibility of a third party, and not local administrators, to consider, comply, implement, maintain, document, and report on data governance (Al-Ruithe et al., 2018).

Al-Badi et al. (2018) conducted a review of relevant studies on Big Data governance frameworks, including Khatri and Brown's (2010) framework based on five interrelated decision domains. The authors found 12 important articles on Big Data governance frameworks, with many of the researchers agreeing on using traditional data governance attributes for Big Data (Al-Badi et al., 2018). The authors propose a conceptual Big Data governance framework consisting of 8 components: identify organization structure, identify relevant stakeholders, identify the scope of Big Data, set the policies and standards, optimize and compute, measure and monitor quality, store the data, and communicate and manage the data (Al-Badi et al., 2018). The authors note that the information governance principles that they found in their literature review have been used in their proposed framework and that those 7 core principles of information governance guidelines are still applicable; these are: organization, metadata, privacy, data quality, business process integration, master data integration, and information lifecycle management (Al-Badi et al., 2018). They compared the Big Data governance frameworks from literature as well as their own proposed framework to the ISO 8000 data governance framework for validation and determined that their proposed framework provides 87% representation, a greater representation of the ISO 8000 standard than the other frameworks (Al-Badi et al., 2018).

In 2020, Janssen et al. investigated the approaches of data governance to big data algorithmic systems (BDAS), which are often based on different forms of artificial intelligence. Many organizations, particularly public sector organizations, are using data governance to exercise control over the various sources of data that are combined in BDAS to ensure the quality of data and compliance with legal and ethical requirements that will allow the BDAS to make trustworthy consequential decisions (Janssen et al., 2020). The authors propose a framework for data governance for trustworthy BDAS, involving three incremental elements: a model for system-level controls for BDAS, data stewardship and base registries, and a trusted data sharing framework based on data sharing agreements and self-sovereign identities (Janssen et al., 2020). The entire framework is discussed with 13 essential principles of data governance in BDAS in mind, which the authors list as: evaluate of data quality and bias, detect of changing patterns, need to know, bug bounty, inform when sharing, data separation, citizens control data, collecting data at the source, minimize authorization to access data, distributed storage of data, data stewards, separation of concerns, and usefulness (Janssen et al., 2020).

2.2.1.1 Khatri and Brown’s data governance framework

Khatri and Brown’s article from 2010 is one of the leading pieces of literature in the field of data governance, for their role in defining data governance and for the data governance framework that they proposed, with over 600 citations of their article. In their article, the authors proposed a framework for data governance with five interrelated decision domains: data principles, data quality, metadata, data access, and data lifecycle (Khatri & Brown, 2010). Figure 2.1 from their paper emphasizes how the decision domains are interrelated: data principles establish direction for the other decisions by deciding on the intended uses of data, standards of data quality can be set, which establishes the basis for metadata and data access, and decisions of the data lifecycle operationalize the data principles into IT infrastructure.

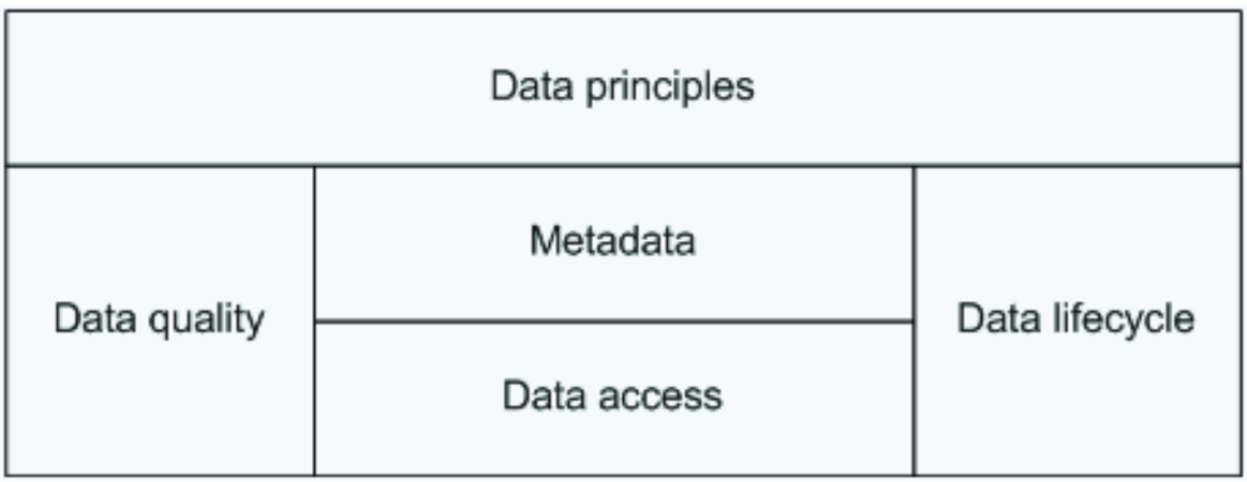


Figure 2.1. Decision domains for data governance (Khatri & Brown, 2010).

According to Khatri and Brown’s framework, the *data principles* decision domain delineates the business uses of data, establishes the purpose of data and data as an asset, and determines appropriate and specific policies, standards, and guidelines, while also taking the regulatory environment into account. Data principles are supported by rationales and a set of implications, and foster opportunities for sharing and reusing data, and they can apply to both internal data and external data from third-party providers.

Data quality refers to the ability of data to fulfill its usage requirements. Data quality has many different dimensions, including: accuracy, the correctness of data; timeliness, that the data is up-to-date; completeness, that requisite data is recorded and of adequate depth and breadth; and credibility, trustworthiness of the data source and its content. The dimensions of data quality are relative and defined to the business use of the data.

Metadata is the data about data, providing a concise and consistent description of the representation of data while helping interpret the semantics of data. There are different types of metadata: physical metadata is the information about the physical storage of data; domain-independent metadata include the descriptions that track the creation and modification of data, authorization, auditing, and lineage information of the data, and can be specified at different levels within the organization; and user metadata are the annotations on data made by users, such as user preferences and usage history. Metadata is dependent on the intended use of and access to the data, as well as its lifecycle, and as such, it is important to standardize metadata as well as maintain changes in line with business changes.

Data access is defined by the ability of data beneficiaries to assign values to different categories of data, such as data security officers conducting risk analysis, which would identify business data needs and address safeguards for confidentiality, integrity, and availability of data. Data access policies and standards are guided by industry standards, through the integration of risk assessment with regulatory compliance and monitoring. Data access standards are based on the definition of what can be considered acceptable and unacceptable uses of data, as well as requirements of auditability, privacy, and availability. Decisions for data access also provide standards at physical and logical levels, such as with physical data integrity where data is made immune to damage from power failure, and logical data integrity like in the preservation of database structures.

As all data moves through its lifecycle stages, the *data lifecycle* decision domain involves mapping data usage patterns to optimize storage media and minimize the cost of storing data over its lifecycle, which can be achieved through understanding how data is used and valued, and how long it must be retained. The data lifecycle decision domain will define how to manage the inventory of data and its various data sources through understanding the different types of data that are prevalent, data storage requirements, and growth trends. Choosing an appropriate storage medium for data to fit business needs will improve data distribution, improve storage utilization, and reduce storage acquisition costs. Compliance issues related to legislation determine how organizations address the decisions for the data lifecycle, data retention, and data archival.

Other authors have used Khatri and Brown's framework for their research and analysis and as a basis for their own frameworks (Alhassan et al., 2016; Alhassan et al., 2018; Abraham et al., 2019). Alhassan et al., in both their 2016 and 2018 papers, selected the data governance framework proposed by Khatri and Brown to present the five decision domains for data governance. They noted that these decision domains resemble those of the IT governance decision domains proposed by Weill and Ross in 2004, which Khatri and Brown had used as a starting point for their framework (Alhassan et al., 2016; Alhassan et al., 2018). Alhassan et al. (2016; 2018) used Khatri and Brown's framework as part of their content analysis to identify the types of data governance activities reported in literature, from both scientific and practice-oriented publications. Their coding scheme defined data governance activities as a combination of an action, an area of governance, and a decision domain, the latter of which were the decision domains of Khatri and Brown's framework (Alhassan et al., 2016; Alhassan et al., 2018).

Abraham et al. (2019) proposed a conceptual framework for data governance in their structured literature review to determine the building blocks of data governance and areas for future research. Their framework is comprised of six dimensions: governance mechanisms, organizational scope, data scope, domain scope, antecedents, and consequences of data governance (Abraham et al., 2019). The areas they identified for future research include governance mechanisms, scope of data governance, antecedents of data governance, and consequences of data governance (Abraham et al., 2019). The authors noted that their study has its limitations in the practical applicability of their conceptual framework (Abraham et al., 2019).

2.2.2 Data governance models

The current data governance landscape can be described by asymmetries in power, as major technology corporations have established "de-facto quasi-data monopolies" and the dominant model of data governance is corporate technology platforms collecting and exploiting personal data loaded with negative societal implications (Micheli et al., 2020). Micheli et al. (2020) derived 4 data governance models emerging from the practises of other actors that also take part in data governance, namely small businesses, public bodies, and civic society, and discuss the models in terms of power relations affecting each model's processes and goals, and how value created from data is redistributed in each model. The authors examined the models from a social science perspective, focusing on the five dimensions of stakeholders, governance goals, value from the data, governance mechanisms, and reciprocity (Micheli et al., 2020). In the first model, data sharing pools, partnerships and contracts between business entities and public bodies are created to fill knowledge gaps, innovate, and develop new services through data sharing and exchange, and derive profit and economic growth from treating data as a commodity (Micheli et al., 2020). The model of data cooperatives is similar in the distribution of data access and in data sharing, but instead focuses on the participation and empowerment of data subjects, driven with the goal of rebalancing the power unbalances of the current data economy and fostering social justice and fairer conditions for value production (Micheli et al., 2020). Public data trusts are run by public bodies that consider data as public infrastructure to innovate and inform policymaking, address societal challenges, and adopt a responsible approach to data, while using different governance mechanisms to build trust with citizens (Micheli et al., 2020). Finally, personal data sovereignty is a model that is characterised by the data subjects having greater control of their data and attaining self-determination, drawing on the history and movements of technological sovereignty, and ultimately creating a more balanced relationship between users and digital platforms as it centres on users' needs (Micheli et al., 2020).

2.2.2.1 Bayat and Kawalek's data governance modes

The structures of the data governance models presented by Micheli et al. (2020) have similarities to the modes of smart city data governance by Bayat and Kawalek in their House Model framework. Micheli et al.'s 2020 paper references Kawalek and Bayat's work from 2017 in which the authors introduced the first iteration of the House Model, then known as the Data as Infrastructure Conceptual Model, as well as the first iteration of the data governance modes. Since then, Bayat and Kawalek have presented their framework in 2018 and most recently 2021 with improved and refined versions of the House Model framework and data governance modes. The analysis in this thesis was originally conducted with the description of the data governance modes presented by Bayat and Kawalek in 2018.

The House Model is a conceptual framework that was designed to help interpret strategic planning of smart city initiatives, focused on governance, and was developed through direct consultations with practitioners, based in evidence in literature, and validated with government agencies in the United Kingdom (Bayat & Kawalek, 2021). In Figure 2.2 from Bayat and Kawalek's studies, the House Model presents a foundational structure of technological solutions and data governance modes led by urban vision, all situated in the context of each city (Bayat & Kawalek, 2021). The urban or smart city vision is described in four directions on two axes, where the vision could be more local or more global, and more centralized and infrastructure-centered, or less centralized and more citizen-centered (Bayat & Kawalek, 2021). The technological solutions address four categories of problems, the selection problem which refers to the problem of making relevant data accessible, the prediction problem which refers to problems of trying to predict outcomes using highly dimensional data, the verification problem which refers to the veracity of data and challenges with establishing validity of data, and the replication problem which refers to the often costly or difficult problems of pattern matching and learning (Bayat & Kawalek, 2021).

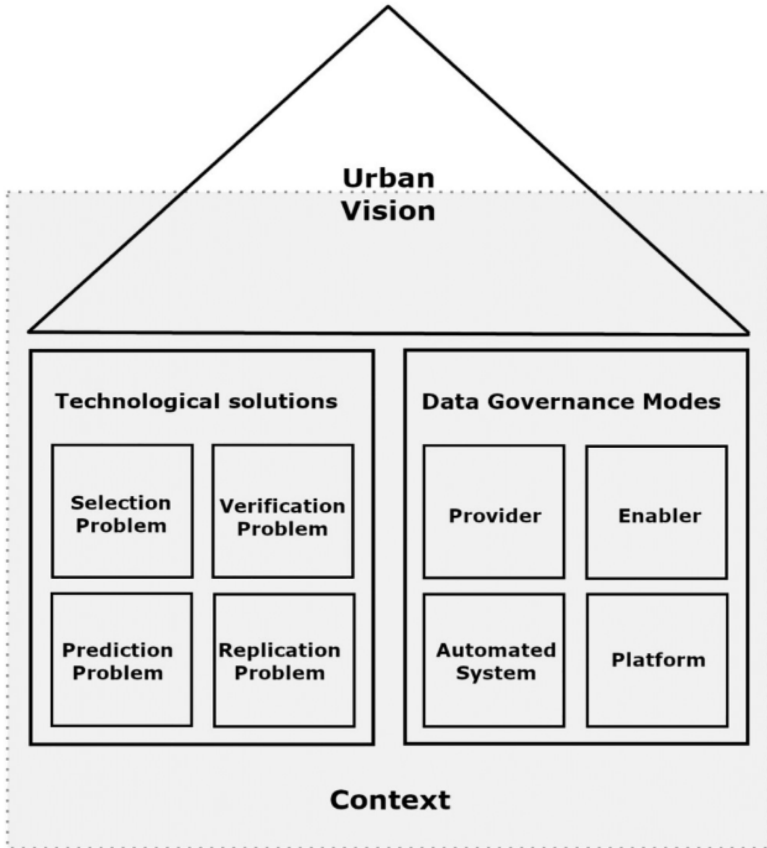


Figure 2.2. The House Model (Bayat & Kawalek, 2021).

The data governance modes are formed around four major themes describing the way that the concept of a city is conceived: city as a provider, city as an enabler, city as a platform, city as an automated system. Each of these modes consider data differently, have different organizational forms, different levels of stakeholder involvement, and different motivations (Table 2.1). This is based on Bayat and Kawalek's (2021) acknowledgement and understanding that different forms of governance exist, as the notion and execution of the smart city is multifaceted, but regardless of the permutations of the data governance strategies, access to and control over data is a strategic asset for cities.

Table 2.1. Data governance modes (Bayat & Kawalek, 2021).

	City as a provider	City as an enabler	City as a platform	City as an automated system
Data considered as	Public good	Commodity	Concept	Feedback
Organizational form	Hierarchy	Market	Network	Hierarchy
Stakeholder involvement				
Government	Low	Medium	High	High
Citizens	Medium	Low	High	Low
IT corporations	Low	Medium	Low	High
Motivation	Transparency, participatory governance	Monetizing the value of the data	Co-creation	Closed governance with highly efficient execution

For the mode *city as a provider*, the city is only the provider of data, and that data can be used for different purposes by different actors, and the control over the type of content released and control over any issues conducted through a hierarchical approach. Designating and releasing data as a public good is one of the most commons forms of data governance, commonly known as open data initiatives, as data is often generated as part of public infrastructure and the motivations behind releasing such data is for accountability and transparency, facilitating evidence-based decision-making, and enabling some form of participatory governance.

In the *city as an enabler* data governance mode, the city provides a marketplace for data, as the city recognizes they are not the only holder of urban data. This mode promotes the exchange of data among suppliers and users in a marketplace format to realize the optimal value of data. Data is considered a commodity, and the motivation of this mode is for more efficient uses of data and potentially driving innovations and economic growth through its exchange.

As a platform, cities seek to develop a network of certain providers and users of data to manage a research agenda, often in a closed or semi-closed environment. This is often known as a *lab*, and it would allow cities to bring together stakeholders to address specific policy issues and concerns. Data is considered to embody a concept as it is the key component to the research-based ecosystem and to the interfacing with urban policy mechanisms, and demands a high level of involvement from all stakeholders in the form of collaborations and partnerships. Co-creation processes are created and in turn they create valuable innovations from the concept. This mode was previously published as *city as a lab* by Bayat and Kawalek in 2018.

Finally, the data governance mode of *city as an automated system* expects to develop highly automated and intelligent closed systems to support real-time work and ongoing processes for analysis and optimization of the urban environment. Often this is illustrated by city dashboards but also extends to higher levels of automation, using monitoring systems for the real-time management of facilities or areas, with algorithms and other forms of artificial intelligence able to determine potential issues, including physical, environmental, political, and economic ramifications. Data is considered to be both feedback and infrastructure, as it generates and resembles the behaviour of infrastructure, needing to be maintained and managed in an analogous manner. The closed system relies on data quality and a hierarchical arrangement to support the collecting, merging, visualizing, and analysing of massive amounts of data. This mode was previously published as *city as a smart system* by Bayat and Kawalek in 2018.

Bayat and Kawalek acknowledge in their 2021 paper that hybrid data governance arrangements for smart city initiatives are possible, but how they are combined and observed depends on the context and the vision of the smart city. Overall, the House Model establishes a framework for the strategic planning and development of smart city initiatives, and the authors note the need to test the House Model and each of its components to shed new light on how they individually or interactively, can predict the outcome of smart city initiatives (Bayat & Kawalek, 2021).

2.3 Data governance of smart cities

Interpretations of data governance of smart cities are embedded in literature from broad perspectives like applications of data governance of big data for enterprises, to more narrowly, such as literature on data governance of urban data spaces (Abraham et al., 2019; Cuno et al., 2019). Many discuss the open data/government movements as part of early smart city data governance activities (Paskaleva et al., 2017; Cuno et al., 2019; Bayat & Kawalek, 2021). Although data governance of smart cities has gained more attention and relevance, it is still a very new area of research (Abraham et al., 2019; Janssen et al., 2020; Bayat & Kawalek, 2021).

Earlier exploratory research examines how data governance could be operationalized in smart city initiatives focused on sustainability (Paskaleva et al., 2017). Paskaleva et al. (2017) characterized data governance for sustainable smart cities as an inclusive and iterative process of stakeholder engagement and citizens' participation on data development to benefit and transform both the city and its people. The authors also described operationalized data governance in sustainability-driven smart cities to have key factors such as performance measurement and showing impact of stakeholder relationships and collaboration on sustainability goals (Paskaleva et al., 2017). Paskaleva et al. (2017) proposed a preliminary conceptual framework for Data Governance in Smart City Initiatives with six main pillars derived from prior studies of data in smart cities and their own: project context, data identification, data collection, data generation, data sharing and management, and data use and legacy. The authors' empirical research determined that sustainability shapes a collaborative approach to data governance in the smart city, but their hypothesis is limited by the sustainability lens and the idea that data governance in the smart city is driven by the goals of sustainable development (Paskaleva et al., 2017).

While Bayat and Kawalek (2021) do not specifically discuss data governance in the context of a sustainability-driven smart city, they introduce their own conceptual framework called the House Model and a sub-framework of data governance modes, as described in the previous section of this literature review. The study presents a way of looking at smart cities based on the role that the city governments play in their data governance, with the four roles being Provider, Enabler, Platform, and Automated System, and acknowledges that there is potential for hybridized roles (Bayat & Kawalek, 2021). In a similar approach, Micheli et al. (2020) presents and discusses a few emerging data governance models, with two of the models driven by key actors from public bodies like city governments: data sharing pools and public data trusts. The authors describe data sharing pools as horizontal partnerships built on a contract between public bodies and business entities, with a legal and policy framework defining data sharing, data handling, and purpose, sometimes also referred to (potentially inaccurately as a marketing tool) as a data trust (Micheli et al., 2020). Data sharing pools are expected to create value from combining data and producing data-driven innovations, new services, and economic benefits for all parties (Micheli et al., 2020). In public data trusts, public bodies establish a relationship of trust with citizens to access, aggregate, and use citizens' data ethically, privately, and securely in order to inform policymaking and promote innovation (Micheli et al., 2020). The public actors must engage with citizens to reassure them that their data and other data with a public interest component will be responsibly used to improve their lives and produce value for citizens and society as a whole (Micheli et al., 2020).

Artyushina (2020) warns that the pursuit of economic rent of data and the privatization of urban governance may corrupt civic data governance initiatives like data trusts, as seen with the Urban Data Trust that was proposed by Sidewalk Labs for their failed Quayside smart city project in Toronto. The Urban Data Trust, as Sidewalk Lab's data governance model aimed to regulate data collection and generate value from data, but also to balance protecting citizens' privacy and assetizing an uninterrupted flow of data for commercial users (Artyushina, 2020). Artyushina (2020) argues that Sidewalk Labs transformed the model of a data trust to assetize citizens' data through five interconnected processes: "introducing new legal definitions for the data, retrofitting city infrastructure with data-tracking devices, creating a self-certification regime for data collectors, accumulating the data collected in the smart city in one physical location, and establishing IP-intensive data sharing agreements". The warped Urban Data Trust construct was essentially data rentiership employed as a data governance model (Artyushina, 2020).

In other literature, there are reoccurring discussions about specific concerns within the realm of data governance and its decision domains, notably regarding privacy and security (Eskridge, 2019; Lupi, 2019; van Zoonen, 2016). The 2019 study by Eskridge states that cities should arrange separate privacy and security to make sure its citizens will cooperate with smart city development and initiatives, and identifies inappropriate regulatory frameworks and security and privacy issues as major obstacles to smart city initiatives in the study's survey. Lupi creates a theoretical construct in a 2019 paper, formulating the outline of a City Data Plan as a data governance policy instrument that takes privacy and security into account based on key aspects of corporate data governance plans and urban planning, in addition to equity and accessibility of data. Many of the studies discussing data-related decisions and concepts of smart cities do not refer to data governance explicitly, even if those decisions and concepts fall within the realm of data governance.

Other literature on data governance of smart cities focuses on inclusivity and citizen-centered data governance (Eke & Ebohon, 2020; König, 2021). Eke and Ebohon (2020) argued that data governance is critical to smart cities for the delivery of equitable, sustainable, and livable cities, as representative data is being used to bridge the widening inequality in cities, and the right data governance will provide wider equal access to the right data and efficient and effective delivery of urban services. The authors propose a framework for imbedding social inclusion in smart cities through data governance, although with no methodological and theoretical underpinnings, involving the right data, right algorithms, right people, and right policies/standards, in order to help address social, political, legal, cultural, and ethical concerns that have impacts on exclusion in smart cities (Eke & Ebohon, 2020).

In a 2021 paper, König examines five different ways in which data can create value for smart cities and its citizens, and identifies ethical and legitimacy challenges that arise from the data value creation chain that smart city data governance handles, such as problems of autonomy, which occur during the value creation chain processes of data collection, data preparation and processing, and the usage of data-generated knowledge and its consequences. König (2021) argues that data governance must extend beyond data extraction and privacy issues, and that the ethical and legitimacy challenges need to be addressed for citizen-centric data governance in the smart city. The author poses democratic accountability as an answer and central value to citizen-centric data governance, in agreement with other literature supporting strong direct citizen influence, but without overemphasizing the role of direct citizen participation in smart city data governance (König, 2021). König (2021) describes extensive citizen participation as neither realistic or necessary to realize democratic accountability in smart city data governance, for reasons including citizens' reluctance to participate in political affairs, unequal participation or overrepresentation of data literate citizens, and emerging data governance models like data trusts not requiring strong citizen involvement.

König (2021) continues to describe a framework of three democratic accountability mechanisms that can safeguard citizen-centric data governance, namely ex-ante testing, operative transparency, and post-hoc testing. Ex-ante testing is the orienting of data value creation processes towards acceptable goals that are authorized, defensible, and justifiable as being in the public interest, and specifies how goals and objectives are incorporated into those processes (König, 2021). Citizens and other stakeholders would be involved to shape the data value creation chain and ensure acceptability of the data processing and its objectives, and impact assessments should be conducted to ensure that data value creation serves a specific purpose and avoids undesirable impacts that affect informational and decisional autonomy, such as biases and unfair discrimination (König, 2021). Operative transparency involves mechanisms for ongoing transparency on the data processes, informing citizens and other stakeholders in both plain language and technical details to allow them to gain basic understanding of the smart city data governance (König, 2021). Only with transparent data governance is it then possible to contest existing practises and hold decision makers accountable (König, 2021). The last accountability mechanism that König (2021) introduces is ex-post scrutiny and inspection, which calls for regular inspection, testing, and reviewing of the goals and processes of the data value creation chain by some overseeing body, as impacts and side effects may change or only be seen over time.

Most recently, a literature review investigates and summarizes the applicability of data governance to smart cities, finding that there is a need for data governance in cities, and by transferring existing knowledge on data governance to the urban context, valuable contributions can be made for city data governance, especially in relation to data protection and privacy, data sharing, data access, and data ownership, and relevant stakeholder involvement (Bozkurt, Rossmann, & Pervez, 2022). Although data governance plays an essential role in smart city research and practice, a focus on urban data governance is missing, and the authors call for a framework to support cities in implementing data governance, and for implementing holistic data governance in smart cities (Bozkurt et al., 2022). Based on the current understanding of smart cities, data governance, and data management, the authors define urban data governance to assess all data-related issues of a city from a holistic perspective, with the main goal to ensure sustainable urban development by managing data in the interest of citizens and promoting businesses and services (Bozkurt et al., 2022).

2.4 Literature Review Summary

In summary, the literature review has shown that the smart city discourse is continually investigating the smart city as a concept and the value of its interpretations to society. Research shows that there are several themes and criticisms of smart cities, including technological solution-ism, profit-driven urbanism, and panoptic surveillance (Hartt et al., 2021). Among the top concerns are the dimensions and challenges of privacy and security of smart cities and the meaningful citizen participation in smart cities. These concerns are also investigated in the Canadian context, drawing attention to the failure of Sidewalk Labs, as well as exploring the possibilities with the Smart Cities Challenge. There has also been a shift in the smart city discourse that has introduced new interpretations and paradigms of smart cities. Regarding data governance, theoretical discussions have conceptualized frameworks and models for data governance but have also revealed that data governance of smart cities is a very new area of research with few empirical studies. The literature review shows that there is room for growth in the scholarship of smart city data governance, and so this thesis hopes to expand on existing literature by providing a comprehensive approach to data governance for smart cities. In addition, as much of the literature for both smart cities and data governance have been theoretical discussions, there exists a gap for empirical studies on the application of data governance frameworks to smart cities that other authors have acknowledged and called for. This thesis aims to address this gap and contribute to this understudied area by providing an empirical study of data governance decisions for the smart city and evaluate proposed smart cities for the roles that they may adopt in developing their data governance.

Chapter 3
Methodology

To understand the current state of data governance for smart cities in Canada, we need to understand the different data governance strategies that these smart cities are using, as well as the roles that these cities play in handling data governance of their smart city projects. Canada's Smart Cities Challenge (SCC) in 2018 opens and avenue for investigating the data governance strategies and roles of the 20 finalists through their proposals. These proposals, which include chapters like "Performance Measurement" and "Data & Privacy", describe what the finalists did or proposed for their smart city data governance. This section will describe the SCC in detail, and then describe how analysis was conducted on the SCC proposals. There will be a brief explanation of content analysis, a description of the level of analysis conducted, how the content was collected and organized, and an explanation of the coding of concepts and analysis.

3.1 Smart Cities Challenge in Canada

3.1.1 Overview

In addition to research, the federal government has been committed to invest in billions of dollars into infrastructure and to help build cities of the future with the 'Investing in Canada Plan', which includes the Smart Cities Challenge. The Smart Cities Challenge (SCC) was issued by Infrastructure Canada in November of 2017, as an innovation challenge for communities of all sizes to improve the lives of their residents through data and connected technology (Infrastructure Canada, 2019a; Impact Canada, n.d.a). With Infrastructure Canada committed to contributing $300 million in funding over 11 years, the SCC received applications from over 200 communities across Canada by the submission deadline of April 24, 2018, and on June 1, 2018, 20 finalists were announced across the three prize categories, and each finalist received a $250,000 grant to help develop their final proposal (Infrastructure Canada, 2019a; Infrastructure Canada, 2019b; Impact Canada, n.d.a). The finalist communities met with the jury in November 2018 and were also visited by the SCC team from October 2018 through February 2019 (Infrastructure Canada, 2019a). The final proposals were submitted on March 5, 2019, and the winners were announced May 14, 2019 (Infrastructure Canada, 2019b).

3.1.2 Applicants, finalists, and winners

Applicants were individual or groups of municipalities, local or regional governments, Indigenous communities, had to represent an identifiable community and must be responsible for services in that community, and could only submit one application to the competition (Impact Canada, 2017a). The population of the community, or two or more combined communities depending on the representative organizations, determined the prize category eligibility for the applicant, and the applicant can only select one prize category (Impact Canada, 2017b). The three prize categories were: $50 million, one prize, open to all applicants regardless of population; $10 million, two prizes, open to applicants with populations under 500,000; $5 million, one prize, open to applicants with populations under 30,000 (Impact Canada, 2017b).

In total, there were 20 finalists: 5 finalists in the $5 million prize category (5M), 10 finalists in the $10 million prize category (10M), and 5 finalists in the $50 million prize category (50M). The winner of the 5M category was the Town of Bridgewater, Nova Scotia; the two winners of the 10M category were the City of Guelph and Wellington County, Ontario, and Nunavut Communities, Nunavut; the winner of the 50M category was the City of Montréal, Quebec (Infrastructure Canada, 2019c). Table 3.1 below shows a list of the finalists by prize category and highlights the winners. Appendix A provides the challenge statement and official summary of each finalists' proposal.

Table 3.1. Smart Cities Challenge finalists and winners by prize category.

$5M Prize Category	$10M Prize Category	$50M Prize Category
• Biigtigong Nishnaabeg (Pic River First Nation), Ontario • Cree Nation of Eastmain, Quebec • **Town of Bridgewater, Nova Scotia** • Mohawk Council of Akwesasne, Quebec • City of Yellowknife, Northwest Territories	• Town of The Pas, Opaskwayak Cree Nation, Rural Municipality of Kelsey, Manitoba • City of Côte Saint-Luc, Quebec • **Nunavut Communities, Nunavut** • St. Mary's First Nation and Fredericton, New Brunswick • Parkland, Brazeau, Lac Ste Anne, and Yellowhead Counties, Alberta • City of Airdrie and Area, Alberta • City of Richmond, British Columbia • **City of Guelph and Wellington County, Ontario** • City of Saskatoon, Saskatchewan • Greater Victoria, British Columbia	• Waterloo Region, Ontario • Québec City, Quebec • City of Edmonton, Alberta • City of Surrey and City of Vancouver, British Columbia • **City of Montréal, Quebec**

3.1.3 The SCC guides and the smart cities approach

The SCC provided guides and rubrics for both the applicant stage and the finalist stage of the competition, and these were available for the participating communities and the public to view. The Applicant Guide described how the use of a smart cities approach will help communities "define their future with the help of their residents", and the Finalist Guide listed the use of a smart cities approach as one of the requirements for finalists to maintain their eligibility (Impact Canada, n.d.b; Impact Canada, n.d.c). Both the Applicant Guide and the Finalist Guide defined a smart cities approach as an approach that aims to "achieve meaningful outcomes for residents by leveraging the fundamental benefits that data and connected technology have to offer" (Impact Canada, n.d.b; Impact Canada, n.d.c). The smart cities approach was to be central to the proposals, and underpinned by four main principles (Impact Canada, n.d.b; Impact Canada, n.d.c):

- Openness: When communities make their data truly accessible, usable, and barrier-free, their decision-making processes become transparent, empower residents, and strengthen the relationship between residents and public organizations.
- Integration: Data and connected technology empower communities to break down silos that exist within local governments and public organizations.
- Transferability: When tools and technological approaches are open-source, transparent, and standardized, they can be used by communities across the country, no matter their size or capacity.
- Collaboration: Connected technology enables communities to bring traditional and non-traditional partners to deliver common objectives.

3.1.4 The Applicant Guide

Other than the smart cities approach, the Applicant Guide discussed the importance of defining a Challenge Statement, emphasizing on the measurable and purposeful use of data, and outlined the applicant eligibility, various application processes, and timeline of the SCC. The bulk of the Applicant Guide was an appendix of Application Instructions, presented as a rubric, broken down into four sections.

Section I asked for general information on the applicant. Section II was the only section of the application to be evaluated by the jury and asked 9 questions in total to form the preliminary proposal. Applicants were asked to define their problem in a challenge statement, outline specific goals and outcomes, plan for meaningful community engagement and involvement, describe proposed activities and projects, relate to existing community plans, describe community readiness, provide budget breakdown and rationale, and identify existing or potential partnerships. The application also gave room for a confidential annex, the only question of Section II that was exempt from the requirement to post online. Throughout the tips and evaluation criteria of Section II, other than the confidential annex, emphasis was placed on measurable projects, defining appropriate use and value of data, as well as transparency and involvement and engagement with community residents, businesses, organizations, and other stakeholders at every stage of the process. The proposals were evaluated for openness, interoperability, scalability, and replicability, and the use of open data approaches were encouraged. Expectations for organization and partnerships were also established in this section, as the guide advised the establishing or assigning of dedicated senior positions or creating dedicated teams to facilitate and manage innovation; the guide also suggested that partners could be found in diverse types of organizations and have relevant contributions to the successful outcomes of the proposal.

Section III had no bearing on the final evaluation of the proposal, but asked for other requirements of the applicant, such as a summary of the preliminary proposal and a link to the full version of the application online, in pursuit of openness and transparency. Section IV also had no bearing on the final evaluation, and instead contained surveying questions from Infrastructure Canada, intended to collect data on the applicants to help improve the processes of future challenges like the SCC, including questions to identify pre-determined focus areas for the proposals and a list of potential technologies to be implemented.

3.1.5 The Finalist Guide

The Finalist Guide reiterated that the smart city approach was to be central to the final proposals, and described pertinent information for the finalists, including how winners were selected. The final proposals were reviewed by experts and then evaluated by the same independent Jury that selected the finalists, based on the criteria in Section 5 of the guide. The three requirements for submission were the final proposal, a finalist video, and a finalist pitch, and of these three, the final proposal was the main component for evaluation, comprised of a single consolidated document to be posted online by Infrastructure Canada, except for additional documents including the Confidential Annex, the Privacy Impact Assessment (PIA), and the Preliminary Rationale Analysis (PRA).

Section 5 of the guide outlined the requirements of the final proposal, for the executive summary and each of the nine predefined chapters: Vision, Performance Measurement, Project Management, Technology, Governance, Engagement, Data & Privacy, Financial, and Implementation Phase Requirements. The final proposal was expected to build upon the Challenge Statement and outcomes of the initial application and “set out concrete plans to achieve real results for the residents through a smart cities approach”.

The Executive Summary was expected to reiterate the Challenge Statement and provide an overview of the upcoming nine chapters, but otherwise had no evaluation criteria. Chapter 1 on Vision requires the finalists to highlight their goals and objectives for their proposal, showing progress and reflection on project outcomes for suitability, scalability, and replicability for their community and other communities in Canada. Chapter 2 on Performance Measurement is the foundation of the outcome-based prize payment and contribution agreement, in which the prize money payments are triggered by successful achievement of deliverables, milestones, and performance indicators as outlined in a performance measurement plan. Appendix 2 of the guide provided additional guidance on outcomes-based performance measurement. Chapter 3 on Project Management is an outline of the project management approach, including project scope, resource assessment, risk assessment, and other management strategies, and provides context for the remaining chapters of the proposal.

Chapter 4 on Technology should discuss the plan for connected technologies that are core to the proposal, the application of technology in detail, futureproofing, compliancy, accessibility, and other strategies that show the feasibility of the plan and how the community and other communities in Canada will benefit from it. Chapter 5 on Governance should demonstrate the dynamic between community leadership, project teams, partners, and other stakeholders, using a governance management plan confirming the roles and responsibilities, with an approach to partnerships that retains community control over sensitive and personal data. Chapter 6 on Engagement should plan and demonstrate the finalist's commitment to engagement with residents, as primary beneficiaries, to obtain and maintain their support and participation throughout project implementation, including approaches and tools used in past, planned, and ongoing engagement activities, and efforts in project design for inclusivity and diversity. Appendix 1 of the guide provided additional guidance on diversity and inclusion.

Chapter 7 on Data & Privacy should provide a detailed data governance plan, including strategies for data management and privacy, in order to leverage data to achieve efficiencies, inform decision-making, and secure and protect sensitive information and privacy, while still making data available publicly and avoiding vendor lock-in. This chapter will demonstrate the finalist's commitment to responsibly managing data throughout its lifecycle, through the development of the required PPIA or PRA, explicit compliancy with the PIPEDA and other relevant privacy regimes, and other efforts towards open and big data strategies. Appendix 3 provided additional guidance on data and privacy consideration, including defining personal information, expanding on the PIA or PRA, important steps for communicating with relevant privacy authorities, and outlining relevant privacy laws at both federal and provincial/territorial levels.

Chapter 8 on Finance should be a comprehensive and detailed breakdown of the use of the prize money and overall project budget, as well as any additional contributions. Chapter 9 on Implementation Phase

Requirements identifies additional requirements that may be applicable, including duty to consult with indigenous groups, modern treaty obligations, community employment benefit, and climate lens assessment. The Finalist Guide also provides information for the optional Confidential Annex section, which would be used to provide confidential information for evaluation. Although one of the goals of the SCC is to encourage as much transparency as possible and posted the final proposals online, the SCC gave room for the confidential annex to be provided for evaluation and not shared online. Near the end of the Finalist Guide in Appendix 4 is the Consolidated Requirements and Evaluation Criteria, in which the requirements and evaluation criteria of each chapter is repeated, and a rubric is provided. Appendix 5 outlined the Infrastructure Canada Web Accessibility Standards to facilitate online posting for non-text content in the final proposals.

3.1.6 Jury selection

Finalists and winners of the SCC were determined by a panel of jury members, who were in turn selected by the Ministry of Infrastructure and Communities (Impact Canada, 2017a). Interested individuals could apply to become a jury member for the competition, and Infrastructure Canada strove to gather a diverse jury with accomplished individuals from across the country (Impact Canada, 2017a). Jury members had to be publicly recognized in their field related to smart cities (such as urban planning, architecture, and policy innovation), have a strong track record of leadership, and have a demonstrated interest in public issues or public service (Impact Canada, 2017a; Infrastructure Canada, 2019d). Thirteen diverse professionals were selected for the Jury, and they covered a broad spectrum of experience and expertise in urban planning and city building, public issues and public service, policy innovation, civic innovation, open data, technology, and business and economics (Infrastructure Canada, 2019d). The Jury was responsible for evaluating the applications and final proposals using criteria outlined in the Applicant and Finalist Guides, and ultimately recommended the finalists and winners to the Minister of Infrastructure and Communities (Infrastructure Canada, 2019d).

3.2 Content analysis

Content analysis is an analysis technique that describes and quantifies phenomena, known largely as a method for analysing documents (Hsieh & Shannon, 2005; Elo & Kyngäs, 2008). Although both quantitative and qualitative content analysis have been used in research, research using qualitative content analysis focuses on language, content, and context for text data (Hsieh & Shannon, 2005). Qualitative content analysis can be defined as the "subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" (Hsieh & Shannon, 2005). Successful content analysis is dependent on the coding process of organizing content into categories, which uses a coding scheme that is developed differently depending on the qualitative content analysis approach (Hsieh & Shannon, 2005). Hsieh and Shannon (2005) identify three distinct approaches to qualitative content analysis: conventional, directed, and summative. The conventional content analysis approach is used when there is limited existing theory or research literature and categories are developed inductively, by defining codes during the data analysis and deriving codes from the data (Hsieh & Shannon, 2005). Directed content analysis starts with existing theory or theoretical framework to validate or conceptually extend it and is considered more deductive (Hsieh & Shannon, 2005). The summative approach to qualitative content analysis starts with quantifying key words and content in text to explore usage, but continues to interpret that content for underlying meanings of using key words in their context (Hsieh & Shannon, 2005).

This study uses the directed approach to content analysis, which has two main strategies. The first strategy starts with highlighting all text that appears to represent a phenomenon, then coding the highlighted passages with codes predetermined from theory; the other strategy is to code immediately with predetermined codes; in both cases, data that cannot initially be coded would be analyzed and assigned a new or existing category, revising and refining the initial coding scheme and improve existing theory (Hsieh & Shannon, 2005). This study uses a mix of both to build a trustworthy understanding on the state of data governance in Canadian smart cities and to validate existing theoretical frameworks on data governance of smart cities. For this study, the main strengths of using the directed approach to content analysis are that existing theoretical frameworks can be explored, supported, and extended (one of the calls for research for the House Model), and that the researcher's approach to understanding the data is informed (Hsieh & Shannon, 2005). However, the latter is also a limitation due to the bias it presents, as researchers are more likely to find supportive evidence for theory than non-supportive evidence (Hsieh & Shannon, 2005).

Existing research on data governance have also employed the content analysis technique for validating theoretical frameworks while exploring literature in those fields. Alhassan et al. (2016; 2018) conducted studies using content analysis for categorizing the activities of data governance as found in scientific and practice-oriented literature to better understand data governance with an existing theoretical framework. Their research adopted an existing eight step coding process to conduct content analysis on literature to ensure clarity and transparency of the processes: decide the level of analysis, decide how many concepts to code for, decide whether to code for the existence or frequency of a concept, decide on how you will distinguish between concepts, develop rules for coding your text, decide what to do with “irrelevant” information, coding the text, analysing the results (Alhassan et al., 2018). This thesis similarly seeks to understand data governance by categorizing its activities with existing theoretical frameworks, as applied to smart cities, and used the same coding steps for content analysis.

3.3 Level of analysis

The data for analysis were collected from all of the 20 SCC finalist proposals. The proposals were read in their entirety, including all chapters and appendices if they were published publicly. While there was a “Data & Privacy” chapter in each proposal, content analysis was not limited to this chapter, as some of the coded activities and aspects may be better expressed in other chapters such as “Vision”, “Performance Measurement”, and “Technology”. The complex concepts were not limited to being described in a single chapter, and in the SCC guidelines themselves, the different activities and aspects were referred to in multiple different chapters, allowing for flexible presentation of the content. By reading all the chapters of the proposals, a better understanding of the data governance strategies and city roles could be established in the nuance of their context.

3.4 Collection of data

Data was collected from the PDF proposals of the 20 finalists, which were read in their entirety twice using Microsoft OneNote. The proposals were read in groups based on the finalist categories for consistency. For the first read-through, the content to be coded was found in sentences, paragraphs, tables, and infographics and highlighted for coding. The highlighted text was annotated, indicating if the content was coded for a decision domain for the Khatri and Brown (2010) data governance framework (referred to as the DG model), or for an aspect for the Bayat and Kawalek (2018) data governance modes model (referred to as the BK model). If the content was coded for a decision domain, additional annotation of descriptive abbreviations was added for the specific data governance activities observed (example annotation: “DA priv, sec”; “DP use, value, sharing”). The specific activities were derived from the descriptions of the decision domains found in the framework of data decision domains table in Khatri and Brown’s 2010 study (Table 3.2). The full list of data governance activities that could be coded for can be found in Table 3.3.

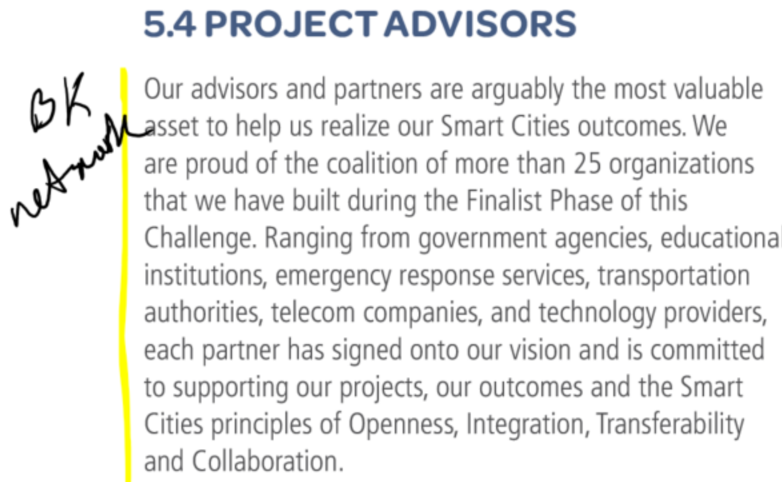
Table 3.2. Framework of data decision domains (Khatri & Brown, 2010).

Data Governance Domains	Domain Decisions	Potential Roles or Locus of Accountability
Data Principles • Clarifying the role of data as an asset	• What are the uses of data for the business? • What are the mechanisms for communicating business uses of data on an ongoing basis? • What are the desirable behaviors for employing data as assets? • How are opportunities for sharing and reuse of data identified? • How does the regulatory environment influence the business uses of data?	• Data owner/trustee • Data custodian • Data steward • Data producer/supplier • Data consumer • Enterprise Data Committee/ Council
Data Quality • Establishing the requirements of intended use of data	• What are the standards for data quality with respect to accuracy, timeliness, completeness and credibility? • What is the program for establishing and communicating data quality? • How will data quality as well as the associated program be evaluated?	• Data owner • Subject matter expert • Data quality manager • Data quality analyst
Metadata • Establishing the semantics or "content" of data so that it is interpretable by the users	• What is the program for documenting the semantics of data? • How will data be consistently defined and modeled so that it is interpretable? • What is the plan to keep different types of metadata up-to-date?	• Enterprise data architect • Enterprise data modeler • Data modeling engineer • Data architect • Enterprise Architecture Committee
Data Access • Specifying access requirements of data	• What is the business value of data? • How will risk assessment be conducted on an ongoing basis? • How will assessment results be integrated with the overall compliance monitoring efforts? • What are data access standards and procedures? • What is the program for periodic monitoring and audit for compliance? • How is security awareness and education disseminated? • What is the program for backup and recovery?	• Data owner • Data beneficiary • Chief information security officer • Data security officer • Technical security analyst • Enterprise Architecture Development Committee
Data Lifecycle • Determining the definition, production, retention and retirement of data	• How is data inventoried? • What is the program for data definition, production, retention, and retirement for different types of data? • How do the compliance issues related to legislation affect data retention and archiving?	• Enterprise data architect • Information chain manager

Table 3.3. Data governance activities as derived from the paper by Khatri and Brown (2010).

Decision Domain	Activities
Data Principles (DP)	value of data, uses of data, sharing and reuse of data
Data Quality (DQ)	fitness of use, standards of data quality, evaluating data quality
Metadata (MD)	documenting the data, defining and modelling the data (i.e. ModelBuilder), maintaining metadata
Data Access (DA)	data ownership, access standards and procedures, security, privacy, compliance monitoring, risk assessment, backup and recovery
Data Lifecycle (DL)	defining data, producing/collecting data, data retention, retirement/archiving of data

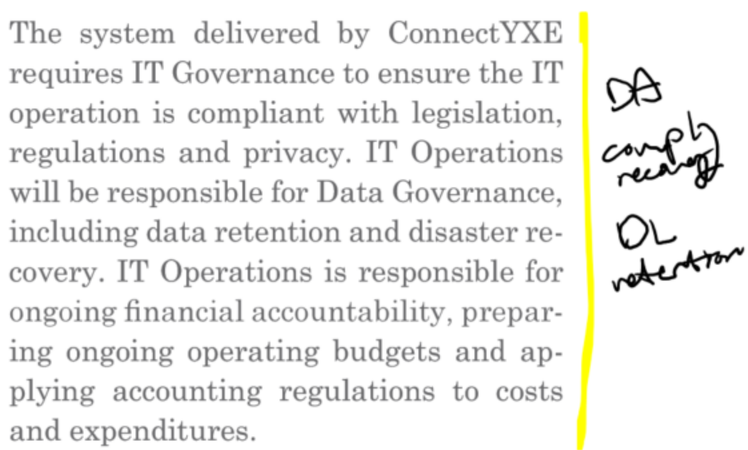
If the content was coded for the BK model, additional annotation was added for the modal aspect that aligned best with what was observed (example annotation: "BK transparency"; "BK network"). Content was coded based on Bayat and Kawalek's 2018 study and how they described the modal aspects by mode, which they summarized in their Data governance modes (Table 3.5 in "Analysis of Data"). In Figures 3.1 and 3.2 below are examples of how text could be highlighted and annotated for data collection.



5.4 PROJECT ADVISORS

Our advisors and partners are arguably the most valuable asset to help us realize our Smart Cities outcomes. We are proud of the coalition of more than 25 organizations that we have built during the Finalist Phase of this Challenge. Ranging from government agencies, educational institutions, emergency response services, transportation authorities, telecom companies, and technology providers, each partner has signed onto our vision and is committed to supporting our projects, our outcomes and the Smart Cities principles of Openness, Integration, Transferability and Collaboration.

Figure 3.1. Annotation example from Richmond (10M) for BK (p53).



The system delivered by ConnectYXE requires IT Governance to ensure the IT operation is compliant with legislation, regulations and privacy. IT Operations will be responsible for Data Governance, including data retention and disaster recovery. IT Operations is responsible for ongoing financial accountability, preparing ongoing operating budgets and applying accounting regulations to costs and expenditures.

Figure 3.2. Annotation example from Saskatoon (10M) for DA and DL (p27).

The purpose of the second read-through was for reviewing for quality and actual data collection. On the second read-through, the highlighted and annotated text were reviewed for content and coding as a quality check, and then the text was copied and pasted from the proposal PDFs into appropriate Microsoft Excel spreadsheets (described in the next section). If the text demonstrated multiple concepts, then a record would be created for each concept. Additional information about the text was collected, such as page numbers and chapters for referencing, and various attributes were collected for coding, such as activity, status, and decision domain for the DG model, and value, aspect, and mode for the BK model. A list of the collected data and their descriptions can be found in Table 3.4 in the next section.

3.5 Organization of data

The content collected from the proposals were initially copied to three Excel workbooks, one for each finalist category (5M, 10M, 50M). In these workbooks, there were two spreadsheets per finalist, one for data following the DG model and one for data following the BK model (i.e., Yellowknife DG, Yellowknife BK, etc.). After data collection was complete, these workbooks were reorganized and consolidated into two master workbooks, one for each model (DG and BK). Each workbook had three spreadsheets, one for each finalist category (5M, 10M, 50M), and each spreadsheet contained the content and attributes collected from the proposals of those finalist categories. Table 3.4 lists and describes the data that were collected, including the coding that was specific to the DG model or the BK model.

Table 3.4. Collected data table structure.

Column Name	Description
ID	Unique ID for the record
MCAT	Finalist category (5M, 10M, or 50M)
CITY_ID	ID number assigned to the finalist
CITY_NAME	Shortname of the finalist
RID	Record ID, carryover from initial organization (unique to model + finalist)
PTEXT	Text from the proposal
PDF_PG	Page number according to the PDF of the proposal
PG	Page number according to the proposal's page numbering system
CHAPTER	Title of the chapter the text is from
ACTIVITY	DG only; coded activities that the text describes
STATUS	DG only; status value (mention, proposed, existing) of the text
DECISION_DOMAIN	DG only; single coded decision domain that the activities fall under
BK_VALUE	BK only; coded value of the aspect/mode combination observed in the text
BK_ASPECT	BK only; coded aspect that the value falls under
BK_MODE	BK only; coded mode that the value falls under

The data collection master workbooks were imported to Microsoft Access as tables to facilitate easier querying of the data, utilizing SQL. The queries focused on frequency counting, grouping records in different combinations, such as by DG decision domains and by BK modes and aspects. These queries were then exported back to Excel for data analysis and visualization.

3.6 Analysis of data

3.6.1 DG Model

The DG model is a data governance framework originally proposed by Khatri and Brown in 2010 and is comprised of five data governance decision domains: data principles, data quality, metadata, data access, and data lifecycle. The scope of each decision domain is described by activities, and these activities and their decision domains were coded for as part of the data collection process. In addition to coding for the activities and decision domains, the collected observations were also assessed by the status of the described activities: if the observation was simply a mention of the data governance issue or concern, if the observation described proposed activities to address a data governance concern, or if the observation described existing activities that address data governance concerns. This distinction between these statuses of data governance activities was created to establish a better understanding of the finalists and the various stages of their work in developing data governance for their smart city projects.

To understand what the finalist cities were doing for their smart city data governance, the data was analyzed through frequency counting, grouping the number of occurrences of activities in each finalist's proposal by decision domain, status, and finalist category. This included counting the number of occurrences by decision domains overall across all the finalists, counting the occurrences by decision domain of each finalist and by finalist category, and counting the decision domain activities by status overall and per finalist. Through this process, the finalists with the highest counts by decision domain, status, and finalist category were determined, and those with zero counts, or non-existence of a decision domain, were identified.

This method of coding for the data governance decision domains and activities was inspired by previous academic studies that utilized Khatri and Brown's framework in a similar way. In two papers, one published in 2016 and another in 2018, Alhassan, Sammon, and Daly conducted analyses of literature on data governance activities, following a coding system in which they defined data governance activities as a combination of an action, an area of governance, and a decision domain, the latter of which honoured the five decision domains as defined by Khatri and Brown (2010). In their 2016 paper, the authors analyzed academic literature for the state of knowledge on data governance activities, and in their 2018 paper, the authors analyzed and compared literature of practise-oriented publications and scientific publications for different types of actions of the areas of governance that they defined, across the five decision domains (Alhassan et al, 2016; Alhassan et al, 2018). While the coding for this thesis did not include additional categories such as "Actions" and "Area of Governance" to define data governance activities as in the works of Alhassan et al., data governance activities were still coded for, based directly on the descriptions and decisions of the decision domains from Khatri and Brown's original framework. The status of activities was defined and coded for as described and explained previously.

3.6.2 BK Model

The other conceptual framework used in this study is the BK model, derived from the Data Governance Modes sub-component of Bayat and Kawalek's 2018 House Model, which breaks down city data governance approaches into four roles that the city can play: City as a Provider, City as an Enabler, City as a Lab, and City as a Smart System. As the BK model is based on Bayat and Kawalek's 2018 conceptual framework, the modes are described in the model using five aspects: Data considered as, Government Involvement, Organizational Form, Stakeholder Involvement, Motivation. The modes and their aspects can be seen in Table 3.5 below and were coded by using the detailed descriptions that were provided in Bayat and Kawalek's 2018 study, which are essentially the same as the descriptions that they published in their 2021 study, as explored in the literature review of this thesis. Observations of 4 out of the 5 aspects were coded for to investigate the role of the Canadian smart city in data governance; specifically, observations of Government Involvement were not collected due to the government-led nature of the Smart Cities Challenge.

Table 3.5. Data governance modes (Bayat & Kawalek, 2018).

	City as a Provider	*City as an Enabler*	*City as a Lab*	*City as a Smart Systen*
Data Considered as	**Public Good**	**Commodity**	**Concept**	**Feedback**
Government Involvement	**Low**	**Medium**	**High**	**High**
Organisational form	**Hierarchy**	**Market**	**Network**	**Hierarchy**
Stakeholder involvement	**Low**	**High**	**High**	**Low**
Motivation	**Transparency, Participatory governance**	**Monetising the value of the data**	**Co-Creation**	**Closed Governance with highly efficient execution.**

To investigate the city roles of the SCC finalists, each finalist was evaluated by the number of observations there were of the modal aspect values in their proposal (e.g. the value of the Provider mode and Motivation aspect is summarized as "transparency and participatory governance"). The count of values was summed per mode, and the mode with the highest count would determine the finalist's city role. There was only one tie that occurred with the 50M finalist Waterloo, for which the final judgement was based on the spread of aspect representation (i.e. the count was tied between the Provider mode and the Smart System mode, but the Smart System mode only had representation from two aspects compared to Provider which had counts in three aspects). During the analysis, it was determined that every finalist had a very high frequency count for the Lab mode of the Stakeholder Involvement aspect, valued "High", and thus it was only counted as 1 point for the Lab mode due to how much it skewed the results, as well as high stakeholder involvement being an approach that the SCC required as per the competition rubrics and guidelines. Beyond determining the roles of the finalists, the totals of values and totals of modes were also counted, as well as counting the evaluated finalists by their mode and their finalist category.

The frequency counting of decision domain activities and modal aspects will help build a better understanding of the direction of the decisions that Canadian smart cities are taking for their data governance. Certain data governance decisions may stand out and show that the SCC finalists are putting emphasis and effort into those decisions or highlight gaps in other decision domains. In categorizing the SCC finalists into data governance modes, the cities are determined to identify with some roles over others, or that they may play multiple roles with focuses on different aspects. This will be investigated in the Results and Discussion sections. Data visualizations of the frequency counting were created using Excel to support those sections.

Chapter 4
Results

The results are divided into observations made for the DG Model and for the BK Model.

4.1 DG results

There are five data governance decision domains that help identify categories of decision-making about an organization's data assets, and they are all interconnected. The framework's five decision domains are data principles, data quality, metadata, data access, and data lifecycle (Figure 2.1). The scope of each decision domain is described by activities, which summarize the types of decisions that are to be made for each domain (Table 3.2 and Table 3.3).

In addition to recording the decision domains activities in the finalists' proposals, each observation was assessed by the status of the described activities: if the observation was simply a mention of the data governance issue or concern, if the observation described proposed activities to address a data governance concern, or if the observation described existing activities that address data governance concerns. This distinction between these statuses of data governance activities was created to establish a better understanding of the finalists and the various stages of their work in developing data governance for their smart city projects. In Figure 4.1 below, the distribution of observations by decision domain and status can be seen. Appendix B includes a series of charts that show the distribution of observations by decision domain for each finalist.

There were 1231 observations for data governance, and all of the decision domains had observations. The results are broken down by the five data governance decision domains and present examples of each decision domain's activities and of each status from the finalists' proposals. This section will show which data governance activities the finalists already engage in by the number of observations, and to what extent.

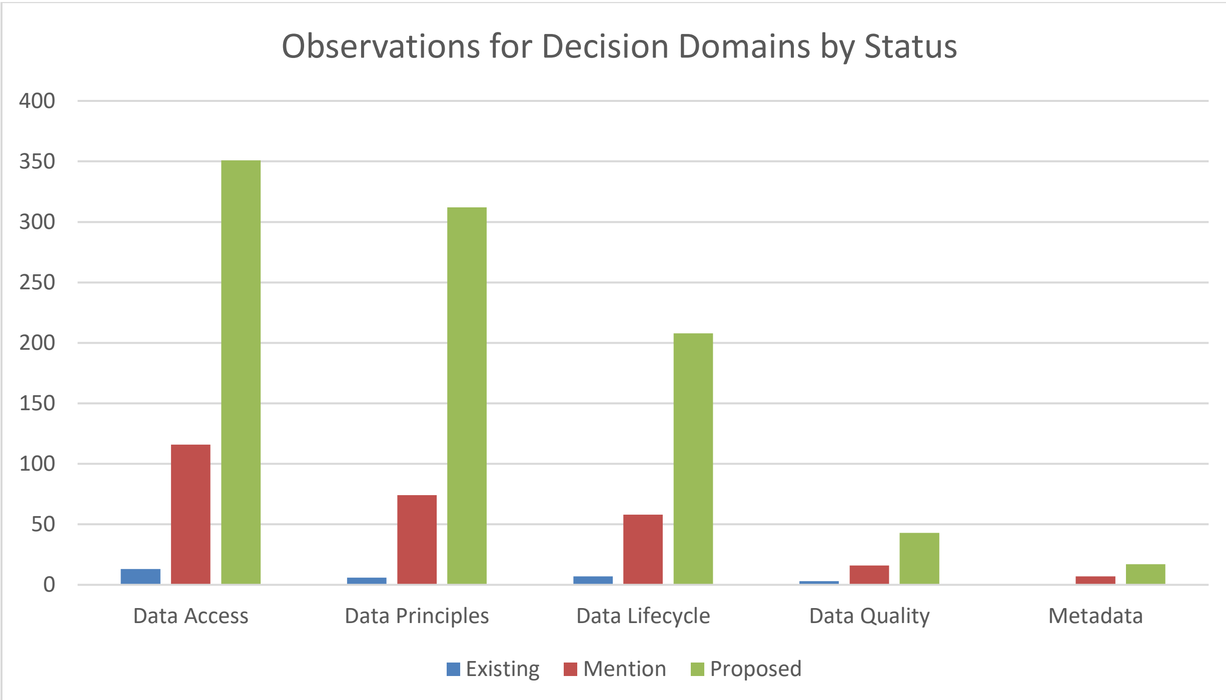


Figure 4.1. Observations for data governance decision domains by status.

4.1.1 Data Principles

The overarching decision domain is Data Principles (DP), which establishes the direction for the other decision domains (Khatri & Brown, 2010). Activities in the DP decision domain delineate the uses of data, including external data; establishes the extent to which data is an asset; fosters opportunities for sharing or reusing data, and guides policies and standards on appropriate handling of data (Khatri & Brown, 2010). More succinctly, the typical activities that outline or determine data principles include activities that describe the value of data, what the uses of data are, and if and how data is shared and reused.

The DP decision domain had the second highest overall count of observations at 392 (31.8%). Most of the observed DP activities are regarding the uses of data and value of data, such as with Eastmain, the finalist with the highest count of DP observations in the 5M category (Table 4.1). Eastmain uses and values its data for their Net Zero Energy program, which involves supporting decision-making and measuring indicators such as energy use and housing conditions for evaluating and improving well-being (5M ID 44, 46, 47). Eastmain's proposal describes the uses and values of the different data they will collect in great detail, including technical data to measure the performance of home construction and retrofitting to make adjustments for the future, social data to measure “success and suitability of the designs” as well as changes for the comfort and enjoyment of the occupants, and costing data to measure actual cost of construction to ultimately reduce cost of housing construction in Eastmain (49, 50).

Richmond is a 10M finalist with the highest count of DP observations of the 10M category and of all the finalists (Table 4.1), demonstrates their data principles in how data will be shared, in addition to describing the uses and values of data. Data is shared in their project through their Intelligent Operations Hub, Data Lake, and a Data Commons. The Intelligent Operations Hub enables the sharing of data from internal and external sources and between partners as a foundation for a West Coast disaster mitigation hub, wherein the data will be analyzed and shared to other organizations to support response plans and operational decisions on issues such as flooding and fuel spills (10M ID 420, 429, 432, 435, 445). The Data Lake is a data repository that will share data in a private version, for partners and other government bodies, and a public version, for consumption by the community; the Data Commons similarly shares data to facilitate research and act as a platform to share information on risk detection and mitigation (448, 461, 483). Both plans are enabled by data sharing agreements and user agreements that Richmond is developing, relying on the consent of other organizations and individuals (463, 473, 483).

Most of the DP activities are proposed activities, 312 out of 392, and Richmond and Edmonton tie for having the highest number of observations of proposed DP activities at 26 each (Table 4.2). Edmonton proposes how data will be used, valued, and shared in their Healthy City Ecosystem, and describes how the data and information collected and shared in the Healthy City program would be used for specific projects, mainly for the purpose of identifying service gaps and informing policy and program changes (50M ID 170, 204). Their proposal outlines both an Information Sharing Framework, which will “facilitate the sharing of anonymous data and information” in order to understand “the current state of data existence and completeness”, as well as Data Sharing Agreements with partners and stakeholders for specific projects, which defines how data is handled for the duration of those projects as well as how they are handled upon project completion (131, 160, 172). Richmond is also tied with Montreal for having the most observations of existing DP activities at 2 each (Table 4.2). In Montreal’s proposal, they describe how they already have a structuring framework established in 2015 by their Open Data Policy and Data Governance Directive that will be strengthened by this proposal (50M ID 265). Finally, Airdrie, a 10M finalist, has the highest count of mentioned DP activities, with 12 occurrences of expressing concerns about the DP decision domain (Table 4.2). Airdrie’s proposal mostly mentions how data could be valued as a measurement or indicator, for assessing their progress on health and well-being determinants and associated goals (10M ID 176, 184, 234). All cities have some observations on Data Principles.

4.1.2 Data Quality

The Data Quality (DQ) decision domain addresses the ability of data to satisfy its usage requirements, which helps define the multiple dimensions of data quality: accuracy, timeliness, completeness, and credibility (Khatri & Brown, 2010). The DQ decision domain activities address these dimensions as standards, define the fitness of use of data, and outlines the procedures for evaluating quality of data.

The DQ decision domain had the second lowest overall count at 62 observations (5%). With such a low overall count, DQ activities were mostly observed in the 10M and 50M finalist proposals, with the highest in those finalist categories being Saskatoon and Edmonton (Table 4.1). Saskatoon also has the highest proposed DQ activity count at 7, tying with 50M finalist Montreal (Table 4.2), mostly proposing activities for evaluating data quality, including the assessment of data for personally identifiable information or personally identifiable health information and removing that information from the data (10M ID 519, 522). A scheduled reporting and evaluation process "to ensure that data is accurate and timely" was also put forward in Saskatoon's proposal, and plans were described to create a committee that will be responsible for data governance, including "data quality improvement" (526, 534). Data quality activities are also proposed in Saskatoon's risk management chapter, and the proposal identifies processes that will help mitigate receiving and using data of poor quality (562).

Montreal proposes additional DQ decision domain activities to address standards of data that can affect data quality: for their mobility hub project to standardize a wide variety of data "for more direct use by all", to create and apply standardized APIs to facilitate standardization of data and interoperability, and to use known standards where possible as part of risk mitigation (50M ID 261, 290, 302). Edmonton also has the highest existing DQ activity count at 2 (Table 4.2), with their already developed Data Governance Roadmap, which includes work on "areas of data quality and standards" (50M ID 194). There are very few occurrences that are just mentions of DQ concerns or activities, with the single highest count by the 10M finalist Richmond at 3 observations (Table 4.2), where in their proposal they mention poor data quality as a part of risk assessment and how it could be mitigated through evaluating "good quality data sources" and having a "clear purpose" for data collection to only collect useful data (10M ID 439); Richmond also brings up standards of data quality for their Intelligent Operations Hub (451). Some finalists do not have any DQ activities described in their proposal (5M finalists: Akwesasne, Yellowknife; 10M finalists: Côte Saint-Luc, Airdrie).

4.1.3 Metadata

Metadata describes what the data is about and helps interpret the meaning of data (Khatri & Brown, 2010). The Metadata (MD) decision domain depends on the other decision domains in the intended use of data, the access to data, as well as data lifecycle management (Khatri & Brown, 2010). MD decision domain activities will support the retrieval and analysis of data, and includes documenting the semantics of data, standardizing metadata, and maintaining metadata.

The MD decision domain had the lowest overall count at 24 observations total (1.9%). The 10M finalist Saskatoon has the most examples by status and in total, with 2 mentions of MD and 5 proposed MD activities for a total of 7 MD observations (Table 4.1 and Table 4.2). Saskatoon's proposal mentions that metadata will be collected on service requests, and how the metadata can help "identify metrics associated with the system" and "determine services that are most in demand and those service requests that most often cannot be met" (10M ID 499). The proposal documents how data from Saskatoon's partners and different sources will be stored in the format they were provided, structured or unstructured, and that data will not be required to transform into a standardized, normalized model (506, 509, 513). There are no observations of existing MD activities, and 8 of the 20 finalists do not have any metadata activities in their proposals at all.

4.1.4 Data Access

The Data Access (DA) decision domain specifies the access requirements of data, which is based on assigning values to different categories of data (Khatri & Brown, 2010). Industry standards can guide the process of updating an organization's access policies and standards, which is driven by effective risk analysis to identify data needs (Khatri & Brown, 2010). Data access standards can be based on unacceptable data usage, auditability, privacy, and availability, and these standards can address issues of physical integrity and logical integrity (Khatri & Brown, 2010). DA decision domain activities are varied in breadth and depth, addressing data ownership, access standards and procedures, security, privacy, compliance monitoring, risk assessment, and backup and recovery of data.

The DA decision domain had the highest overall count of observations of all the decision domains at 480 (39%). DA activities that were frequently observed included privacy, security, access standards and procedures, and risk assessment, while activities for compliance monitoring and data ownership were less common. Eastmain, the finalist with the highest DA count for the 5M category (Table 4.1), demonstrates many activities for access standards and procedures in their proposal. Eastmain, officially the Cree Nation of Eastmain (CNE), identifies various stakeholders that have access to the data collected by the technologies of their NZE program, including builders, local tradespeople, HVAC contractors, building occupants, researchers, and the Housing Department, who all have varying levels of access to different types of data (5M ID 79). For example, the Housing Department "may have access to monitoring equipment and data collected including energy monitoring data, production data and will have access to material cost breakdowns" (79). The NZE program data collection system will communicate with a cloud-based server that can set custom access levels to the data, such as read/write to authorized personnel and read only access for open data sharing (81). Eastmain will also be implementing integrated management systems following ISO standards, including "ISO/IEC 27001 Information Security Management System (ISMS) for the protection and monitoring of CNE's information, data, privacy, security, and accessibility" (82, 102). In addition, there are processes for requesting access to information. Authorization for access to information by a third party can only be given in the form of a letter that "must set out the purpose of the access and the period of the access", and access to information requests by members of the CNE are received by the CNE administration offices and the appropriate department, and individuals may "access information pertaining to them to ensure its accuracy and make corrections" (103, 109).

Most of the finalists engage in many DA activities regarding privacy, including Côte Saint-Luc, the 10M finalist with the highest DA observations in the 10M category (Table 4.1). Côte Saint-Luc puts a lot of emphasis on privacy throughout their proposal and committed to a "Data Governance and Privacy Protection Policy" as well as a privacy expert on the governing board for their project, in order to "maintain data governance and privacy protection as a constant consideration throughout the execution, implementation and entire lifecycle of the project" (10M ID 73, 106). Côte Saint-Luc also consulted with Sharon Polsky, "President of the Privacy and Access Council of Canada, and a Privacy by Design Ambassador" to advise the city (10M ID 73, 107). This consultancy resulted in a "thorough assessment of the City's information protection and privacy compliance policies" and produced the PPIA as required by the SCC, submitted in the proposal's Confidential Annex (107, 109).

Meanwhile, Edmonton, the highest DA count 50M finalist (Table 4.1), shows some of the examples of data ownership, which is not observed as often as other DA activities. In their proposal, they promise to ensure that “data ownership remains within the jurisdiction of the community” and with appropriate project partners (50M ID 150). The city recognizes the community’s need for data ownership and protection of sensitive data, and thus have a Data and Privacy Advisory Group to ensure that the community is “consulted and collaborated with on an ongoing basis regarding data and privacy” (185). In addition, Edmonton declared that data ownership will not be transferred from the “primary owner and steward of that data” for the Healthy City program, although data may be shared under a formalized data sharing agreement (185).

There are more proposed DA activities than existing or mentioned DA activities (Figure 4.1), and all of the previous examples are proposed DA activities. The finalist with the highest overall observation count for proposed DA activities is the 50M finalist Quebec City (Table 4.2), who has similar DA activities encompassing privacy, security, and the like. Existing DA activities tend to be about privacy and security, as Richmond, the 10M finalist with the overall highest existing DA activity count (Table 4.2), describes in their proposal how they designed their data flow with a security-by-design approach to “exclude the collection and transfer of personal data”, as well as engaging with stakeholders to “ensure protection of personal data and the security of City systems” (10M ID 415, 417). Richmond also has an existing MyRichmond web portal with a PIA that was included in their Confidential Annex to support the PPIA of their project for the SCC (478). The DA activities or concerns that are typically mentioned in the proposals are about privacy, like the mentions in Côte Saint-Luc’s proposal on how privacy is a “constant consideration” throughout the “entire lifecycle of the project” (10M ID 106); Côte Saint-Luc had the highest number of mentions of DA activities (Table 4.1). All cities have some observations on Data Access.

4.1.5 Data Lifecycle

The Data Lifecycle (DL) decision domain is also critical to the process of designing data governance, as all data have a life cycle (Khatri & Brown, 2010). To understand the uses of data is to understand its collection and storage requirements, as well as best practices for storing different types of data (Khatri & Brown, 2010). When data is appropriately stored, data distribution can be more effective and reduce costs, and the retention and archival of data can achieve compliance with legislation (Khatri & Brown, 2010). DL decision domain activities include defining data, producing or collecting data, and data retention, retirement, and archival.

The DL decision domain sits in the middle of the pack at 273 counted observations (22.2%). All cities have some observations on DL. The 5M finalist with the highest DL count is Eastmain (Table 4.1), and most of them describe the different types of quantitative and qualitative data that will be collected to monitor and evaluate the progress of their net zero energy program and the technologies used to collect that data (5M ID 53, 69, 74, 76). This includes surveys and group meetings to collect information on occupants' satisfaction with the NZE home designs and retrofits, and relative humidity and CO2 sensors to collect data on hygrothermal conditions, and smart meters and thermostats to measure energy consumption and temperature control (55, 59, 61, 66, 68, 72). Eastmain also has an excellent example of a consideration for data retention, retirement, and archival in their Data & Privacy Chapter, where the proposal explicitly presents the personal information that will be collected, used, and retained, and it is broadly stated that "information collected for the purposes of administering the housing program is held for the duration of the housing project (i.e. until final payment) or until it is no longer relevant (such as a change of occupant)", and that one of the research partners, McGill University, "may retain information for up to 20 years under its policies" (89, 100).

Montreal is the 50M finalist with the overall highest number of mentions of DL activities at 10 observations (Table 4.2), and they mention in their proposal that both quantitative and qualitative data will be collected and hosted for their project through their proposed mobility data hub and social data hub (50M ID 224, 227). As the finalist with the highest DL count for the 50M category at 24 observations, Montreal also intends to retain collected data, but plans to design projects with integrated "personal information withdrawal mechanisms, such as depersonalization or data disposal", and understands that "where data cannot be depersonalized satisfactorily, approval from the relevant governance bodies will be required, as well as the implementation of mitigation measures including post-use destruction" (280, 281).

The 10M finalist with the highest DL count at 27 observations was Richmond, which also had the overall highest number of proposed and existing DL activities at 20 and 2 respectively (Table 4.1, Table 4.2). Richmond proposes a platform like Montreal's data hubs, called the Intelligent Operations Hub, where collected data will be sent and the City and partner agencies can "quickly analyze collected information and use it to make timely and effective decisions" (10M ID 404, 449). Data will be collected from "[c]ity systems, smart sensors and cameras, business applications, external systems and partner organizations" in Richmond's Multi Partner Sensor Network, "a network of smart infrastructure that collects, connects, and centralizes raw data across asset types and partners" (405, 419). Ultimately, the data from these sources and entities will be "collected, transmitted, integrated and processed to create meaningful information that supports integrated operations, emergency response, traffic management and integrated communication" (479). In previous work with a proof-of-concept, Richmond demonstrated their experience by collecting and combining traffic sensor data and crash data to produce visualizations and predictive analysis, and to predict traffic incidents (453).

Table 4.1. Finalists with the most observations per prize category and decision domain.

		Decision Domain				
		DP	**DL**	**DA**	**MD**	**DQ**
Prize Category	**5M**	Eastmain (22)	Eastmain (22)	Eastmain (23)	Bridgewater (2)	Biigtigong / Bridgewater (4)
	10M	Richmond (33)	Richmond (27)	Côte Saint-Luc (31)	Saskatoon (7)	Saskatoon (7)
	50M	Edmonton / Montreal (29)	Montreal (24)	Edmonton (42)	Waterloo / Montreal (2)	Edmonton (10)

Table 4.2. Finalists with the most observations per status and decision domain.

		Decision Domain				
		DP	**DL**	**DA**	**MD**	**DQ**
Status	**Mention**	Airdrie (12)	Montreal (10)	Côte Saint-Luc (13)	Saskatoon (2)	Richmond (3)
	Proposed	Richmond / Edmonton (26)	Richmond (20)	Quebec (29)	Saskatoon (5)	Saskatoon / Montreal (7)
	Existing	Richmond / Montreal (2)	Richmond / Guelph (2)	Richmond (3)	N/A	Edmonton (2)

4.2 BK results

There are four city roles in the model of data governance modes of smart cities, as presented by Bayat and Kawalek (2018): City as a Provider, City as an Enabler, City as a Lab, and City as a Smart System. These roles are described in the model using five aspects: Data considered as (DCA), Government Involvement (GI), Organizational Form (OF), Stakeholder Involvement (SI), Motivation (MO). Data on 4 of the 5 aspects of this model were collected for analysis; observations of GI was not collected due to the government-led nature of the SCC. This results section will describe the city roles by the remaining four aspects and consider how the finalists and their proposals fit into each of the four city roles.

In total, 5 finalists were identified as Providers, only one as an Enabler, 14 finalists as Labs, and no finalists for Smart Systems. This can be seen below in Figure 4.2, and Table 4.3 labels each finalist by their evaluated role. Appendix B includes a series of charts that shows each finalist and the observation count for each modal aspect. Figure 4.3 further shows the total number of observations by role and aspect.

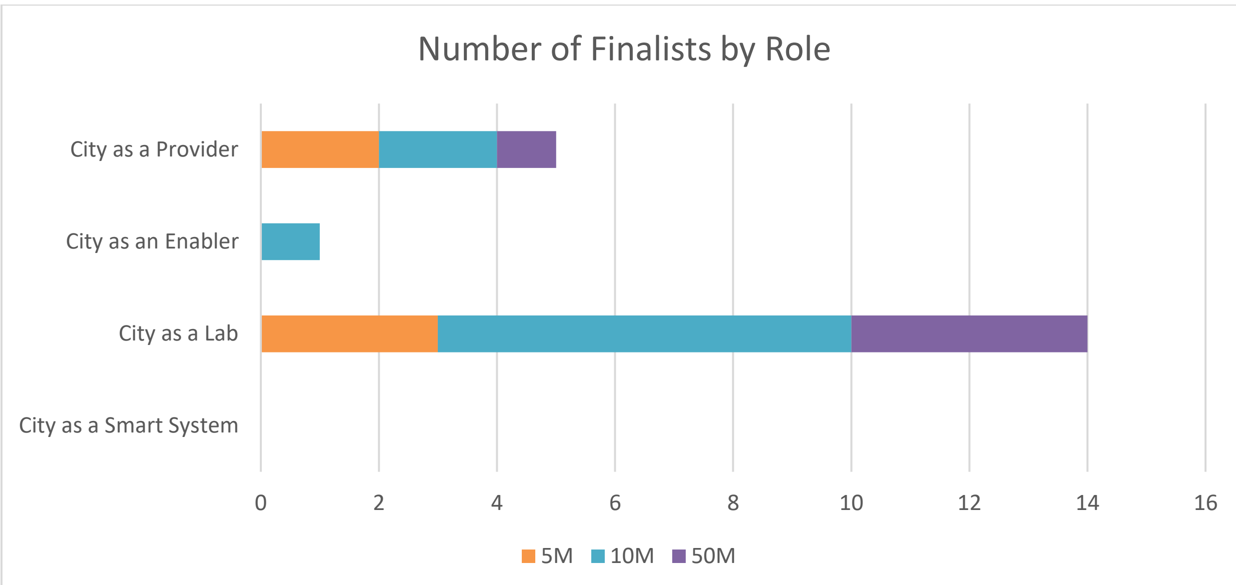


Figure 4.2. Number of finalists by role.

Table 4.3. The SCC finalists and their roles.

Prize Category	Finalist	BK Role
5M	Biigtigong	Provider
	Eastmain	Provider
	Bridgewater	Lab
	Akwesasne	Lab
	Yellowknife	Lab
10M	Manitoba	Lab
	Côte Saint-Luc	Provider
	Nunavut	Lab
	Fredericton	Lab
	Parkland	Enabler
	Airdrie	Lab
	Richmond	Lab
	Guelph	Provider
	Saskatoon	Lab
	Victoria	Lab
50M	Waterloo	Provider
	Quebec	Lab
	Edmonton	Lab
	Vancouver	Lab
	Montreal	Lab

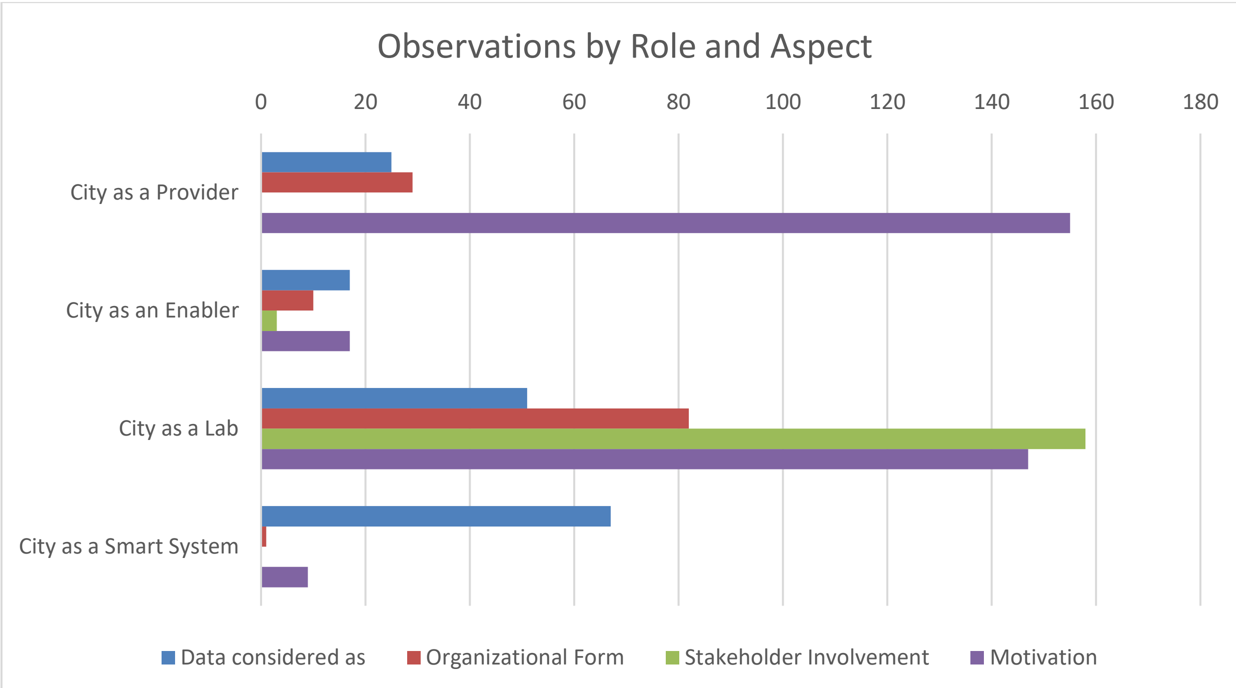


Figure 4.3. Number of observations by role and aspect.

4.2.1 Provider

Cities that have the role of Provider consider data to be a public good, which means that data is provided without profit to citizens for their benefit, and access to data is a right. In this role, the city is the provider of data, and has little involvement other than controlling the type of content released and its identifiability and imposing minimal control over others' use of the data, such as with open data. They maintain their control of the data in a hierarchical, unidirectional manner, and thus stakeholder involvement tends to be low. The motivations of Provider cities stem in transparency and accountability, as well as for the promotion of participation and participatory governance.

Out of 771 total observations, Provider had the second highest count at 209 observations (27%). Of the 20 finalists in the SCC, 5 were determined to be Providers (25%), with 2 from the 5M category, 2 from the 10M category, and 1 from the 50M category (Figure 4.2, Table 4.3).

Providers often consider data to be a public good, such as with the 10M finalist Guelph: their proposal described their data as a "public Data Utility" and compared this concept to public utilities of core infrastructure services like electricity and water, and also describe that the core proposition of their project is that "access to public data is a service provided to the community" (10M ID 184). The highest count of observations for the Provider DCA was by 10M finalist Fredericton at 9 observations, and although they were determined to be a Lab, the city described in their proposal in several instances that their data was considered as a public good through their Digital Community Hub project. The Digital Community Hub would "combine aggregate data from shared data platforms and disparate data systems to create a multi-level hub – creating rich, open data on and for our community, opportunities for unique collaborations on issues that matter to residents, as well as personalized access to what matters most to people." (10M ID 61). Many of the finalists mentioned that they considered data to be a public good (11 of 20).

The Organizational Form of Providers tends to be a hierarchy, and this can be clearly seen in the 50M finalist Waterloo's proposal, where not only is their governance structure composed of tiered sub-committees, each with different levels of oversight and strategic direction, but more importantly that they will "develop policies, procedures and protocols that outline appropriate levels of authorized access to the data and information being included" through their SWR Data Collaborative (50M ID 15). SI for Providers is described to be low, but this was not true for the SCC finalists, as there were no observations of low SI.

The greatest number of Provider-type observations are from MO, of which there are 155, and the highest count for the Provider MO by a single finalist is 18, by 10M Provider finalist Guelph. Guelph's finalist proposal describes in multiple instances that transparency and participatory governance is important to their project, specifically that there would be transparent access to data through their Data Utility (10M ID 143, 194), so that decision-making processes could be transparent (162), and the governance strategy of Guelph's project would be open, inclusive, and driven by a core set of principles, including transparency, accountability, and strengthening democratic participation (164, 166, 189).

4.2.2 Enabler

Cities that play the role of Enabler consider data to be a commodity, something of economic value because they were gathered by the government at taxpayers' expense. Involvement from the government is not insubstantial (medium), as the government is an important holder of city data, and the city may become the designer or host of a unified data marketplace. The organizational form is that of a market, a multidirectional exchange between data suppliers and data consumers. Stakeholder involvement is high, as there are many different stakeholders that have data important to the city, including private sector, universities, and other organizations, and the stakeholders can exchange data on the market. The ultimate motivation of the Enabler is to monetize the value of data, as there is an underlying belief that government-gathered data should not be used by businesses free of charge. The data marketplace would facilitate more efficient uses of data and help realize the optimal value of data, as it has the potential to lead to more data-driven innovations and ultimately economic growth.

Very few of the SCC finalists demonstrated traits or intentions that resembled that of an Enabler. Across the four city roles, Enabler had the lowest count of observations at 47, and only one of the 20 finalists were identified for the Enabler role: Parkland (Table 4.3). Parkland's proposal described how they considered data to be a commodity in many ways, namely as a "second crop" or "new crop" for the farmers to profit from, and as a "new enterprise currency" (10M ID 234, 238, 244, 257, 264). They also use the term "evergreen crop" to describe how the data can be combined with other data to then generate more data (234). Parkland's motivations also lie in monetizing the value of data, as they describe it as one of the main goals of their Agora Data Trust and marketplace business model, to capitalize on data that "many commercial enterprises already exploit" (241), to "add value to the data" (250) and to "enable farmers, and all rural residents, to improve their operations and monetize data" (250). Because the "data collected from farm and business operations would be monetized and deliver value" (255), the financial benefits are direct and circular, as the participation of AGora farms and local businesses is incentivized and would lead to enhancing the value of the data collected and increasing revenue (280). Their beliefs behind their motivations are that "financial wealth should increase social resilience and collective investment in environmental sustainability – a much larger virtuous circle that underpins prosperity overall" (280) and that "data collected by the private sector and governments underpins decision-making and boosts economic productivity and competitiveness" (284). The OF presented in Parkland's proposal is mentioned several times to be a market through the AGora Data Trust and demonstrates a high level of SI due to this structure, as the AGora Data Trust acts as a broker to data "on behalf of the farmers, businesses and others that maintain and provide data to it" (265).

While the 10M finalist Guelph was ultimately determined to be a Provider, it was the closest runner-up to Parkland for Enabler traits, as Guelph had at least one Enabler-type observation for each aspect. This can be seen in their proposal for potential revenue models for their Data Utility project, which includes a description of the government charging a "transaction cost from users" of the Data Utility, like fees for services, which commodifies and monetizes the value of the data (10M ID 192, 193).

4.2.3 Lab

Cities that play the role of Lab consider data to be more conceptual, as a resource that can be developed into valuable innovations. The level of government involvement for Labs is high because the city defines its research agenda and is the creator of the research lab or network. As a Lab, the city government is proactive and designs and maintains its data ecosystem. With a network being a Lab's organizational form, there is a combination of collaborations and partnerships with different data providers and users of data in a closed or semi-closed environment, and thus stakeholder involvement tends to be high due to these strong relationships. Labs are motivated by co-creation, using their research agenda to turn the resource of data into valuable innovations through collaborative work with their research partners.

With the highest overall count across all of the city roles, Lab had most of the observations from the SCC finalists' proposals, totalling 438 observations (57%). 14 of the 20 finalists were identified for the Lab role (70%), which was comprised of 3 of 5 5M finalists, 7 of 10 10M finalists, and 4 of 5 50M finalists (Figure 4.2, Table 4.3). The finalists identified strongly as Labs, and several identified with Provider as a secondary role, mostly for the aspect of Motivation (Figure 4.3). The 10M finalist Victoria is an excellent example of a city in the Lab role, with every aspect evaluated as the Lab-type overall.

Labs consider data as a concept, and Edmonton is the finalist with the highest number of Lab observations for this aspect at 7. Edmonton, a 50M finalist, describes data as a concept through how it can be leveraged to "understand the challenges in the community and create sustainable solutions" as well as "influence the development of policies, programs, services, and innovative funding models" (50M ID 72, 79). By working with their partners and stakeholders, Edmonton can leverage data in a way that "enhances services, stimulates economic opportunities, encourages innovation and unlocks new social values" (119). Edmonton is closely followed by 10M finalists Victoria and Fredericton who both had 6 observations for data as a concept.

Edmonton also has the highest count of observations for the Lab OF, network, at 12, followed by 10 observations by both 10M finalists Victoria and Richmond. Edmonton describes their Lab OF as a network of partners, including "residents, other levels of government, community organizations, educational institutions and businesses" (50M ID 80, 71). Edmonton's Healthy City Ecosystem and their Digital Innovation Collective show how collections of partnerships, collaborations with the community, groups of stakeholders working together with the city as the leader can define the goals and guiding principles, identify gaps, and enhance the development and delivery of municipal programs and services (87, 89, 95).

The highest number of Lab observations for SI is by Victoria at 13 observations, although many other finalists had similarly high counts. Stakeholder involvement for Labs is high because of both the breadth and depth of partnerships they develop with other departments, organizations, and companies, and this can be seen in Victoria's network of 117 partners, which includes "13 funding partners, six program partners, 14 funded development and research partners and 84 collaborative partners" (10M ID 363). The SIPP's Partners Committee drives the guidance and participation in decision-making as a connection between stakeholders (399). Victoria's data trust project similarly demonstrates the involvement of stakeholders as they provide "governance, decision-making and oversight on critical issues regarding the management of data" and to extend control over data to the users from which it is gathered (10M ID 405).

The motivation of Labs is rooted in innovation through co-creation, and 50M finalist Montreal is a great example, as the basis of their proposal is about innovations on their processes and governance, driven by the desire for co-creation and collaboration with stakeholders, citizens, and the community (50M ID 127, 157, 158, 160). This is demonstrated in their mobility projects and their Civic Innovation Lab for Regulatory Testing, as they bring together experts, citizens, and other actors to explore and redefine municipal regulations to better meet the needs and realities of communities and foster local innovation in a collaborative approach (138, 152, 162, 164).

4.2.4 Smart System

Cities that play the role of a Smart System consider data to be feedback, such as when data is presented in city dashboards for real-time monitoring and response. The ongoing analysis of data for optimization and management of the city considers data as feedback, pushing data through an automated system and its algorithms to provide decision-making for management of the city. Government involvement for Smart Systems is high due to the government's development and application of regulated algorithms, as well as implementation of monitoring systems controlled by or on behalf of the government. The organizational form is a hierarchy, with centralized silos and a closed hierarchical arrangement for the control and application of data and algorithms. Stakeholder involvement is low, as the governance structure is closed in order to control and maintain data quality for its algorithms and processes. The motivation of Smart System cities is to achieve a highly efficient execution of its processes using a closed governance structure, monitoring city environments in real-time and analyzing and learning from the feedback for optimization of the city's infrastructural behaviour.

Observations of the Smart System role have the second lowest count of the four roles, at 77 observations (10%). None of the finalists were determined to play the role of a Smart System (SS), although most cities had at least one observation for the SS-type of data, which is feedback. An example of this is by Waterloo, a 50M Provider finalist, as they describe their data as a source of evidence for decision-making and "identification of trends, impacts, and progress towards targets", specifically "quantitative and qualitative data related to the well-being of children and youth" (50M ID 3, 11). Waterloo's Data Collaborative uses data as feedback and aims to allow the community to "track and monitor the well-being of children and youth" over time through the use of a Dashboard, which would provide a "visual output" of data and build an understanding of "how local children and youth are faring compared to the rest of the country" (13, 18, 27).

The other aspects do not have many SS-type observations, although Waterloo does demonstrate some motivation for closed governance involving detailed monitoring of progress of youth and child well-being, and ongoing processes of "defin[ing] relevant gaps, needs and challenges generally and regionally, and see relationships and trends", and "learn[ing] from available data and make decisions that address the complex issues of child and youth well-being" (50M ID 21). There is also one occurrence of Richmond, a 10M Lab finalist, that mentioned a hierarchical style of organization like centralized data silos, using their Multi-Partner Sensor Network to "centraliz[e] raw data across asset types and partners" (10M ID 302).

Chapter 5
Discussion

This study collected and analyzed data on the 20 finalists of the Smart Cities Challenge (SCC) and content analysis was conducted on the finalists' proposals following the theoretical frameworks presented by Khatri and Brown (2010) and Bayat and Kawalek (2018). The discussion will present a review of how the applicant and finalist guides of the SCC may have influenced the finalists on their role in their proposed smart city projects and their data governance strategies. Then, it will discuss how those roles and data governance activities can be explained by the emphasis on open and collaborative approaches to the development of smart city data governance in media reports and academic literature.

5.1 SCC Guides Discussion

This part of the discussion will review how the applicant and finalist guides of the SCC may have influenced the finalists on their role in their smart city projects and their data governance strategies as described in their proposals. The two guides provided the evaluation criteria and rubrics that the jury evaluated the applications and finalist proposals against, and thus have meaningful impact on the presentation and content of the finalist proposals and the selection of finalists and winners.

5.1.1 DG findings

5.1.1.1 Most observations from the candidate proposals fit the Data Access, Data Principles, and Data Lifecycle decision domains

The majority of the observations from the finalists' proposals fall into three of the five decision domains, in descending order: data access (DA), data principles (DP), and data lifecycle (DL). Smart city data governance strategies in the finalists' proposals are focused on activities from these decision domains, such as privacy, security, uses of data, value of data, sharing of data, and defining and collecting of data. Both the SCC applicant guide and finalist guide focused on these decision domains and activities in their evaluation criteria, driven by an overarching smart cities approach, which is a requirement of the challenge for communities to follow in their initial applications and final proposals.

5.1.1.1.1 The smart cities approach

The smart cities approach has four underlying principles of openness, integration, transferability, and collaboration, and there are many data governance activities that the finalists used to demonstrate those principles in their proposals in the DP, DA, and DL decision domains. The principles of the smart cities approach explicitly calls for communities to make their data open, accessible, and usable to citizens, public organizations, partners, and other communities, to achieve transparency, break down barriers and improve relationships between stakeholders. To answer this call, finalists have identified the uses (DP) and value of data (DP) to make their data usable to others, defined the data (DL) to be produced or collected (DL), and engaged in various DA activities to make the data open and accessible. The DA activities include establishing access standards and procedures, privacy and security considerations, compliance monitoring, and risk assessment. The smart cities approach also strongly implies the sharing of data between institutions, communities, partners, and other stakeholders, and as the finalists define how and why they share and reuse of data (DP), they also reinforce how they address DA concerns with activities like privacy and security considerations, and occasionally discuss the retirement and archiving of data (DL).

5.1.1.1.2 The applicant guide

The applicant guide specifically asked questions for the preliminary proposal that would lead applicants to describe activities that support DA, DP, and DL decisions. The first few questions of the preliminary proposal are on problem definition, and specifically questions 3 and 4 ask the applicant to define their Challenge Statement and elaborate on the outcomes posed in the Challenge Statement. The applicants are asked to identify and justify their goals, supported by baseline data and evidence for their chosen metrics, and provide rationale for the application of the smart city approach to those outcomes. By asking applicants to describe their strategy for measuring progress and achievement of outcomes, the applicant guide prompts applicants to determine the uses and values of data (DP), as well as how data is defined and collected (DL). Applicants are asked to describe their preliminary proposal in question 6, and the evaluation criteria outlines expectations for scope and size of the proposal outcomes, to make the applicant consider how their problem and outcomes can be measurable by defining and collecting data (DL) to be used to form a baseline for measuring progress (DP). The evaluation criteria also outlined how a successful proposal would be open, interoperable, scalable, and replicable, and specifically describes that the preliminary proposal should incorporate open standards, built in such a way to prevent vendor lock-in, allowing the community and other Canadian communities to leverage the data for other uses and purposes through open data and in-house analytics. These criteria should prompt the applicant to consider how they and others might use and value the data (DP), as well as how the data might be shared (DP), and the measures that they may have to take to maintain data ownership and data sovereignty (DA). Another question asks the applicant to identify existing or potential partnerships, which, while not specifically addressing the partners' access to data, may prompt the applicant to consider access standards and procedures, privacy and security, and risk assessment (DA).

5.1.1.1.3 The finalist guide

The finalist guide is more direct in its requirements for data governance activities in the DA, DP, and DL decision domains. Section 5 of the finalist guide outlined the requirements of the final proposal, which was the main component for evaluation for the SCC. The guide provided evaluation criteria for the executive summary and each of the nine predefined chapters: Vision, Performance Measurement, Project Management, Technology, Governance, Engagement, Data & Privacy, Financial, and Implementation Phase Requirements. Many of the chapters directly required DA, DP, and DL activities, with some chapters representing one decision domain more than others. An excellent example of this is in the chapters and appendices dictating the requirements for Technology and Data & Privacy: the DA decision domain is best represented, with more required DA activities than other activities in those sections. The DP and DL decision domains are better represented in the chapters and appendices for Vision and Performance Measurement, with an equal number of activities between both decision domains, and more of those activities required than other decision domains. This distribution of DA, DP, and DL activities is replicated and amplified in the finalist proposals. The greatest number of DA activities in the finalists' proposals are found in the Data & Privacy and Technology chapters and easily surpass other decision domain activities in those chapters. The DP decision domain leads the Vision chapter by over twofold compared to the other decision domains and follows closely behind the DL decision domain in the Performance Measurement chapter, while DL activities maintain second or third place behind the DP and DA decision domains. The finalist guide's influence on data governance activities in the final proposals is made obvious when comparing the number of occurrences of DA, DP, and DL activities between the finalist guide and the final proposals (Figure 5.1, Figure 5.2). The finalist guide has met its intended purpose in guiding the finalists in their smart cities approach for the development and composition of data governance activities in their smart city proposals.

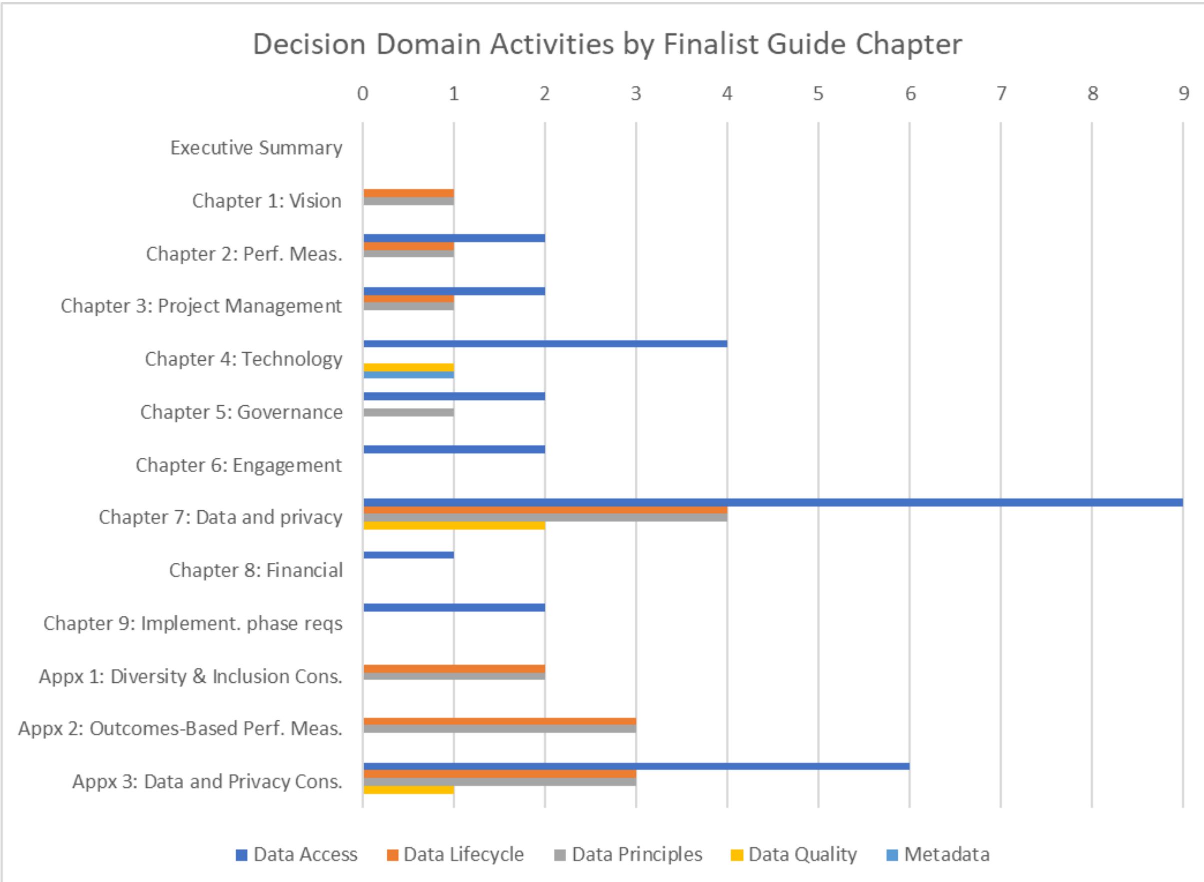


Figure 5.1. Decision domain activities by finalist guide chapter.

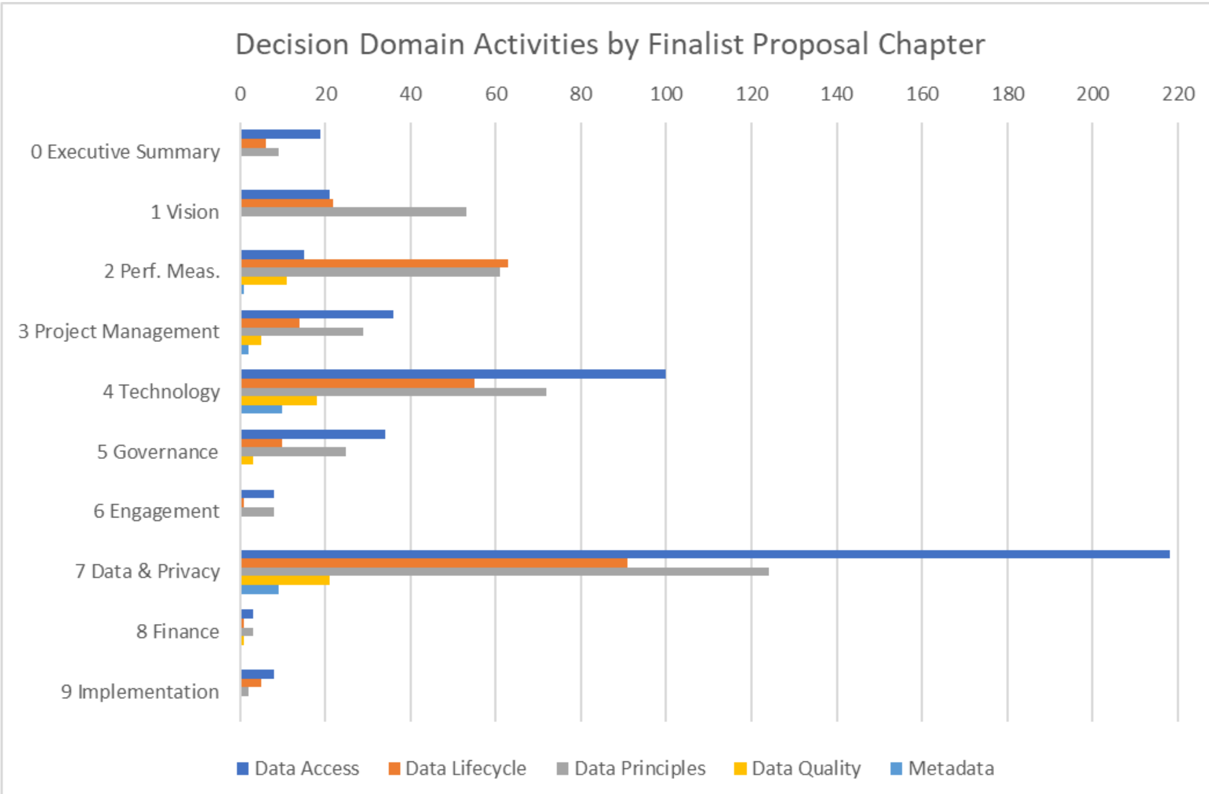


Figure 5.2. Decision domain activities by finalist proposal chapter.

Notably, a major contributor to the amount of required DA activities comes from risk assessment. Appendix 4 of the finalist guide is titled the Consolidated Requirements and Evaluation Criteria, which includes point distribution and rubrics for each chapter's Evaluation Criteria section. While not much is added to the original text from Section 5's requirement breakdown earlier in the finalist guide, Appendix 4 places more emphasis to risk strategies related to each chapter, dedicating a rubric and 5 points of almost every chapter's point total to risk assessment and mitigation. This renewed emphasis on risk assessment and mitigation has likely influenced the finalists to reiterate discussions on risk associated with data (as a DA activity), even in chapters where data-related risks are not the main concern.

It is also important to note that there are potentially many data governance activities hidden in the confidential annex of each final proposal, if the finalist chose to submit one, as the confidential annex was an optional additional document that the finalist could provide for details that could not be published on the Infrastructure Canada website and viewed publicly. As such, the confidential annex prevents the counting of any data governance activities that may be described within it. Based on the finalists' descriptions of their confidential annexes, however, it is safe to assume that there would potentially be a higher DA count if the confidential annex of each proposal could be accessed for analysis.

5.1.1.2 Few observations for Metadata and Data Quality decision domains

In contrast to the many observations for the data principles, data access, and data lifecycle decision domains, the other two decision domains of metadata (MD) and data quality (DQ) have very few observations. These two decision domains appear to be neglected in the finalists' proposals, as well as in the requirements presented by the applicant and finalist guides of the SCC. Even within the smart cities approach as defined by the SCC, the data quality and metadata decision domains are not explicitly addressed within the four underlying principles of the approach (openness, integration, transferability, collaboration), and indeed it is hard to read between the lines for any implications for data quality or metadata activities.

5.1.1.2.1 The smart cities approach

In the first principle of the smart cities approach, openness, having "usable" data might imply some evaluation for data quality and fitness of use (DQ), but it is harder to extrapolate and apply the principles to the DQ and MD decision domains compared to the other three decision domains. The integration principle to break down silos within organizations and the transferability principle to use standardized tools and technological approaches may lend to activities in metadata standards (MD) and data quality standards (DQ).

5.1.1.2.2 The applicant guide

There is no further content that may introduce other potential MD and DQ activities in the applicant guide outside of what is mentioned in the smart cities approach. While this makes sense for the applicant guide as the smart city projects are in the earliest stages of development, the low level of interest for MD and DQ activities is reflected in the finalist guide as well, and ultimately the final proposals.

5.1.1.2.3 The finalist guide

The finalist guide has more requirements and goes into greater detail on evaluation criteria than the applicant guide and dedicates an entire chapter on Data & Privacy. However, even with the chapter on Data & Privacy and a separate Appendix on Data & Privacy Considerations, there are only 4 occurrences of DQ activities and 1 occurrence of a MD activity in the entire finalist guide (not counting text repeated in Appendix 4). The requirements of the Technology chapter imply the need for data quality and metadata standards, while the Data & Privacy requirements seek more breadth from the finalists with evaluating data quality and assessing fitness of use. The lack of MD and DQ requirements in the finalist guide indicate only a perfunctory need for such activities, and this is reflected in the finalists' proposals. With DQ and MD activities accounting for less than 7% of the total number of data governance observations and half of the finalists having no observations for either or both the DQ or MD decision domains, it shows that the dearth of DQ and MD activities throughout the evaluation criteria have impacted the finalists' proposals to the point where finalists fail to mention or address the MD and DQ decision domain at all. While it is possible there are some MD and DQ details hidden in the Confidential Annex of the finalist proposals, the few observations for MD and DQ activities in the finalists' proposals makes it seem unlikely that the finalists would extend any consideration for those activities into the Confidential Annex.

5.1.1.3 Most activities are proposed

Most of the data governance activities observed from the finalists' proposals are proposed activities. The SCC asked the finalists to describe the outcomes of their smart city projects and how their plans for action would achieve those outcomes, and so the finalists provided detailed descriptions on what they planned to do but had not yet done. Often, the finalists repeated their proposed data governance activities throughout the proposal to emphasize how they addressed specific evaluation criteria across multiple chapters. The finalist proposals are demonstrations of project readiness and feasibility, most of the data governance activities discussed in the proposals are exactly that, proposed. As each of the 20 finalists received a $250,000 grant to help create pilot implementations of their smart city projects and to help develop their final proposal, and some finalists' projects have been in development since before the SCC, some data governance activities may already exist and be in place. However, most observations show how the proposals represent the finalists in the planning stage, and that the selected winners would be able to move onto the implementation phase.

While some finalists may have had existing policies for data governance, there may not have been enough detail to be counted as an existing or proposed activity and was instead counted as a mentioned activity. Additionally, existing activities may not have been described frequently enough to record many observations, or the finalist may have chosen to not include or repeat them in their proposal. Mentioned data governance activities are also few in number, most likely because it was more important for the finalist to describe what decisions they would make for their data governance strategies to adequately address the requirements posed by the SCC guides, instead of simply stating that some data governance decision was important or of concern.

5.1.2 BK findings

5.1.2.1 Most cities evaluated as Labs and Providers

The results of the study have shown that the roles that Canadian smart cities play are mainly those of Labs and Providers, based on the Data Governance Modes of the BK Model. The Lab mode is best described by the city's motivation for co-creation, for the purposes of conducting research and innovation with partners to address specific issues, through the development of a network of stakeholders, including public sector, private sector, and citizens, that are highly involved in the processes. The Provider mode can be described by how cities value data as a public good, service, or other resource, often making data available to the public as part of an open data initiative in pursuit of transparency, accountability, and a form of participatory governance in their data governance policies.

5.1.2.1.1 The smart cities approach

Both of the SCC guides and the underlying smart cities approach have supported the characteristics of the Lab and Provider roles. The smart cities approach, as previously described, has four principles of openness, integration, transferability, and collaboration. The principle of openness directly supported the Provider role through the promotion of transparency and valuing data as a public good, while also placing value on the Lab organizational form of networks and a high level of stakeholder involvement, through the strengthening of relationships between residents and public organizations. The principle of integration implicitly supported the Lab aspects of the network organizational form as well as the motivation of co-creation in the breaking down of silos within local governments and public organizations. The transferability principle explicitly identifies transparency as a motivation, promoting Provider values including that of valuing data as a public good. Finally, the collaboration principle seems to be more supportive of co-creation and innovating to deliver common objectives together, through networking, partnerships, and also a high level of stakeholder involvement.

5.1.2.1.2 The applicant guide

The language of the applicant guide is mostly suggestive of observations for Lab aspects, with 22 observations almost evenly divided between the co-creation motivation, network organizational form, and high stakeholder involvement. While clearly supportive of the Lab approach to data governance, the applicant guide also had many observations for Provider, with 10 observations just for transparency as motivation. Within the applicant guide, the SCC demonstrated that they wanted applicants to discuss how they would place value on the aspects of the Lab and Provider roles, and little to none of the Smart System (1) or Enabler (0) roles. In the section in the applicant guide on the preliminary proposal, several of the questions appear to address or support specific modes or modal aspects. In question 5, applicants are asked to describe how their residents have been engaged with to shape the challenge statement, detailing an expectation of high stakeholder involvement and working transparency with the residents. Question 6 also pushes for transparency as it expects applicants to make their proposals open and shareable to be replicable for other communities across Canada and to have broader impact, in addition to treating data and associated technologies as public goods. Question 8 asks the applicant to describe their organizational structure, processes, and practises but the requirements do not describe or support any one form in particular, although the guide does mention both the Provider-style hierarchy and Lab-style network as examples. In question 10, the applicants are asked to describe the involvement of partners and their contribution to the execution of projects, and the tips and evaluation criteria places value specifically in high level of involvement from a network of diverse types of partners, and how they might potentially co-create with the applicant or otherwise contribute. Other questions in the applicant guide like questions 11 and 13 repeat that one of the goals of the SCC is to "encourage as much transparency as possible", making each proposal's motivation for transparency clear and obvious.

5.1.2.1.3 The finalist guide

The finalist guide does not differ too much from the applicant guide in its requirements and expectations by way of the BK model mode distribution, with mostly Lab and Provider observations. The finalist guide had 23 Lab observations, with a prioritization of a high level of stakeholder involvement as the Lab aspect was observed in almost every section and in the requirements of every chapter. Of lesser importance was the network organizational form and the co-creation motivation, both of which were implied instead of outright mentioned. The 12 Provider observations were almost entirely for the transparency motivation, scattered throughout the guide but also concentrated in the requirements for the chapter on Data & Privacy and Confidential Annex. There were also 6 observations for the Smart System role, all of which were valuing data as feedback. For the few Smart System observations there were, they were all for considering data as feedback, occurring mostly in the Vision and Performance Measurement chapters, including the Appendix 2 for Outcomes-Based Performance Measurement. It is evident how the requirements in the finalist guide regarding the BK model modes could translate into the observations of those modes in the finalists' proposals, and this can be seen in Figure 5.3 and Figure 5.4 below comparing the total observations for the modes between the finalist guide and the final proposals.

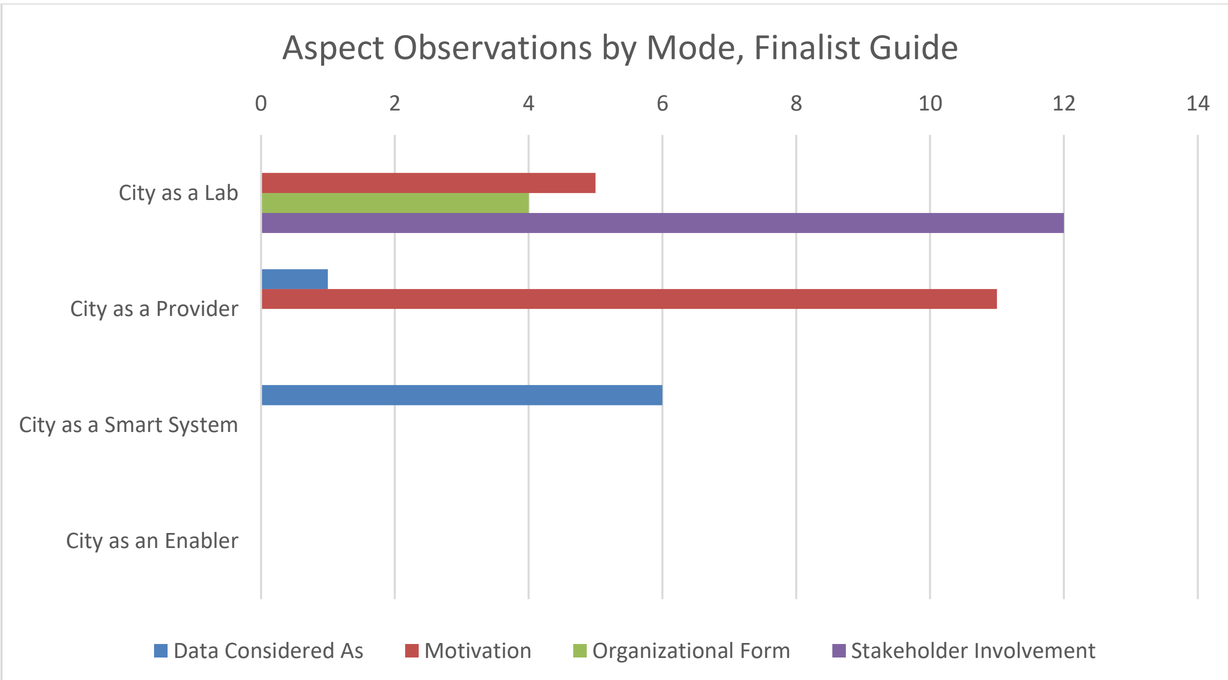


Figure 5.3. Finalist guide aspect observations by mode.

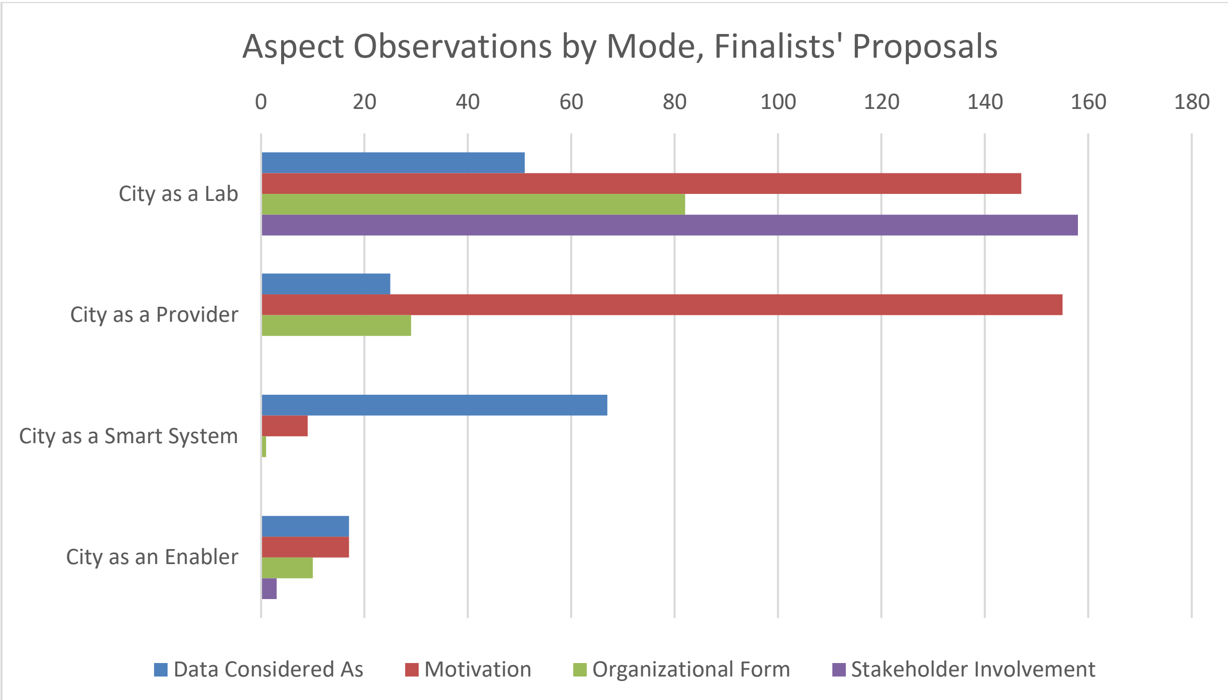


Figure 5.4. Finalists' proposals aspect observations by mode.

The requirements of the SCC guides have demonstrated that the SCC expects finalists to maintain a high level of stakeholder involvement, with different stakeholders and partners that could lead to a network organization form, but also drive a motivation for co-creation with those partners, while still demanding transparency as a core tenet for the data governance of every proposal. These requirements have influenced the finalists to outline their plans and describe their proposal in such a way that they would strongly resemble the Lab or Provider modes of the BK model. While not all of the finalists were evaluated as a Lab or a Provider, these roles do compose of the majority of the finalists, with only one of the 20 finalists who evaluated as a different role (Parkland, Enabler). Bayat and Kawalek mention in their 2021 paper that hybridized data governance modes are possible, but that they may be combined and observed in different ways, depending on the context and the vision of the smart city. The methods used in this study eliminated any potential hybridized evaluations, but it is important to acknowledge that with a different methodology, hybrid data governance modes would have likely occurred and been evaluated. The analysis conducted on the Data Governance Modes of the BK House Model hopes to partially address the call for empirical testing by Bayat and Kawalek on their model and its components.

5.1.2.2 Few observations for Smart System and Enabler modes

While there were many observations of the Lab and Provider modes throughout the finalists' proposals, there were very few observations for the other two modes, Smart System and Enabler. Of the 20 finalists, none of them were identified to be a Smart System, and only one, Parkland (10M) was evaluated as an Enabler. The principles of the smart cities approach as defined by the SCC do not support any of the characteristics of the Smart System and Enabler roles, and both the applicant and finalist guides do not describe many requirements that push for cities to act as smart systems or enablers. There are only a few comments in the applicant and finalist guides that value data as feedback (Smart System), regarding the use of baseline data and data as evidence for appropriate metrics and outcomes to measure their smart city development progress.

Although there are few requirements posed in by the SCC that would push cities to adopt Smart System and Enabler data governance behaviours, there is room in the structure of the SCC to allow for them, and this can be seen in the example of Parkland (10M), which is the only finalist that was identified as an Enabler. Parkland is significant in that even though the SCC guides placed no value towards the characteristics of an Enabler, over half of the observations for the BK model in the Parkland final proposal were of an Enabler-type data governance approach, including all four observed aspects. The content of the SCC guides does not explain why Parkland adopted a monetization and commodification approach to data governance, but the SCC does not prevent this approach either. The other observations from the Parkland final proposal followed the pattern of the previous finding, with mostly Lab-type observations and some Provider-type, reflecting what was recommended and required by the SCC guides. Even though the SCC guides have not placed much value to the traits of the Smart System and Enabler data governance modes, the structure of the challenge itself has allowed for flexibility in the finalists' proposals, and ultimately some room for Smart System and Enabler-type approaches to data governance. Although most of the finalists were not evaluated as Smart Systems and Enablers, many valued data as feedback (Smart System) and some also valued data as a commodity (Enabler), motivated by the prospect of monetizing their data to drive innovation and economic growth (Enabler).

5.1.2.3 Cities have high stakeholder involvement and are motivated by transparency and co-creation

The findings have shown that there is very high stakeholder involvement across all of the finalists, and most of the cities are motivated by either transparency or co-creation.

5.1.2.3.1 High stakeholder involvement

Throughout the finalists' proposals, there were descriptions of high levels of stakeholder involvement, often in the forms of citizen engagement and collaboration with partners. These were the two forms of stakeholder involvement that were demanded by the applicant guide and finalist guide, as well as by the smart cities approach outlined by the SCC. The smart cities approach explicitly called for the relationship between residents and public organizations to be strengthened, the empowerment of residents, and collaboration between communities and partners. The applicant guide established that meaningful engagement and involvement of residents was required for every stage of the SCC, and that the challenge statement was to be shaped by residents and should reflect the concerns and needs of residents based on their input. The applicant guide addressed requirements for establishing and evaluating partnerships with other organizations that may be involved in the proposals, including their relevance, selection process, and expected responsibilities and contributions. The finalist guide built on the applicant guide by dedicating the entire chapter to Engagement with citizens, and also described the roles and responsibilities of partners and stakeholders in other chapters, namely Governance, but also in the Project Management and Technology chapters. The SCC guides want the finalists to engage with their citizens to understand the challenges experienced by citizens and to help address their problems and expect the finalists to create opportunities for citizen engagement and civic involvement. With citizens as one of the three major stakeholders identified by Bayat and Kawalek's 2021 study, they are the stakeholders that feel the biggest impact from smart city actions and policies. The finalists' proposals have demonstrated that all of the finalists are willing to involve their stakeholders at a high level, as the proposals have shown them engaging with their citizen stakeholders in town hall meetings or participatory governance, and collaborating and partnering with other stakeholders in order to implement the smart city projects.

5.1.2.3.2 Transparency motivation

The findings on the motivations behind the finalists' proposals have shown that the finalists are particularly driven by their pursuit of transparency and co-creation, which can be explained in part by the language and expectations of the SCC. As the applicant guide describes transparency as a "core tenet" of the SCC, it comes to no surprise that transparency was observed as a motivation by every finalist in their final proposals and had the highest count of observations across the motivations of the four roles in the BK model. It was discussed earlier that the SCC wants the cities to engage with their citizens to support their civic involvement, but part of that is to increase transparency in the decision-making process and empower citizens in some form of participatory governance. This is described in the openness principles of the SCC's smart cities approach, which is central to the challenge and the proposals of both the applicant stage and the finalist stage. By underpinning transparency and openness throughout the final proposal process, the finalists generate accountability to their stakeholders and build trust, strengthening the relationship between residents, local government, and public organizations. As described by the integration principle of the smart cities approach, transparency can also be pursued internally, by using data and connected technologies to empower communities to break down silos and connect local governments and public organizations, even across the country. Transparency is enforced throughout the stages of the SCC, described in the SCC guides as a major requirement, and it is outright stated in the finalist guide in the section on the Confidential Annex that "one of the goals of the SCC to encourage as much transparency as possible among applicants, potential applicants of future competitions, other communities, stakeholders, and with the general public" (Impact Canada, n.d.c.).

5.1.2.3.3 Co-creation motivation

The second most observed motivation of co-creation aims to turn data into valuable innovations and help in the delivery of public services. Co-creation can also help build trust between stakeholders, as it is not limited to the organizations in the public sector and the private sector, but is possible with all the city's stakeholders, including its citizens. Citizens can become involved in more and more meaningful ways through civic tech and other forms of civic collaboration and participation, and co-creation gives citizens an active design role and not just a "voice" that may or may not be seriously considered in the decision-making process. The SCC wants the cities to engage with their citizens to understand their priorities and to support their civic involvement, and the finalist guide outlines how the Engagement chapter is expected to include an approach of engaging with and gaining acceptance from residents and other stakeholders to ensure ongoing alignment between project outcomes and resident concerns and needs.

By investigating the high level of stakeholder involvement and the motivations of the SCC and the finalists separate from the associated city roles as presented by the BK model, these findings demonstrate the shift in the smart city discourse from a top-down approach to a bottom-up approach, building rapport and trust with citizens and other stakeholders. It is apparent that the federal government by way of the SCC, and the participant smart cities across Canada, are prioritizing dynamic and meaningful engagement with citizens and other stakeholders in order to maintain a good understanding of the challenges of residents, and appropriate way to address their problems.

5.2 Media and Literature Discussion

This thesis set out to understand what the current state of data governance for smart cities in Canada is, through investigating the data governance decisions and roles of Canadian smart cities in governing their data using two theoretical frameworks from literature: the Data Governance Framework by Khatri and Brown (2010) and the Data Governance Modes from the House Model by Bayat and Kawalek (2018). Canadian smart cities are prioritizing open and collaborative data governance strategies that allow for government-driven innovation. This is evidenced by the prolific proposal of activities in the data access, data principles, and data lifecycle decision domains, as well as cities adopting the role of a platform, networked with highly involved stakeholders motivated by transparency and co-creation. These data governance activities and the platform role that Canadian smart cities have taken on can be explained by media reports on the high-profile failures of tech-driven smart cities, the challenges of smart cities discussed in literature, how openness and collaboration are considered important principles of smart city data governance development throughout literature, and the shift of the smart city discourse from vendor-driven innovation to citizen-driven innovation and now potentially to government-driven innovation. This part of this discussion section will discuss the key findings on the data governance strategies of smart cities and how they may have been influenced by these factors.

5.2.1 High-profile failures of tech-driven city development projects

Smart cities and their technologies have been growing in popularity since the term was coined by IBM/CISCO in 2008, and many companies and governments have invested in smart city technology and development over the years. More recently, major companies in the tech industry have expressed interest in starting their own smart city projects or equivalents, which has resulted in several tech-driven development projects hitting the headlines, although most have reported public backlash. Big tech companies such as Siemens, Google, and Amazon have made plans to invest in smart city projects encompassing whole neighbourhoods and building corporate tech campuses with extensive digital infrastructure, but residents have been concerned about their intentions and resisted these developments. Media has reported on the high-profile failures of these tech-driven city development projects due to public backlash and how controversy can be caused by the lack of transparency and ambiguous processes of private-sector-driven development.

5.2.1.1 Google and Siemens in Berlin

In Berlin, two smart city projects took the spotlight, with one involving Google and their plan for a tech campus in the Kreuzberg district, and the other with Siemens planning a corporate campus and a new neighbourhood in the Siemensstadt district. Google planned to develop a tech campus in the Kreuzberg district but backed down in 2018 due to widespread local protest of two years of counter-campaigning and a lukewarm attitude from officials (O'Sullivan, 2018). Berlin observed that the rejection of Google by the Kreuzberg community was not about rejecting the major tech employer, but instead about preserving the integrity of the neighbourhood and avoiding the disruption and displacement that Google's tech-driven city development would cause (O'Sullivan, 2018). The Kreuzberg district is historically known for its edgy atmosphere, alternative culture and nightlife, and affordable housing, and Google's decision to attempt to develop a tech campus in this already desirable neighbourhood was short-sighted (O'Sullivan, 2018; Schaer, 2019). Among the concerns of the protesting neighbourhood organizations included Google taking advantage of the issues of the district's infrastructure as an opportunity to harvest information about residents in a smart city fashion (Harris, 2019). Ultimately, Google's plan to develop in the Kreuzberg district failed in 2018 after two years of community resistance (O'Sullivan, 2018; Schaer, 2019).

Elsewhere in Berlin, Siemens proposed a smart city project called "Siemensstadt 2.0" in late 2018 to redevelop the eponymous district, intending to create a new corporate campus in addition to building a whole neighbourhood (Schaer, 2019). Siemens has historical ties to the Siemensstadt district, as it was the location of its old headquarters, employee housing and community facilities before World War II, and the company still owns most of the proposed redevelopment site (Schaer, 2019). The residents in and around the district have mixed feelings about the project, given the criticisms of other tech-driven development projects such as Google's failure in Kreuzberg, Amazon's alienation of New York City, and the controversy that surrounded Sidewalk Lab's Toronto smart city proposal (Schaer, 2019). While Siemens claims to place emphasis on local dialogue and wanting to be a good neighbour, a politician has stressed that the company needs to integrate into the community, and not just expect the community to integrate with them (Schaer, 2019). Other community members have echoed these concerns about transparency and inclusion, and the article notes that "the most important thing is that the company learn from the mistakes that other tech titans have made when they venture into smart-city-building" (Schaer, 2019). Data privacy for this smart city project is an issue discussed in the context of GDPR, which would determine what data Siemens can collected on residents, but a data expert, Maximilian von Grafenstein, argues that companies need to collaborate with stakeholders to build GDPR-sustainable systems of data governance, and that they cannot build up these systems in retrospect, but instead they “must be designed in at the very start of the project” (Schaer, 2019). Siemens will need to engage with stakeholders, including residents, and approach the whole community as equals, to develop its smart city plans and governance systems (Schaer, 2019). The Siemensstadt 2.0 project is still ongoing.

5.2.1.2 Amazon in New York City

Although not branded as a smart city project, the proposed Amazon HQ2 in New York City (NYC) represented a city development proposal driven by the tech giant that was heavily debated by the residents and politicians of NYC. Amazon announced its competition for selecting the location of its second corporate headquarters known as HQ2 in September 2017, and cities across the USA put in their bids to host HQ2 (Plitt, 2019). In January 2018 Amazon announced its shortlist of 20 cities for HQ2, including NYC, and in November 2018 Amazon announced that HQ2 would be split between two areas, the Long Island City neighbourhood of Queens in NYC, and the neighbourhood of Crystal City of Arlington, Virginia (Plitt, 2019). Opposition to HQ2 in NYC started early when the city was shortlisted, as Amazon intended to bypass NYC’s uniform land use review procedure (ULURP) which would have given the city some oversight on major developments (Plitt, 2019). Both the city through Mayor de Blasio and the state of New York through Governor Cuomo promised Amazon many incentives to select NYC, including almost $3 billion in generous tax breaks and grants (Plitt, 2019). Protests were held over several months after NYC was selected, and included local advocacy groups and elected officials, with concerns including the disruptive impact of the expected influx of workers on housing supply and housing prices, the government-provided financial incentives, and lack of both oversight and transparency throughout the process (Plitt, 2019; Budds, 2019). Amazon announced the withdrawal of their HQ2 offer to NYC in February 2019 after experiencing local protests and opposition and long-term uncertainty from politicians (Plitt, 2019; Goodman & Weise, 2019). Local leadership expressed that transparency and public involvement in corporation negotiations was necessary for successful future developments after Amazon withdrew from NYC, as both Amazon and NYC did not act with full transparency, and local lawmakers are seeking to ban non-disclosure agreements in future development deals (Budds, 2019). Campaigners against Amazon in both New York and Virginia observed that it is important to talk to the community and see the needs of the community, as the engagement gap is made worse by the “failure of both Amazon and the relevant local authorities to open up to people how their decisions will directly affect them” (Harris, 2019). NYC offered Amazon many incentives from tax breaks, grants, and real estate, to detailed data on local economics, but Amazon only had two hearings with the City Council after NYC was selected (Weise, 2018; Plitt, 2019).

5.2.1.3 Sidewalk Labs in Toronto

The Quayside project in Toronto was a high-profile smart city development plan by Sidewalk Labs that garnered local and international media attention as well as academic discussion due to its bold urban innovations and the many criticisms on its data governance strategies and controversies. Sidewalk Labs, a subsidiary of Alphabet and sister-company to Google, drew up plans to develop the Quayside site in fall of 2017, but those plans were cancelled in May 2020 citing the economic uncertainty of the then-burgeoning COVID-19 pandemic (Walker, 2020). The criticisms and controversies surrounding Sidewalk Labs' lack of transparency on their digital infrastructure and data governance policies and resulting public backlash were discussed as likely reasons for the eventual failure of their project, as the company downplayed the importance of data governance in their communications and public engagements, in contrast to the increasing interest the public expressed on their data-related concerns (Jacobs, 2022; Walker, 2020; Bliss, 2018). There were unclear definitions and unanswered questions abound about defining the purpose of the collected data, who would own the data, meaningful consent, and the selling of personal and aggregate data (Bliss, 2018). Local advocates warned of public surveillance and the reality of a private company promising better urban governance when they are "really there to sell software and monetize citizen data" (Bliss, 2018; Walker, 2022). Additionally, there were multiple resignations by advisors, notably the former Ontario privacy commissioner who had concerns about Sidewalk Labs' inadequate commitment to data security and privacy (Canon, 2018). Ultimately, Sidewalk Labs' top-down approach and lack of seriousness about the privacy concerns of residents demonstrated their hubris and arrogance and provided critical contributions to the scholarship of the smart city discourse and data governance discourse (Walker, 2022; Johnson et al., 2020; Artyushina, 2020; Spicer & Zwick, 2021). In academic literature, the many criticisms of Sidewalk Labs' data governance processes are reiterated with the project's lack of meaningful public engagement as well as Sidewalk Labs' top-down planning approach was observed, while others warned against the potential corruption of data governance initiatives due to the pursuit of monetizing data and the privatization of urban governance (Spicer & Zwick, 2021; Johnson et al, 2020; Artyushina, 2020).

5.2.1.4 Lessons learned by Canadian smart cities

These high-profile failures have set the stage for future tech-driven smart city developments around the world. Canadian smart cities will have learned from these private-sector-driven cases on the appropriate and inappropriate approaches to take when developing their own smart city projects, especially as these media reports happened around the time of the SCC and the participating cities were developing their initial applications and final proposals. The SCC finalists will have learned important lessons on transparency, citizen engagement, and privacy for their own smart city proposals.

5.2.1.4.1 Transparency

Cities have learned that transparency is critical in building trust from each of the cases discussed from media. The failure of Google in Berlin showed that without good communication with residents, urban development projects by tech firms would generate local resistance. The situations of Amazon and Sidewalk Labs both showed that decision-making cannot be closed, opaque, and unilateral, as without transparency, trust cannot be built, and instead would be worn down to the point of backlash against the proposed smart city projects. Transparency is a core tenet of the SCC, from the start when the applicants were just developing their problem statements with their communities, to the finalists' proposals which were posted online for the public to check in with the plans that were made.

5.2.1.4.2 Citizen engagement

Hand in hand with transparency, citizen engagement is another lesson that Canadian smart cities can take away from the examples reported in media. Cities would learn from Amazon in NYC that they should inform and engage with all stakeholders, and especially citizens, to be able to make sustainable decisions. The community feedback on the Siemens smart neighbourhood in Berlin showed that the smart city developer must integrate and collaborate with the community in an inclusive and equal way, especially when developing data governance strategies and other governance systems. Although the SCC finalists are not as separate from the community as the private sector may be, the finalists still prioritized citizen engagement in the development of their smart city plans. From the outset, they engaged with their communities to establish openness in their process and achieve multi-lateral decision-making, as their priorities were defined by residents and the projects integrated iterative engagement throughout.

5.2.1.4.3 Privacy

Cities learned that privacy is always a concern when the driver/developer of innovations has an interest in collecting data, as seen with some of the concerns residents had about Google in Berlin. The failure of Sidewalk Labs in Toronto highlighted that citizens have strong concerns about many aspects of data governance, such as data privacy, data protection, and data ownership, and these concerns must be addressed before the planning process can proceed. The SCC finalists directly and transparently addressed the public's concerns of data governance throughout their final proposals, with a chapter dedicated to how they would handle data and privacy.

Because of the high-profile failures of these tech-driven development projects before or around the time of the SCC, and the opportunity to review and study the criticisms of each project and how they failed, these experiences will have taught Canadian smart cities to consider transparency, citizen engagement, and privacy in a more open and collaborative approach to data governance compared to tech-driven city development.

5.2.2 Data governance literature on the challenges of trust

Literature has also warned of the challenges of trust that befall smart city development, with recurring themes within the realm of data governance, including privacy, security, and surveillance capitalism. Hartt, Zwick, and Webb (2021) describe three common critiques of smart city developments, including technological solution-ism, profit-driven urbanism, and panoptic surveillance. These critiques describe how technology and data is expected to solve all problems when this approach could lead to over-reliance on data to conduct urban governance and forgetting to define the problem to apply technological solutions to, or even forgetting to consider people-centered policy solutions (Hartt et al., 2021). The critiques also describe how city governments are treated as a market for new technologies and digital infrastructure, and the problems of the monetization of public data or data that belongs to citizens, and the risk to the right of privacy as smart city technologies create digital panopticons and opening a pathway to surveillance states (Hartt et al., 2021).

These critiques prompt many questions about data that may be on the minds of citizens. What is the purpose of the data being collected? What will the data be used for, and how will it provide value? Will data really solve the problems experienced by residents? How will the residents see the benefits of applying the technology and data? Who owns the data, and will the data collected on residents be sold? How can residents provide meaningful consent to data collection, and how can they control their own data? The authors themselves question if citizens trust that their data are safe in the hands of private or public entities, and if that data would only be used altruistically (Hartt et al., 2021). The authors remind readers that people and not technology alone make cities smart, stating that truly smart cities require engaged, informed, and empowered residents (Hartt et al., 2021). These questions and thoughts describe some citizen concerns about data governance that could be addressed in open and collaborative approaches to build trust in the planning processes of smart cities, largely involving the data governance decision domains of data principles, data access, and data lifecycle.

Other scholarship dives deeper into the importance of these questions as they explore the issues of privacy and citizen input, which are at the core of these challenges of trust and contribute to the considerations for many data governance activities. During the rise of tech-driven smart city development, van Zoonen (2016) introduces a privacy framework to identify the kinds of privacy concerns that smart technologies and data may raise among smart city residents. The author describes how people perceive data as personal or impersonal and how their concerns differ if the purpose of the data is collected for service or for surveillance, with their privacy concerns ranging from hardly any (impersonal data for service) to extremely high (personal data for surveillance) (van Zoonen, 2016). With this framework in mind, cities can begin to better understand the privacy concerns of residents about smart cities and collaborate with residents to establish what kinds of data they feel are appropriate for collection and for which purposes, using an open and collaborative approach to build trust in the cities' data governance strategies. This includes transparently engaging in data governance activities in the data principles, data access, and data lifecycle decision domains, as both the findings and literature show that residents want to know what data will be collected and why, how data will be used, and what will be done to control access and protect their data. The author concludes with recommendations that place emphasis on the input and support of citizens, acknowledging that although they live with the outcome of smart city projects, residents are often ignored as partners in the development of those projects, degrading their trust and increasing their concern (van Zoonen, 2016).

Bannerman and Orasch (2020) surveyed Canadians on their privacy concerns about smart cities and found that generally, there was a strong level of concern in the privacy issues surrounding smart cities. Canadians strongly opposed the sale of personal data and the use of personal data for targeted advertising and behaviour modification, while personal data collection for public uses were not as strongly opposed (Bannerman & Orasch, 2020). These findings verified the service and surveillance axis of the framework introduced by van Zoonen (2016). The authors also found that Canadians want to have some level of data control regarding certain rights and protections for their data, preferring the ability to opt out, opt in, delete their data, correct their data, and download their data, and the survey results suggesting a high level of concern for data anonymity (Bannerman & Orasch, 2020). The authors recommend for a citizen-based approach to data policy development, noting that municipalities should be careful and engage in public consultation as they adapt to and integrate smart city technologies (Bannerman & Orasch, 2020). These preferences and privacy concerns of Canadians reflect that some data governance decision domain activities will matter more to citizens and should be emphasized when smart cities plan their data governance strategies. By openly engaging with and involving citizens in the planning of data governance, Canadian smart cities will be able to build trust through acknowledging and addressing citizens' concerns on data governance.

The literature suggests that the data governance activities that Canadians are concerned about and would value discussion largely belong to the decision domains of data principles, data access, and data lifecycle, which the findings support. In the overarching decision domain of data principles, the activities of greatest interest are identifying the uses of data, the value of data, and the sharing of data. Driven by data principles, the data access and data lifecycle decision domains follow, with activities from data lifecycle including defining data, collecting data, and data retention, and regarding data access, activities such as access standards and procedures, data ownership, security, privacy, and risk assessment are emphasized in both literature and the findings. There is significantly less discussion of the data quality and metadata decision domains in comparison. The findings have shown that the DP, DA, and DL decision domains are the data governance activities that the SCC finalists have prioritized in their proposals and suggest that the SCC finalists understand the need to build trust and respond to the data governance concerns that citizens have emphasized about Canadian smart cities. The challenges of trust of transparency, citizen engagement, privacy, and the concerns of data governance were observed by Canadian smart cities, and the next section will discuss how they are trying to address these challenges by undertaking an open and collaborative approach for developing smart city data governance, and how literature informs this approach.

5.2.3 Open and collaborative approach to developing smart city data governance

The findings of this study show that Canadian smart cities are prioritizing open and collaborative approaches to their data governance, as the SCC finalists propose many activities in the data access (DA), data principles (DP), and data lifecycle (DL) decision domains. The SCC finalists have also shown how they are acting largely as Labs and Providers with networks of highly involved stakeholders motivated by transparency and co-creation. Through these activities and roles, the finalists apply the lessons that they have learned from the challenges of trust, as described by media and academic literature, to the development of their smart city projects and data governance strategies. The lessons of transparency, citizen engagement, privacy, and citizens' concerns regarding data governance have led the finalists to utilize an open and collaborative approach to be successful in their smart city projects and in developing their data governance.

5.2.3.1 Openness, collaboration, and the smart city

The SCC already identify openness and collaboration as two of the four principles underlying their smart cities approach that participating communities are expected to adopt. The SCC describes openness as making data accessible, usable, and barrier-free, and that decision-making processes are transparent to empower residents and to strengthen the relationships between residents and public organizations. Collaboration is described as bringing together traditional and non-traditional partners to deliver common objectives enabled by using connected technologies. The findings show this emphasis on these two principles and are supportive of the claims in literature that openness and collaboration are critical for the success of smart cities. In a discussion paper by Evergreen and Open North, the authors state that openness is critical for smart cities and explain openness as to be "understood in terms of open data infrastructure, open standards, open source information, and open collaboration that enables building new or modifying existing services for residents at any scale" (Sodhi, et al., 2018). They describe openness to have three distinct elements that are critical to smart cities: interoperability, which improves the ability to exchange and re-use data across systems such as through data standardization; accessibility and equity, to help ensure that the needs and perspectives of all communities are represented in a smart city and minimize data poverty; and engagement, for governments to meaningfully interact and collaborate with "civil society, private sector, academia and citizens" (Sodhi et al., 2018). This latter element of engagement more closely resembles the principle of collaboration as described by the SCC, and so it can be understood that openness and collaboration go hand in hand as critical components to developing successful smart cities.

The elements of openness create the context for designing open smart cities, a new paradigm of smart cities originally defined in a separate pair of documents from a collaborative project led by Open North: open smart cities are where "residents, civil society, academics, and the private sector collaborate with public officials to mobilize data and technologies when warranted in an ethical, accountable and transparent way to govern the city as a fair, viable and liveable commons and balance economic development, social progress and environmental responsibility" (Sodhi et al., 2018; Lauriault et al., 2018; Bloom et al., 2018). In those papers, Lauriault, Bloom, and Landry describe an open smart city to have five characteristics and assess four cities across Canada for current smart city practices, three of which who moved on to become finalists of the SCC (Bloom et al., 2018; Lauriault et al., 2018). To briefly summarize those five characteristics, governance in an open smart city is ethical, accountable, and transparent; the open smart city is participatory, collaborative, and responsive so that all stakeholders can meaningfully participate in its governance; the data and technologies used in an open smart city are fit for purpose, adhere to open standards, equitable, and any automated decision-making is adaptive and accountable; data management and data governance for public interest is the norm; and it is recognized that data and technology are not a quick solution to the systemic issues of cities (Lauriault et al., 2018). These characteristics appear to closely resemble and describe the open and collaborative approach taken by many of the SCC finalists as found in this study, and indeed the authors had hoped that their definition of the open smart city would be useful for the SCC projects and that the SCC applicants would provide an example of what an open smart city could look like (Lauriault et al., 2018).

Sodhi et al. (2018) expand on the definition and characteristics of the open smart city by identifying eight key principles for developing an open smart city approach: user-centered, inclusive, open by default, tech-driven, participatory, resilient and adaptive, accountable and transparent, and resource optimization. Also in the Canadian context, Gladstone et al. (2018) provide 9 insights to consider for successful approaches to smart city development in mid-sized cities, derived from examples in Ontario: identify needs first, technology second; design for inclusion; let community in; look outside for new solutions; think beyond city boundaries; enable and empower public servants; invest in the fundamentals; integrate to implement; brand to build buy-in. Together, openness and collaboration appear to drive the very similar ideas and recommendations from both papers and reinforce the idea that openness and collaboration are both critical to the success of smart cities. Gladstone et al. (2018) identifies gaps in need of further investigation, including "understanding and mitigating privacy and data sovereignty issues", which is a data governance concern. The findings demonstrate that the open and collaborative approach as recommended by smart city literature can be applied not only to the planning of smart city projects but also to the development of data governance for smart cities.

It is important to note that while these authors often describe the principles of openness and collaboration together as if they come hand in hand, it is possible to have one without the other. As seen in the literature discussed in this section, openness is often described to imply the inclusion of collaboration, and collaboration also often implies openness, but this relationship may not be fully understood and guaranteed without being explicitly named. Thus, it is important to make a distinction between the principles of openness and collaboration in research and public-facing project and policy development. This is the reason why this thesis emphasizes the inclusion of both openness and collaboration as principles in the approach to developing data governance.

5.2.3.2 Openness and collaboration in developing smart city data governance

The findings advance the idea that openness and collaboration are important principles to the development of data governance strategies in Canadian smart cities. Openness, collaboration, and other traits that lend to them are also discussed in studies on the data governance of smart cities, contributing to the idea that openness and collaboration are important to the development of smart city data governance. Paskaleva et al. find in their 2017 paper that there can be collaborative work between public and private sector actors for data collection, but the lack of interoperability and standardization for data and technology act as technical barriers to data collection and data sharing, and other regulatory and organizational barriers exist in the form of "privacy and associated ethical concerns" and data protection. This supports the idea that openness and collaboration are both critical principles that work hand in hand in developing smart city data governance, as their paper's findings show that a collaborative approach needs to incorporate more characteristics of an open approach to be successful (Paskaleva et al., 2017; Sodhi et al., 2018, Gladstone et al., 2018). Paskaleva et al. (2017) conclude that "smart city initiatives seeking to deliver sustainable urban development require engagement with stakeholders to collaboratively identify, collect, generate, and use data", and that a more collaborative approach to data governance in the smart city will benefit stakeholders in raising awareness and facilitating collaborative learning and behaviour change.

In a more recent paper, König (2021) discusses how openness and collaboration may be used in citizen-centric data governance of smart cities to achieve and maintain democratic accountability throughout the data value creation chain. To conform to democratic accountability, smart city data governance needs to start from end goals, the purposes and impacts of data, and orient data processes towards them to prevent unduly extensive collection of data and transparently tying data-based processes to specific goals (König, 2021). The concept of democratic accountability is central to the idea of citizen-centric data governance, but it also avoids overemphasizing the role of direct citizen participation in smart city data governance, in contrast with what is presented in recent literature (König, 2021). König (2021) claims that democratic accountability can be realized without strong direct citizen participation, as it is not realistic or necessary, and that citizen participation is one possible instrument for democratic responsiveness and accountability. König (2021) introduces three democratic accountability mechanisms for citizen-centered data governance: ex-ante testing, operative transparency, and ex-post scrutiny and inspection. Although König (2021) claims that with these mechanisms for democratic accountability do not necessitate strong citizen participation, he does not discard their participation completely, and recommends some level of direct citizen involvement from the beginning in shaping the data value creation chain and its objectives, recurring involvement for oversight purposes, or otherwise reflecting citizen values and views through collaboration with intermediary organizations. The accountability mechanisms that König (2021) introduces are open and collaborative, involving citizen and stakeholder input on the goals and objectives of data governance processes, ongoing transparency for those processes, and regular oversight, allowing for citizens, stakeholder organizations, and media to gain information and monitor the processes.

The studies by Paskaleva et al. (2017) and König (2021) both value the engagement of stakeholders, transparency in the processes, and other lessons or traits that lend to the principles of openness and collaboration in developing smart city data governance. The findings support the idea that both openness and collaboration need to be incorporated into the processes for developing of smart city data governance to be successful. The finalists incorporated engagement throughout their smart city development in compliance with the SCC and consequently their smart city data governance, involving citizens and other stakeholders in the development of their data governance activities, such as determining the purposes of data, privacy and access control, and risk assessment, thus also realizing the democratic accountability mechanisms described by König. Though König argued that strong and direct citizen participation was not necessary to achieve democratic accountability, it is clear from the proposals that meaningful citizen participation is the main way to achieve democratic accountability and would likely be used to support future iterations of the combined open and collaborative approach to the development of data governance of smart cities.

5.2.3.3 Meaningful citizen participation for openness and collaboration

Meaningful citizen participation has been described in many papers as a mechanism of open and collaborative approaches to developing smart cities and their data governance, especially to address the challenges of trust that smart cities seem to experience. Sodhi et al. (2018) name an element of openness to be engagement, and many of the principles they describe to develop an open smart city approach involve the participation and engagement of citizens and other stakeholders, such as user-centered, inclusive, and accountability principles. Lauriault et al. (2018) define that one of the characteristics of the open smart city is that it is participatory, collaborative, and responsive so that all stakeholders can meaningfully participate in its governance. Gladstone et al. (2018) highlight several participatory insights that encourage engagement and collaborative solutions development involving citizens and other stakeholders. Both Paskaleva et al. (2017) and König (2021) call for the engagement and collaboration with citizens and other stakeholders to identify the data processes and objectives for smart city data governance.

Other studies on citizen participation in the smart city discuss this mechanism with more nuance. After studying the case of Dublin with their own theoretical framework for smart citizen participation, Cardullo and Kitchin (2018) conclude that there are numerous roles for citizens to play in the smart city, and that citizens can experience different forms of empowerment and participation at the same time. The authors use their framework to help build an understanding as to who is involved and in what capacity outside of the usual rhetoric of citizen-centered smart city initiatives (Cardullo & Kitchin, 2018). Given that the neoliberal ideals of "citizen-centric" smart city approaches do not intend for citizens to challenge or replace the fundamental political rationalities shaping an issue or plan, the authors remain concerned that these "citizen-centric" smart cities appear to be largely tokenistic, and that city governments or corporations still control the narrative and direction of smart city data governance (Cardullo & Kitchin, 2018). Meaningful citizen participation further up the scaffold of smart citizen participation, towards citizen engagement and citizen power, would see more democratic approaches and uses of technology, as Cardullo and Kitchin (2018) note in the case of Barcelona. Simonofski et al. (2017) make a similar analysis on the risk for tokenistic and instrumental participation of citizens, expressing that instrumental participation should be avoided and that citizens should be involved in more meaningful democratic processes when participating in the smart city. The authors state that the essential role of citizens has been neglected and that smart cities often do not meet their objectives if citizens are not involved in their design (Simonofski et al., 2017). In their framework, Simonofski et al. (2017) identify three means of citizen participation that smart cities enable: citizens as democratic participants, citizens as co-creators, and citizens as ICT users. When citizens act as democratic participants, they can contribute in more meaningful ways, such as helping prioritize projects and collaborating with administrators on policy changes and finding compromises (Simonofski et al., 2017).

Ghose and Johnson (2020) conclude such discussions on the role of the citizen with a reminder that citizens are the smart city's ultimate beneficiary, acknowledging that citizen participation has its challenges but is critical to successful smart city development. Although there may be challenges such as the differences and values of traditional versus transactional forms of citizen engagement, it is still a common and accessible mechanism for achieving and maintaining democratic accountability in the development of smart city data governance in an open and collaborative way that builds trust (Ghose & Johnson, 2020; Johnson et al., 2020; König, 2021). The SCC process presents an under-explored opportunity to extend citizen engagement towards a recursive citizen-centered learning process and the ex-post scrutiny and inspection mechanism for democratic accountability as previously discussed (Johnson et al., 2020; König, 2021). This opportunity could allow for types of engagement that move smart citizens up the scaffold of participation, and as democratic participants, citizens can have more direct control over policy development and avoid the tokenistic and instrumental participation that is warned of in the neoliberal smart citizenship ideals that are prevalent in the smart city discourse (Johnson et al., 2020; Cardullo & Kitchin, 2018; Simonofski et al., 2017). The process of developing plans with community consultation, participation, and engagement is important as process is a critical component of civic dialogue, and process can achieve and maintain democratic accountability when approached with the openness and collaboration principles in mind (Johnson et al., 2020; König, 2021).

5.2.3.4 From literature to real world smart cities

It is clear from the literature that there is a strong emphasis on the combination of openness and collaboration as important principles that would support the successful, effective, democratic, and citizen-centric development of data governance of smart cities. Literature has shown that open and collaborative discussion of data governance strategies and objectives for data processes are effective ways to allow citizens to participate, engage, and contribute with their views and concerns, thus realizing democratic accountability in the data value creation chain. This is how literature may have informed and influenced the SCC finalists' smart city roles and data governance strategies, as the findings are this study are consistent with the open and collaborative approach to the process of developing smart city data governance.

The findings have shown that the SCC finalists know that openness is a critical component to successfully developing data governance for smart cities. By proposing many DP, DA, and DL activities with great detail and frequency, the finalists are able to clarify the goals and objectives of their data value creation chains and data governance processes, demonstrating how they directly addressed the data-related concerns of citizens and the challenges of trust in smart cities. As the DP decision domain addresses the purposes of data and the sharing of data, and in turn establishes the direction for the other decision domains, the findings are aligned with the elements of interoperability, accessibility, equity from literature to successfully develop data governance for smart cities in an open approach. It is interesting that there were fewer observations for DQ and MD activities such as data quality standards and data modelling, contrasting with the expectations of interoperability. The finalists instead placed a lot of emphasis on DA activities, such as privacy, security, access standards, and controls of personal data, engaging with and reflecting the values and concerns of their residents and Canadians in general (Bannerman & Orasch, 2020). The finalists' Lab and Provider motivations reflect many of the characteristics and recommendations for the open smart city concept that would address the challenges of trust, such as transparent governance and inclusive participation, and show how the Lab and Provider roles are driven by openness and collaboration at their core.

With most of the finalists taking on the Lab role with networks of community actors and strong motivations in co-creation, as well as all the finalists having high stakeholder involvement, it is easy to see that the finalists understood that collaboration was a critical component to the success of the smart city and their data governance in addition to openness. As part of the SCC process, the finalists had to consult with residents from the start to determine together the goals and objectives of their smart city initiatives, and this would have also applied to collaborating with residents to develop the goals and objectives of their data governance strategies, in line with the ex-ante testing mechanism for democratic accountability that allows residents to shape the data value creation chains for smart city projects (König, 2021). In this way, citizen participation is a mechanism to help achieve democratic accountability, but literature notes that it must be meaningful and not tokenistic in such a way that citizens can act as democratic participants. The finalists focus on this in their Lab and Provider motivations of co-creation and participatory governance, and the Engagement chapter of each finalist proposal elaborate on just how citizens may act as democratic participants in developing smart cities and their data governance. The findings show how the finalists were possibly influenced by media and literature to incorporate openness and collaboration into the development of their smart city projects and data governance strategies, and advance the idea that openness and collaboration together are critical to the success of smart cities and their data governance strategies. Ultimately, the findings have demonstrated that Canadian smart cities are currently taking this approach to developing their smart city data governance strategies.

It is important to note that while the literature might have informed the SCC finalists, it may be more accurate to say that the literature informed the SCC guides and its judging, which in turn directed and required an open and collaborative approach to smart city development and data governance policy planning. The SCC guides were developed with consultation from Evergreen, Open North, Future Cities Canada, and other partners, and the finalists were supported throughout the SCC with the Smart Cities Community Support Program and in the Community Solutions Network (Infrastructure Canada, 2020). These consultations have had a clear impact on both the guides and the findings, as both Evergreen and Open North have published literature that was previously discussed and are proponents of the "open smart city" concept (Lauriault et al., 2018; Sodhi et al., 2018). Analysis of the SCC guides using both the DG framework and BK model has shown that the guides strongly reflect the results, as the composition and distribution of the activities and modal aspects are very similar between the guides and the proposals. This could suggest that the SCC guides also follow an open and collaborative approach same as the findings and influenced the findings in that way. Regardless, the combined open and collaborative approach to developing data governance strategies can be considered in part a reaction to the media reports and in part to the published literature. Moving forward, smart cities may proactively implement openness and collaboration together to developing their data governance.

5.2.4 Shifts in the smart city discourse

Today's Canadian smart cities are embracing a more open and collaborative approach to developing smart city data governance, and in doing so they are also demonstrating a broader shift in the smart city discourse. Smart cities are transitioning away from vendor-driven innovation towards citizen-driven innovation, and the open and collaborative approach to developing smart city data governance is part of this transition. However, the increasing importance of the principles of openness and collaboration may also open a new direction of smart city development towards government-driven innovation of smart cities. Governments are prioritizing data governance strategies based on citizen input and becoming platforms of innovation for stakeholders from the private sector, public sector, and residents to co-create together. What do the shifts in the smart city discourse mean for smart city data governance and the role of the city?

5.2.4.1 Defining smart city 1.0

Literature on the smart city discourse is mostly in agreement in defining the first iterations of the smart city, smart city 1.0, as technocratic and vendor-driven, where innovative technologies from the private sector, such as ICT, artificial intelligence, and big data decision making, are hallmarks of a centralized approach to urban governance. Barns (2018) establishes this foundational understanding of the smart city 1.0 as a top-down, vendor-oriented urban growth concept, with commercial agendas seeking the city as a market for digital products and services and ideals in leveraging these digital solutions to improve the way a city works. Other literature discusses the smart city 1.0 in hindsight, describing how these traditional smart cities have been criticized for being overly technocratic, driven by corporate interests instead of public, and with little meaningful citizen involvement in its neoliberal smart citizenship (Cardullo & Kitchin, 2018). Robinson and Biggar (2021) also describe the traditional approach to smart cities in similar terms, as vendor-driven innovation, technocratic, closed and proprietary in nature, with profit-driven outcomes, and accelerating neoliberal agendas, to name a few. In this traditional vision of the smart city, the smart city 1.0, vendors are telling governments what problems they think need solving, without considering the actual needs of the city, and there is a narrative from smart city vendors that governments can't innovate (Robinson & Biggar, 2021). Notably, the some of the early smart city funding competitions were driven by private corporations such as IBM, to market their new ICT solutions to city governments (Gharaibeh et al., 2017; Hartt et al., 2021).

5.2.4.2 Transition to smart city 2.0

More recently in literature, the smart city 2.0 has emerged, although with different interpretations. Barns (2018) explicitly defines smart city 2.0 as one that emphasizes "a role for city governments in the curation and management of data assets to support a city's strategic priorities". The reason for this shift away from smart city 1.0 to a "collaborative [model] of smart city governance" that the author describes as smart city 2.0 is explained by the capacity of city governments to support and cultivate partnerships with public and private actors such as data custodians and software developers (Barns, 2018). Barns (2018) also describes how the wider transitions of digital era governance, such as the government as a platform model (in which government encourages external actors to create digital governance innovations through access to government data) and the open government movement (in which government undergoes a cultural change to implement accountability, technology and innovation, citizen participation, and transparency), provide the context for the shift away from smart city 1.0 towards smart city 2.0. In her study, Barns (2018) focuses on how the shift towards smart city 2.0 has incorporated those wider transitions by using urban data platforms like dashboards to open up government and facilitate access to data so that external actors can co-design and co-produce solutions like government digital services.

However, other literature that also mentions the shift away from the smart city 1.0 instead draws attention to its criticisms, namely that of its technocratic and top-down nature, as well as the industry and academic response. Some studies identified that social inclusion, the wellbeing of citizens, other qualities of people and communities were initially missing from the early definitions of smart cities (Neirotti et al., 2014; Albino et al., 2015). Cardullo and Kitchin (2018) described how "the developers, promoters and deployers of smart city technologies and initiatives" have tried to rebrand smart cities as citizen-centric, but that this emphasis on the role of the citizen in the smart city is tokenistic and the underlying neoliberal ideals of the traditional smart city were still unchanged. Simonofski et al. (2017) briefly compared the traditional top-down centralized approach of the smart city 1.0 to a newer, bottom-up model that takes advantage of citizens' input and ideas, criticizing the former for underestimating the "high creative potential of the bottom-up approach" and its failure to design solutions that meets citizen expectations. Hartt et al. (2021) also outline the call for smart cities to move towards citizen-centric, bottom-up smart city approaches, in the face of the problematic situation of technological fixes taking precedence over people-centered policy solutions in the smart city 1.0. Robinson and Biggar (2021) observe the rise of alternative smart city thinking that contrasts the traditional smart city 1.0, such as the open smart city, that may produce innovative approaches that deliver public good outcomes rather than profit-driven outcomes.

Based on the broader literature of the changes to the smart city discourse, it may be more apt to define the smart city 2.0 along the lines of a bottom-up smart city approach that is not just citizen-centric, but actually led and driven by citizens with less involvement from both government and corporations, in contrast to the smart city 1.0 which is closed and vendor-driven. Although this interpretation of the smart city 2.0 may be more on the extreme end, it gives room for the smart city approaches with more middling levels of citizen participation that are neither citizen-driven or truly collaborative, such as the tokenistic "citizen-centric" response or the more open, Provider-type response as described by Barns (2018), as cities could be on the path of transitioning to the smart city 2.0 (Cardullo & Kitchin, 2018). Another interpretation of this transition could be that of a sliding scale, in which the transition from the vendor-driven smart city 1.0 to the citizen-driven smart city 2.0 has varying levels of citizen participation in between, denoting different updates of smart city 1.x.

The findings of this study demonstrate that the shift away from smart city 1.0 has already occurred and present a newer version of the smart city that is more in line with the vision of smart city 2.0. The SCC intended that the smart city projects were to be government-driven and resident-driven, not vendor- or tech-driven, with residents defining the problems and values of the city to help the governments identify priorities and find solutions (Robinson & Biggar, 2021). This follows the recommendation of Simonofski et al. (2017) to incorporate citizen input in their bottom-up approach. The finalists' proposals have shown that almost all the city governments valued the aspects of the Provider role, such as treating data as a public good to be accessible to external actors, or being strongly motivated by transparency and participatory governance, which resembles the vision of the smart city 2.0 presented by Barns (2018). The role of the Lab, which most finalists evaluated as, also contribute to the shift away from the smart city 1.0, as they demonstrated in the findings how every finalist valued high stakeholder involvement, often in the form of citizen engagement, and that co-creation was a strong motivator. The role of the city as a Smart System most closely resembles the vision of the smart city 1.0, being automated and technocratic, and as such, there were very few observations for any of the Smart System aspects. Whether or not the citizen-centric or citizen-driven approach of the finalists' proposals were real or tokenistic, this still places them in transition or on the scale towards the smart city 2.0.

5.2.4.3 Other new paradigms of smart cities in literature

There are new paradigms and new terms introduced to describe types of smart cities all the time in the smart city discourse, such as platform city, information city, future city, but they all capture a slightly different essence of the same smart city idea (Hartt et al., 2021). While some may argue that this is a problem of definition in trying to understand what a smart city really is, the concept of the smart city has been debated enough, and it may be time to consider the changes of the smart city as society continues to adapt and evolve (Hartt et al., 2021; Chourabi et al., 2012; Albino et al., 2015). In 2018, Calzada introduces the experimental city as the next stage of the smart city and presents ten conceptual transitions from the traditional smart city (smart city 1.0) to the experimental city (akin to smart city 2.0). Experimental cities are living labs using citizen-sensing to unpack urban problems, publicly scrutinized as platforms, where citizens are decision-makers and not just users or data providers (Calzada, 2018). Calzada (2018) poses Barcelona as leading this "experimental city" approach for a more citizen-driven and citizen-centric smart city, as Barcelona has sought to re-politicize and shift “away from private interests and the state toward grassroots, civic movements and social innovation”, which epitomizes the vision of the smart city 2.0 as previously described (Cardullo & Kitchin, 2018).

In the previous section, the concept of the open smart city was introduced by Open North and defined as a place where “residents, civil society, academics, and the private sector collaborate with public officials to mobilize data and technologies when warranted in an ethical, accountable and transparent way to govern the city as a fair, viable and liveable commons and balance economic development, social progress and environmental responsibility” (Sodhi et al., 2018; Lauriault et al., 2018). This new paradigm of the smart city is characterized by open, accessible, inclusive, and participatory smart city development (Robinson & Biggar, 2021). The positioning of the open smart city contrasts with the closed proprietary nature of traditional smart city 1.0s, as it values meaningful citizen participation and citizen control over personal data, making it more closely related to the smart city 2.0 (Robinson & Biggar, 2021). These variations of the smart city, either epitomizing or at least in alignment with the smart city 2.0, highlight how the shifts in the smart city discourse increasingly reject vendor- and tech-driven innovation in urban governance, and instead values citizen-driven approaches, openness, and transparency. This focus on either the private sector or the citizen begs consideration for what roles the government has other than providing, enabling, or facilitating private or citizen-driven innovation, and if there is the possibility for government-driven innovation.

5.2.4.4 Government-driven innovation and the potential for a smart city 3.0

Just as how the newer vision of the smart city 2.0 imagines what the smart city could look like when solutions and innovations are driven by citizens instead of vendors, a potential smart city 3.0 envisions the smart city when its innovations are driven by government. Robinson and Biggar (2021) introduce the idea of government-driven innovation with the theory of collaborative innovation, which is when the process of innovation is opened up to a network of public and private actors, citizens, and other stakeholders, creating the conditions for collaborative innovation. The idea of collaborative innovation is that “the eyes and minds of many can bring diverse experiences and knowledge to pinpoint inefficiencies and shortcoming across domains of government” (Robinson & Biggar, 2021). Most scholars agree that collaboration is the key driver of public-sector innovation, and not competition, in contrast to earlier theories of public-sector innovation which were informed by private-sector innovation theories, such as the “new public management” theory which saw entrepreneurialism and competition to create incentive for the public sector to innovate (Robinson & Biggar, 2021). Robinson and Biggar (2021) explain how normative ideas of innovation are inherently biased towards the private sector, as the prevailing attitude and narrative on innovations and smart cities is that the public sector cannot innovate or be an innovator, it can only be a facilitator of the private sector, or worse impeding technological progress, and that it should rely on the private sector to help create innovative solutions.

The authors briefly observe that the success of public sector innovation is dependent on strong institutional foundations of governance networks ready for public sector collaborative innovation, but the conditions for success are hard to conceptualize and operationalize (Robinson & Biggar, 2021). Robinson and Biggar (2021) draw connections between government-driven innovation and the smart city, as innovation is an implied, essential element to smart city development, and there is room for future research on understanding collaborative innovation and how governance may drive smart city initiatives. The authors pose that the SCC will help develop more perspectives on the impact of governance and innovation on government-centred smart city approaches in midst the shift in the smart city discourse from emphasizing technology and vendor-driven innovation to citizen-driven smart city innovation (Robinson & Biggar, 2021). Already, the findings show a new perspective of government-driven smart cities using open and collaborative approaches to their development and data governance strategies.

In the context of this and the transition from a vendor-driven smart city 1.0 to a citizen-driven smart city 2.0, a smart city 3.0 with its innovations driven by government would care to address the challenges of governance with openness and collaboration. Some studies found that non-technical challenges such as collaboration, learning, and awareness were perceived as greater than technical challenges like security, interoperability, and privacy when rolling out smart city initiatives, and limited trust and understanding among stakeholders resulted in a lack of collaboration (Robinson & Biggar, 2021). The smart city 3.0 would be open and collaborative in nature in following the collaborative innovation theory, providing opportunities to open the innovation process for public, private, and citizen stakeholders alike to contribute their experiences and knowledge, while combining people-oriented and technology-oriented approaches to smart city planning to realize the benefits of new urban technologies (Robinson & Biggar, 2021). Future theoretical development of the smart city 3.0 could also draw upon the approach of the open smart city as defined by Lauriault et al. (2018), as the open smart city shares similar values in openness and meaningful citizen participation. The SCC gives a peek into what the smart city 3.0 could look like, as its smart city approach is centered heavily on the government, with local governments submitting applications and generating, fostering, and deciding on innovation, removing any emphasis on technology firms as necessary for smart city implementation (Robinson & Biggar, 2021).

The findings have already shown that the SCC is an innovation competition for municipal, local, regional governments or Indigenous communities, and not for technology vendors or citizens. This was accounted for in the data collection process when observations of the Government Involvement aspect of the 2018 BK model were not collected due to the government-driven nature of the competition. Although citizens may have helped the finalists identify the priorities to address, the governments led the innovation process and enabled their success by opening that process to co-create with a network of partners and actors from the public sector, private sector, and residents. All the finalists demonstrated high levels of stakeholder involvement, and most were strongly motivated to co-create within a network organizational form, largely reflecting the Lab/Platform role of the BK model. The prominence of the Lab role among the finalists and the correlation of Lab aspects with the idea of a smart city 3.0 suggest that the finalists may already be on their way to defining and becoming a smart city 3.0, with innovation led by a governance agenda, driven by collaboration with a network, and having meaningful citizen engagement. The findings further show that the finalists do not quite resemble the smart city 1.0 or smart city 2.0 as they are neither vendor-driven or citizen-driven, but tech vendors are still able to participate as stakeholders and potential partners, and citizens define the problem statement and are wanted to meaningfully engage with the planning process. The findings describe how the participating governments could embody the idea of a smart city with government-driven innovation, as these governments are strongly motivated in a Provider and Lab manner to act openly with transparency and co-create with partners for the purposes of innovating with data. Using the findings to define a smart city 3.0 would counter the prevailing narrative that government cannot innovate and instead show that government will indeed innovate with motivated by open and collaborative principles.

5.2.4.5 Shifting smart cities and their data governance towards openness and collaboration

The shifts in the smart city discourse from the technocratic, vendor-driven smart city 1.0 to the citizen-oriented and citizen-driven smart city 2.0 has demonstrated how the principles of openness and to some extent, collaboration, have become embedded in the smart city planning process, to the point of becoming the expectation for smart cities, and this applies to smart city data governance strategy as well. Media and literature have both reported on the challenges of trust and the lessons of transparency, privacy, citizen engagement, and data governance concerns to address those challenges, and this has been reflected in the ever-evolving smart city paradigms discussed in literature. The findings of this study have shown that Canadian smart cities have followed the shift away from smart city 1.0 towards smart city 2.0 in incorporating citizen input, but more importantly adopting the principles of openness and collaboration that may imply a further shift towards a new version of the smart city, smart city 3.0. The data governance strategies of the finalists are imbued with the principles of openness and collaboration as they prioritize and emphasize what data they intend to collect, the uses of data, value of data, sharing of data, privacy and security measures, access control, and risk management. The finalists have demonstrated the aspects of the Lab role in innovating and co-creating with a network of many different stakeholders while also maintaining the Provider motivation of transparency and the inherent valuing of data as a government-provided good. This drives the participating governments to lead public-sector innovation and defy the existing narrative of governments being unable to innovate. The burgeoning open and collaborative approach to developing smart cities and their data governance strategies may reveal significant changes in the goals and future of smart cities.

Chapter 6
Conclusion

6.1 The current state of data governance in Canadian smart cities

This thesis has found that data governance in Canadian smart cities, as seen using the framework by Khatri and Brown (2010), is focused on decisions regarding data principles, data access, and data lifecycle. Canadian smart cities are very interested in determining the uses and value of data as well as how data could be shared, but they are especially interested in data access activities such as access standards and procedures, privacy and security, compliance monitoring, and risk assessment. There are few occurrences of activities that address the decision domains of data quality and metadata, despite the call from literature for standardizing data quality and modelling data as an element of openness. Almost all of the observed activities are in a state of proposal and are not yet actually existing in the data governance policies of Canadian smart cities. In identifying the data governance decisions that Canadian smart cities are proposing, this investigation contributes to the understudied area on data governance of smart cities by expanding existing empirical research beyond Alhassan et al.'s (2016; 2018) analysis of scientific and practise-oriented publications for data governance activities.

This thesis has also found that Canadian smart cities are developing their data governance strategies mainly as Labs and Providers, while there is very little representation of the Enabler and Smart System roles as derived from the model by Bayat and Kawalek (2018). The proposed smart cities consider data to be a public good or a conceptual resource for innovation, and they are focused on establishing a network of stakeholders to co-create and innovate. Canadian smart cities place a very strong emphasis on high levels of stakeholder involvement, as they value the engagement and contributions of citizens, partners, and other community actors. Their data governance strategies are strongly motivated by transparency and co-creation, opening up their data and data processes to citizens and other stakeholders so that they can access data and create valuable innovations together. This investigation classifies proposed Canadian smart cities into roles for data governance and directly addresses the lack of empirical testing of Bayat and Kawalek's (2021) House Model, specifically regarding the Data Governance Modes.

The study has found that the approach to data governance of Canadian smart cities is driven by openness and collaboration. In light of the high-profile failures of other tech-driven city development projects reported by media, Canadian smart cities have learned many lessons on the challenges of trust, which highlighted the importance of transparency, citizen engagement, and privacy. Canadian smart cities also observed concerns of data governance in recent literature, and these concerns and the challenges of trust are taken into account when developing their data governance strategies. These lessons promote the data principles and data access decision domains and support the Lab and Provider roles, while rejecting the Enabler and Smart System roles. Additional literature and thesis findings have revealed that openness and collaboration are critical principles that must be incorporated into the processes of developing smart city data governance in order for the smart city to be successful. Openness and collaboration have been discussed as success criteria in the Canadian context, and more broadly, the combined open and collaborative approach drives mechanisms for democratic accountability. One such mechanism is citizen participation, which has been increasingly scrutinized in the development of the tokenistic neoliberal "citizen-centric" smart city. Meaningful citizen participation can achieve and maintain democratic accountability when approached with the openness and collaboration principles in mind to design the processes of data governance and smart city development. The research findings concur with and support the principles espoused in literature as the proposed Canadian smart cities have demonstrated that they are using a more open and collaborative approach to developing smart cities and their data governance.

The open and collaborative approach that Canadian smart cities have taken reflects the shifts in smart city discourse in recent years. From a smart city 1.0 that is technocratic and its innovation vendor-driven, to a smart city 2.0 that instead develops with a bottom-up approach and citizen-driven innovation, smart cities have been changing in response to the growing technological capacities of governments and governance, wider digital transitions, and open movements. Other smart city paradigms have emerged, such as the experimental city and the open smart city, but these new definitions and changes in the understanding of what drives public sector innovation lend themselves to an emerging smart city 3.0. As conceived from the transitions in the smart city discourse and demonstrated in the findings of this study, a smart city 3.0 is a city where innovation is government-driven but with an open and collaborative development approach includes citizens and other actors. Canadian smart cities have followed the shift away from smart city 1.0 to smart city 2.0, but their open and collaborative approach to planning smart cities and their data governance supports the further transition to a smart city 3.0.

6.2 Limitations

There are three major limitations to this study that would affect its objectives of understanding the current state of data governance decisions and the role of the city in governing data. The first limitation pertains to the use of content analysis for data collection. As the content was coded by hand, there is a limitation of consistency, as nuances of language could cause the texts to be misinterpreted. Data could be collected where the concepts of interest do not exist, or vice versa, data could be missed where concepts did exist. As data was collected from the SCC finalists' proposals over a long period of time, coding may have evolved to produce different results.

The second limitation is about the concepts and categories presented in the DG and BK models used for data collection and analysis. The concepts in both the DG and BK models are broad and loosely defined within their studies, and the descriptions of the decision domain activities and modal aspects may harbour conceptual gaps or overlaps that cannot be clearly addressed. Sanchez-Corcuera et al. (2019) warns of similar limitations of definition when categorizing smart city applications into the domains presented in the taxonomies they reviewed. The definitions of the DG model's decision domains may be limiting for some activities such as consent, which often falls in both DP and DA domains as separate activities. The data governance activities derived from Khatri and Brown's (2010) framework could be developed and made more comprehensive in future research.

This limitation also applies to the aspects of the BK model, as the study's methodology uses the BK model published in 2018, which describes Government Involvement and Stakeholder Involvement as separate aspects. In comparison, the BK model published in 2021 is slightly more nuanced, removing the Government Involvement aspect but instead including it as a subcategory of the Stakeholder Involvement aspect, which breaks down into involvement of government, citizens, and IT corporations. Unfortunately, the data for this study was collected before the 2021 BK model was published. More broadly, this limitation could affect the roles that the proposed smart cities were identified as, because the methodology and results of this study did not leave room for the hybridized data governance modes which Bayat and Kawalek (2021) theorized could occur. Future research could present a methodology that is more open to hybridized data governance modes.

The third and final limitation regards the data itself, as content analysis was conducted on the finalists' proposals. The finalists' proposals mainly described proposed data governance activities, and few activities were found to be already existing and underway. This data of the study was also limited because the confidential annexes of the finalists' proposals were not accessible. The confidential annex is the only part of the proposal document that was not published and made publicly accessible due to confidential information, such as information from a third party like a private-sector partner. Many proposals referred to the existence of data governance information such as privacy impact assessments and data workflows that were only included in the confidential annex. It is possible that if the confidential annexes were available for analysis, it would change the results on data governance decision domain observations, and more broadly, the finalists' transparency and openness could potentially be improved if they did not have to utilize the confidential annex.

The second objective of classifying the SCC finalists into the city roles of the BK Model was also affected by another data limitation, which is that of path determinacy. The SCC process effectively guaranteed that most of the finalists would be classified as Labs or Providers, as the proposals were required to be socialized in the community and presented on a public-facing website. By requiring public consultation at every stage of the SCC process, from crafting the initial challenge statement to the publishing of the final proposals, public interest and contribution was built into the finalists' proposals. This made the finalists appear to be strongly motivated by transparency and co-creation and causing their Lab and Provider roles to be somewhat predetermined. The SCC, the applicant and finalist guide, and their smart city approach, were inherently vested in the values of the Lab and Provider roles, thus leading the finalists to write their proposals in support of Lab and Provider values.

6.3 Wider impacts of this study

There are three broad impacts of this study. The first is that this study presents a comprehensive approach to data governance compared to other smart city literature that may only focus on some decisions of data governance. The study expands smart city research to consider a comprehensive approach to understanding data governance of smart cities. The smart city discourse is prompted to direct its attention to decision domains other than DA, which traditionally draws focus in literature and media due to its decisions on privacy, one of the challenges of trust. This study reminds scholarship that there is more to smart city data governance than privacy and security.

Beyond the impact on academia, the policy implications of focusing on some data governance decision domains and neglecting (or neglecting to mention) others can be revealed. The SCC applicant and finalist guide highlight the data governance decision domains that the Canadian federal government values, and consequently the values of the SCC finalists, but the results identify gaps in their data governance considerations. More resources could be invested into policymaking to address the gaps of the DQ and MD decision domains and provide more balance the data governance decisions. The unevenness in their data governance planning can also be informative for stakeholders such as citizens and other actors in the public and private sectors. Those stakeholders can create innovations for the cities to fill the gaps or otherwise invest in the niches. The study also shows the public that there are many more data governance activities and decision domains to be aware of, other than the concerns imparted by the challenges of trust. Bringing awareness to citizens and prospective residents of smart cities would improve their knowledge and ability to get involved, allowing them to participate more meaningfully in their local smart city initiatives and potentially help smart cities achieve and maintain democratic accountability in the development of their data governance.

The second major impact of this study is about how openness and collaboration have been determined as critical principles to smart city and data governance development. The open and collaborative approach to developing smart city data governance can reassure citizens of the intentions of the proposed Canadian smart cities to address the challenges of trust and strive for success. The findings have shown that the SCC finalists are invested in activities for defining appropriate collection, use, protection, and control of access to citizens' data. Citizens would be more accepting and trusting of smart cities if the open and collaborative approach was consistently utilized and maintained in developing smart city data governance. Citizens could become more open-minded about introducing new urban innovations if city governance was more open and there were opportunities for collaboration. Other smart cities in Canada and even cities from around the world could learn from this study to adopt the principles of openness and collaboration in their own plans. Even the variations of the open and collaborative approach that this study has explored, such as the original SCC smart cities approach, or the open smart city and experimental city paradigms, can help future smart cities in planning and developing their data governance processes in an open and collaborative way.

Both the first and second major impact areas should also inform the decision-makers in municipal and provincial or territorial governments and push them to act. The SCC demonstrated the federal government's investment and commitment to appropriate, open, and collaborative smart cities. Provincial and territorial governments should demonstrate support and commitment to developing and improving data governance with the open and collaborative approach for smart cities, as municipal governments are in their purview in Canada. Provincial and territorial governments should also consider establishing policy standards for their municipalities to follow so that municipalities do not research and develop data governance in silos and repeat each others' efforts. However, they should create teams and roles to lead and develop smart city planning and data governance strategies, such as a Data Governance Committee, Chief Data Officer, Data Custodians, and Data Policy Advisors. The finalists' proposals showed that some roles were created to address the data and privacy of their projects, but this can be cemented into the organizational structure of the participating government authorities with dedicated roles for data governance strategy, policy creation, and research.

Finally, this study could advance the approach to smart city development in practise and in theory, as the smart city discourse shifts away from smart city 1.0 and even smart city 2.0 towards smart city 3.0. Conceptualizing the smart city 3.0 can generate recognition for government-driven innovation by city governments and their stakeholders, driving cities to openly invest in their own capabilities or co-creating with others for their own purposes. The idea of a smart city 3.0 could ignite interest in scholarly discussions of the contributions of government in the conceptual framing of smart cities, and this study paves the path for the inclusion of data governance in those discussions.

6.4 Directions for future research

Future research in this area can follow up on the finalists of the SCC and reassess their data governance strategies using the same or improved data governance frameworks. This direction of research will be able to investigate if the proposed activities had deviated or otherwise changed in the implementation phase of the SCC. Improving on the data governance frameworks and methodology could address some of the limitations of this study and could draw new insights. Future studies on the SCC finalists can also explore if a smart city 3.0 was actually realized, or if new paradigms of smart cities were formed. Another direction for future research is to investigate cities for their data governance strategies regardless of if they have any smart city initiatives or other “smart” marketing. As data is ubiquitous, analysis of cities not labelled “smart” could look at differences between them and “smart” cities in the approaches to data governance. A comparison of approaches to data governance of smart cities can also be conducted between Canadian smart cities and smart cities from around the world. Finally, a direction for future research that this study was unable to explore was the merging and synthesis of the DG and BK models, so future research could produce a more robust framework that evaluates smart cities for their roles in data governance in relation to which decision domains and activities that may be of greater interest to each role. Future research could also synthesize the DG model with Bayat and Kawalek’s (2021) House Model to understand how data governance decisions can better support the broader strategic planning of smart city initiatives, to expand beyond analysis using the Data Governance Modes component.

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Appendix A
Finalists' Summaries

Finalists' challenges statements and summaries as found on the Infrastructure Canada website (Infrastructure Canada, 2019a).

Table A.1. Finalists' challenge statements and summaries (Infrastructure Canada, 2019a).

Prize Category	Finalist	Challenge Statement	Summary
5M	Biigtigong Nishnaabeg (Pic River First Nation), Ontario	By means of active, cross-generational, technology-empowered, real-world participation in the intergenerational transfer of traditional Nishnaabe knowledge through the medium of our language, and the bilingual delivery of modern K-12 STEM (Science, Technology, Engineering and Mathematics) knowledge, our community will transform our youth into better-educated, more employable, better-grounded, and more holistically Nishaabe people.	We are indigenously embracing the bilingual (Nishnaabemwin and English), K-12 STEM education of our youth. At the end of high school, our youth will have received more than 2,000 hours of mobile-enabled, online Nishnaabe-language immersion instruction in all of our core aadsookaanan (sacred stories). Additionally, our youth will be nearly-completely able to comprehend spoken Nishnaabemwin, will have attained a basic proficiency in coding and robotics, and will possess a strong foundation in mathematics and science. All STEM subject videos and courses will be available under a creative commons license, in both Nishnaabemwin and in English. All of this education will occur online with a strong real-world participation component built into the program. Our community's open source, mobile-enabled, eLearning platform facilitates the learning of the STEM subjects. And, our open source, mobile-enabled, eAcquisition platform facilitates the acquisition of our Nishnaabe language. The entire educational experience is tied together with our community's mobile-enabled meetup platform serving as a bridge between the digital, online world and the material, real world. Our youth are strongly encouraged and empowered to participate not only in online communities, but in the traditional Nishnaabe activities going on in the real-world community, as well.
	Cree Nation of Eastmain, Quebec	"IMPROVING COMMUNITY WELL-BEING" Our community will develop an affordable Net Zero Energy Housing Program, offering culturally appropriate designs, using smart technologies, innovative building techniques and alternative energy systems in order to address the housing shortage crisis, the poor-quality and costly construction of houses	As our Challenge Statement says, the Cree Nation of Eastmain (CNE) is committed to improving the quality of life and the well-being of its members. As a remote Indigenous community, CNE, like other Indigenous communities across Canada, is faced with a critical housing shortage, compounded by poor quality and costly construction. Housing is inarguably the foundation of a strong, healthy community without which communities struggle with various social, environmental and health issues. Through local consultations, CNE has determined that high construction costs combined with the high costs of home operation and maintenance, the result of inappropriate construction materials and techniques, are significant barriers to homeownership in Eastmain.

		in Eastmain and Indigenous communities across Canada.	Smart technologies, sustainable building practices and alternative energy systems are the cornerstone of CNE's plan to develop, in collaboration with public and private sector stakeholders, an affordable, culturally-appropriate Net Zero Energy (NZE) housing program, for new and existing housing, to respond to its housing crisis. The NZE program is designed to encourage openness, transparency and transferability. Through capacity-building, job creation and encouraging community participation, our NZE program will foster prosperity and a sense of pride in the community and in the culture, becoming a model for Indigenous communities across Canada.
	Town of Bridgewater, Nova Scotia	Our community will lift its residents out of energy poverty, starting by reducing the energy poverty rate by 20% by 2025.	Energy poverty is having a profound and debilitating impact on our community. It systematically strips many of our residents of their dignity and damages their physical and mental well-being. Yet, the real, lasting, and practical solutions to this problem are so close at hand that we can already see them emerging. Our community is planning for a new kind of energy economy - one where energy services are universally available and affordable, clean, efficient, and secure. We are ready for a massive shift toward a smart energy economy…one that leaves no family behind. We are also ready to show Atlantic Canada, and the nation, how it can be done. With $5 million in Smart Cities funding, our town will install sophisticated energy monitoring and communications equipment in over 1,000 low-income homes, develop a self-funding energy retrofit financing program, improve its transportation systems, and increase local clean tech sector training and literacy. It will allow our community partners to increase their capacity to exchange knowledge and work more efficiently and effectively to reduce, and ultimately end, energy poverty in our community. Every dime will be used, because the need is so great.
	Mohawk Council of Akwesasne, Quebec	Decrease the rate of new cases of diabetes per year in Akwesasne to the Canadian average (0.5%; 5.9/1,000) by improving community wellness using traditional approaches encompassing holistic Indigenous practices, improved access to community services and health diagnostics.	The scourge of diabetes falls heavily on Aboriginal people around the world. In Canada, the rate of diabetes for Indigenous people is 3 times that of other Canadians. The Mohawk Council of Akwesasne will use the Smart Cities Challenge to decrease the rate of new cases of diabetes, and provide a framework for similar communities. Drawing on holistic Indigenous practices focussed on protecting and restoring the natural world, our program will integrate modern health diagnostics, improved diet and food security, access to health services and physical

			fitness as ways to reduce the risk and prevalence of diabetes diagnoses. Smart technologies in the form of electric vehicles, smart greenhouses and an integrating mobile/websystem will be key tools in achieving positive change in lifestyle, education and accessibility issues at the root of problem. Akwesasne community members will share personal scoring on measures related to the areas of focus publicly but anonymously, so that the community's digital scorecard is transparent and a shared challenge. Software will seamlessly organize reporting, communication with health professionals, scheduling clinical access, food delivery and the education of risk reduction. Traditional practices will renew our Mind, Body and Spirit, while digital technology will help overcome our geographic challenges.
	City of Yellowknife, Northwest Territories	Yellowknife will experience a rise in our community's social and environmental well-being by transforming the simple lamppost into a beacon for sustainability.	Our proposed concept is to make the lamppost a beacon for sustainability. The sustainability referenced in this challenge statement ranges from ecological to financial to social sustainability, which we will realize by incorporating a variety of technological innovations into the lampposts around our city to improve quality of life for our residents and visitors in several ways. The first step will be creating a mesh network among our lampposts that allow them to communicate with each other and with a central location. From there, much like apps on a smart phone, a variety of innovative ideas could be incorporated into the lamppost to help us achieve our desired outcomes and to improve the sustainability of Yellowknife. These innovations will include smart lighting that can be motion activated or dimmed and brightened as needed, electric vehicle charging stations, data monitoring and collection, interactive tourism information, and Wi-Fi hotspots. This mesh network and technological innovations will help Yellowknife to become an innovative and adaptable Smart City with the ability to adapt with the times as technology advances.
10M	Town of The Pas, Opaskwayak Cree Nation, Rural Municipality of Kelsey, Manitoba	Our community will utilize LED Smart Farm technology to support local nutritious food growth and promote food security, create a smart phone distribution system and integrate wearable technology to achieve a 40% reduction in the number of imported vegetables and a 20% reduction in community diabetes rates by 2023.	Our challenge centres around food security and reversing the escalation of the occurrence rate of diabetes by leveraging the local LED Smart Farm technology. The Smart Farm produces fresh fruits and vegetables within weeks without the use of pesticides and with low impact on land resources. The quantity of food that can be produced is flexible and based on demand. The region will be able to depend on a stable, nutritious local food supply with a concurrent reduction in the requirement for long distance transportation resulting in fresher food, reduction of food waste and a

			reduction in the carbon footprint due to fewer long distance truck deliveries. Food distribution will be aided through the development and use of a smart phone app and the use of electric vehicle and drone delivery technology. The health benefits realized from increased consumption of healthy foods will be monitored through data collection via wearable technology. Bio-metric data such as blood sugar levels, heart rate and blood pressure can be utilized for individual feedback or aggregated to support ongoing education and incentives to encourage continued lifestyle changes among the population of the region and for other communities who wish to adopt similar strategies.
	City of Côte Saint-Luc, Quebec	In the face of a rapidly aging population, the City of Côte Saint-Luc will implement a connected framework, leveraging smart devices and related technologies that will empower seniors to: live more safely and independently in their homes; be better connected to their communities and city services; be more socially engaged, Improving the overall well-being and quality of life for older adults and reducing stress on families and caregivers, the healthcare system, and long-term care facilities.	Spaces in nursing homes and senior residences are limited and these accommodations often cost more than seniors can afford. Many seniors prefer to continue living in their own homes and apartments. This puts them at risk, especially if they have health concerns, live alone, or have a limited support network. More than 25% of all seniors in Canada live alone where there is often no one to watch over them to intervene when a problem arises. Our city offers many senior programs, but we feel it crucial to find technological ways to connect with isolated seniors. We seek to implement a comprehensive yet cost effective solution that will provide peace of mind, security, and support for those who need it. It must be easy to use and affordable. Our solution will help seniors who live alone by installing home monitoring sensors, GPS tracking, fall sensors and environmental sensors. It will use AI techniques to identify problems and share information gleaned with community, city and health services. It will allow us to know if the person living alone is okay, or not okay, and will route "situation analysis" reports to appropriate service organizations so that they can deliver timely intervention.
	Nunavut Communities, Nunavut	Our communities will implement protective and preventative measures to reduce the risk of suicide in Nunavut, which is ten times the national average, and increase the amount and accessibility of peer support networks, educational resources and creative outlets that promote positive	The Community, Connectivity, and Digital Access for Suicide Prevention in Nunavut is a collaborative effort to implement protective and preventive measures to reduce the risk of suicide in Nunavut through a decentralized and community-based digital health and wellness platform. This platform will leverage digital access and connectivity to increase the availability and accessibility of mental health resources and support systems like peer to peer networks, educational initiatives, and

		Mental Health to all Nunavummiut.	creative outlets to all Nunavummiut. This includes an Inuktitut based digital literacy curriculum, improved and innovative network infrastructure, mobile applications, gamified interventions, digital art therapy, and permanent makerspaces available in each community. This platform will rely heavily on community leadership and participation, and is based on Inuit Qaujimajatuqangit, the Inuit knowledge system and worldview, to provide the foundations upon which social, emotional, spiritual, cognitive, and physical well-being define health and wellness. It will provide Inuit youth with contemporary forms to engage with their heritage, reinforce Inuit language and enable cultural continuity through the use of technology. This is a transformative opportunity to incorporate a framework of cultural safety and trauma-informed care toward suicide prevention that is responsive to community needs.
	St. Mary's First Nation and City of Fredericton, New Brunswick	Fredericton & St. Mary's First Nation are collaborating to create an accessible, welcoming, supportive community, starting with youth, newcomers, older adults, and persons with mobility-related disabilities; recognizing what is important to individuals and connecting them to what matters most, empowering residents with personalized digital tools, data & technology that enable them to create an exceptional quality of life.	After conducting many rounds of public consultation and listening to citizens speak with passion about issues ranging from basic human needs to the desire for better services, one thing became abundantly clear…the biggest issue facing the community was different for everyone. With this insight, Smart City Task Force Chair, Adam Bell, approached Deputy Mayor Kate Rogers and asked "what would your best Fredericton be?" Ms. Rogers, well versed in the City's history, community and ongoing initiatives, responded quickly: "I want to live in a City that empowers me with a personalized inclusion plan connecting me to things that matter most: Imagine Fredericton, a Digital Fredericton that collaborates with First Nations, welcomes youth, supports newcomers and aging populations, connects people, creating an exceptional quality of life with measurable outcomes." Thus, laying the groundwork for a Smart Cities Challenge submission focusing on: initiatives underway that have meaningful impacts a layered approach – core, citizen, and connected community putting our most vulnerable, first the data, always capture the data "It's personal" building to replicate We will build a Smart City that will recognize, connect and enable all citizens, across generations and cultures, in unique and different ways that are meaningful to them.

	Parkland, Brazeau, Lac Ste Anne and Yellowhead Counties, Alberta	Our agricultural community will revitalize and grow through the connection of people to the land and food while attracting citizens to share in its prosperous, innovative and resilient way of life.	This proposal has a lofty goal. The applicants seek to increase the prosperity and safety of rural communities – farm and rural residential alike – through the full use of integrated data and connected technologies. Increased rural prosperity will support more people living on farms and in rural areas. This will require greater technology adoption, proper decision support tools and market linkage between rural/farm areas and urban Canada and beyond. The proposal seeks to build more prosperous market and knowledge links with urban Canada and beyond. Data-driven discussions will bring farmers closer to people's kitchen tables and address misconceptions about how our food is produced. We will improve the safety and security in rural areas by reducing accidents between large machinery, and improve regional security through technology adoption. Overall, these initiatives seek to create a more prosperous and safe way of life in rural Canada. In turn, a growing population is anticipated; a greater interest in living a rural lifestyle will prompt more young people to move into farming, and incent greater inter-generational farm transfer.
	City of Airdrie and Area, Alberta	Become Canada's healthiest community, by engaging and securing the participation of all in the community to create a community healthy culture that improves social, economic, physical and health care environments and individual characteristics and behaviours, so that healthy life expectancy is increased by 3+ years over 5 years.	We will become Canada's Healthiest Community – Own Our Own Health. We will increase healthy life expectancy by 3+ years over 5 years. That will be enabled through our Smart Community Project. Vision: "Own Our Own Health Information: Enabling efforts to be Canada's Healthiest Community – Individually and Collectively" Mission: "Create a Community "Health Information Sharing" Culture" Over the past two years, we have engaged hundreds of individuals and dozens of organizations in the community in thinking about what it would take to be Canada's Healthiest Community. Five projects have been identified: Airdrie & Area Blue Zone Project Airdrie & Area Health Park Project Airdrie & Area Need-Based Networks Project Airdrie & Area Health Coop Project Airdrie & Area Smart Community Project The Smart Community Project will leverage and connect existing and add new infrastructure, platforms and applications to create an open data platform for use by all. Data will be secured and customized content pushed out to enable informed action.

			The City of Airdrie sponsored this project. We know that one party cannot "do it to" the community. A Health Coop has been incorporated as the tool to bring all together as equal owners and equal beneficiaries.
	City of Richmond, British Columbia	Richmond, an island city with a rapidly growing and diverse population and home of nationally significant infrastructure and government services, requires resilient physical and virtual platforms that are integrated seamlessly across all levels of government to enhance quality of life in day-to-day activities and minimize community impacts from major disasters.	Richmond is comprised of 17 islands at the mouth of the Fraser River, on the West Coast. A gateway to the Asia Pacific, over 65% of the population originates from Asia Pacific countries. Home to YVR, the Port of Vancouver, and 30 minutes from the US border, Richmond's population, currently 220,000, is expected to reach over 300,000 with the City Centre population tripling, by 2041. Multi-levels of government and businesses have incident response plans and activation protocols utilizing for communication technology, decision making, and asset mobilization/ movement during an incident. The challenge is systems are not currently interconnected and integrated. This impedes response efforts, resulting in nuisance for citizens with minor events or potentially more serious consequences associated with major events. Richmond has invested in stable, reliable infrastructure and services as the basis for implementation of the Smart Cities Challenge. Citizen communication and built-in system resilience are essential to an integrated platform enabling data driven decision making to improve response rates and reduce recovery time. Project goals: Protect our island city; Integrate citizen, infrastructure and emergency data and communication platforms; Bridge language barriers; and Create scalable systems that both enhance daily life and improve emergency response rates and recovery times.
	City of Guelph and Wellington County, Ontario	Guelph/Wellington will become Canada's first technology-enabled Circular Food Economy, reimagining an inclusive food-secure ecosystem that increases access to affordable, nutritious food by 50%, where "waste" becomes a resource, 50 new circular businesses and collaborations are created, and circular economic revenues are increased by 50%: 50x50x50 by 2025.	Food is a fundamental requirement of life on this planet. However, the basic structure of today's linear "take-make-dispose" food system is unsustainable — economically, socially and environmentally. Guelph-Wellington aims to become Canada's first circular food economy, bringing our food system and communities back into healthy balance. Through our rural-urban partnership, we will enhance access to nutritious food, turn "waste" into valuable resources and create new economic opportunities. Situated in the heart of Ontario's Innovation Corridor, Guelph/Wellington is a hub of food innovation and environmental sustainability, making us uniquely positioned to achieve this vision. Leveraging local expertise, big data and the latest technology, we will transform our food ecosystem into a connected "living lab" where researchers, social innovators, farmers,

			entrepreneurs and other community partners collaborate to solve complex food problems. The Smart Cities Challenge is an important catalyst, enabling us to fund impactful circular food projects, create collaboration spaces, undertake baseline data mapping to guide programs and planning, create a suite of digital tools, and more. Together, we will build the "Circular Food Community of the Future," creating positive quadruple bottom line outcomes — prosperity, planet, people and purpose — and share the roadmap with the communities across the country and around the world.
	City of Saskatoon, Saskatchewan	To be the city that breaks the cycle of Indigenous youth incarceration by creating a new cycle focused on building purpose, belonging, security and identity.	Saskatoon has a bold vision to be a city that supports all individuals to feel a sense of purpose, belonging, security and identity. People are being left behind, many of them are youth, and many of them are urban Indigenous youth. Urban Indigenous youth face multiple challenges that are rooted in intergenerational trauma, racism, and a disrupted relationship with cultural and spiritual traditions. This is manifesting itself in an escalating cycle of crime that results in Saskatoon having a youth incarceration rate that is double the national average. This cycle of crime and social exclusion is resulting in millions of dollars being spent to warehouse people in facilities where instead of rehabilitating they become hardened and in many cases involved in increasingly serious crime. This cycle continues through generations. The existing system is failing all of us. The City of Saskatoon has initiated a partnership with key institutions all committed to working together in finding proactive, preventative solutions to youth incarceration. Our Smart Cities Challenge will build on this collaborative work and use innovative technology to strengthen and connect the supports for youth to grow in a positive learning cycle rather than find themselves pulled into a cycle of crime.
	Greater Victoria, British Columbia	"Freedom to move" We will collaboratively create a multimodal transportation network that is convenient, green and affordable, which will boost South Islanders' mobility wellbeing score by at least 20%.	We wish to acknowledge we are on the traditional territory of the Coast Salish First Nations. A Smart City is comprised of countless elements. It is challenging to decide which initiatives to pursue, and what to leave for later. While our ambition was to work on initiatives on multiple fronts, we saw that as a recipe for mediocrity. We want to create something great, which other cities will emulate. That's why we chose to go deep on transportation.

			Greater Victoria is not a big city by population. It is, however, an important city strategically. Canada's 15th largest metropolitan area. A $5 billion high-tech sector. Located in one of the world's most progressive and innovative regions: The Pacific Northwest. A gateway to Asia. A place where forward-thinkers thrive. A place people visit and tell their friends. We want Greater Victoria to showcase how mobility can be done right. How everybody should enjoy the freedom of mobility. How all points of friction can be eliminated between multiple modes of transit, even in a single trip. How big data, big ideas, and big thinkers can make a big difference in quality of life, while reducing the impact that cities have on the environment.
50M	Waterloo Region, Ontario	We will become the benchmark community in Canada for child and youth wellbeing by using early intervention, youth engagement and a connected-community framework to create adaptive, data-driven programs and scalable learning technologies that improve early child development, mental health and high school graduation rates.	We have selected Healthy Children and Youth as our smart cities challenge area. Based on data and community consultation, we have identified six priority areas of focus that will address through our smart cities initiative: early child development; mental health; bullying; literacy rates; high school graduation rates; and youth sense of belonging. Working with our local youth and community partners from the private, not-for-profit, educational and government sectors, we will develop connected community spaces, broader education platforms and technology-based programing that supports equity, mentorship, volunteering, mental health, food security and nutrition and STEAM learning. In partnership with UNICEF Canada and their One Youth Initiative, we will build Canada's first real-time child and youth wellbeing dashboard. Using a community-based data platform that connects data from multiple organizations, we will create a framework that measures child and youth wellbeing in Waterloo Region against UNICEF's Canada's Child and Youth Wellbeing Index. Together, we will work with UNICEF Canada to scale this framework to communities of all sizes across the country helping to make Canada the number one country in the world for child and youth wellbeing over the next decade.
	Quebec City, Quebec	"THE SOCIAL INEQUALITIES IN HEALTH: UNDERSTANDING AND ENGAGING DIFFERENTLY" To engage the community of Quebec City in a societal project centered on citizens' sustainable health and well-being using the collective intelligence and the deployment of digital tools	Through the implementation of the project Social Inequalities: Understanding and Engaging Differently, the community of Quebec is committed to a societal project that focuses on sustainable health and citizens' well-being. This societal project will bring together the collective intelligence and the deployment of digital tools in support to decision-making and follow-ups. Our proposal for the Smart Cities Challenge relies on a large study conducted by the Regional Direction of Public Health in 2012. The Study acknowledges the

		that support decision-making and follow-ups.	social inequalities in health as a major public health problem requiring a concerted action from all. In Quebec, this fact calls for action and mobilization. The consultations directed by the City confirm that citizens are committed to promote projects with a positive impact on health. We will leverage the knowledge of academic researchers, the commitment of institutional and business partners, the citizens experience, the wide potential of new technologies, and the expertise of the municipal staff, to initiate and launch an ambitious project in line with the innovative solutions implemented by the City of Quebec in the last decade.
	City of Edmonton, Alberta	Edmonton will lead the transformation of Canadian healthcare using an unprecedented municipal approach by focusing on leveraging relationships, health data and innovative technologies to provide a personalized health connection and experience as unique as the health of every Edmontonian.	A Smart City is first and foremost a Healthy City. Recognizing urbanization and the increasing role residents' health affects and is affected by City services, the City of Edmonton proposes that municipal-level intervention is necessary. The City of Edmonton is facilitating the creation of a Healthy City Ecosystem (a partnership of government, industry, academia and residents) to work collaboratively to provide integrated, community-based health support. Addressing social determinants of health, such as connectedness, loneliness and sense of belonging is an innovative, transformational approach, shifting the focus from treating symptoms to one of prevention. A smart cities approach will enable the creation of a single Health Data Repository, connecting disparate datasets from the stakeholders and the data collected by new technologies, ensuring anonymity and integration to facilitate assessment, analytics and data mining. Residents will access the new municipal health support through a digital tool and devices, allowing them to identify and access additional services, relationships and technologies to improve their individual health and connectedness.
	City of Surrey and City of Vancouver, British Columbia	Surrey and Vancouver will implement Canada's first two collision-free multi-modal transportation corridors, leveraging autonomous vehicles and smart technologies to demonstrate the path to safer, healthier and more socially connected communities while reducing emissions, improving transportation efficiency and enhancing livability in the face of rapid growth and	Surrey and Vancouver will implement Canada's first two collision-free multi-modal transportation corridors, taking an ambitious step toward improving our residents' quality of life by removing transportation safety risk, reducing greenhouse gas emissions, and increasing transportation efficiency. We will provide a model for Canadian cities and will turn Canada into a global autonomous vehicle and smart mobility leader. To achieve this, our two collision-free corridors will be equipped with smart mobility solutions related to: autonomous shuttles

		traffic congestion. #SmarterTogether	smart mobility infrastructure advanced data and analytics, and enhanced user experience The Surrey-Vancouver joint proposal is the result of an extensive, inclusive, and community-first engagement with our residents and an unprecedented collaboration between our two cities. Our journey together has involved rich conversations that have led to strong bonds and a new inter-city culture. We have learned and innovated together to propose a vision that will increase transportation safety, contribute to a greener environment, and build stronger communities. We have become #SmarterTogether through the Smart Cities Challenge. Our collision-free multi-modal transportation corridors, enabled by smart city technology, represent a bold step in the move from incremental transportation safety improvements to exponential progress.
	Montréal, Quebec	The Montreal community is shaping an efficient and dynamic neighbourhood life by innovating mobility and access to food. Through a co-creation and citizen participation process, the accessibility of services and the well-being of Montrealers are increasing significantly.	The city of Montréal and 36 project owners and partners are committed to take action on systemic issues of urban life including mobility and access to food so that all Montrealers may enjoy a pleasant quality of life where their basic needs are met. Technology will allow us offer Montrealers efficient and sustainable transportation alternatives, thus reducing automobile usage. As a result, neighbourhoods will become more enjoyable places, conducive to a rich and local way of life. An improved public transportation offering associated with new and innovative forms of mobility (car sharing on-demand, autonomous vehicles, bike sharing, etc.) will reinforce the access to local services, most notably to food supply. As a complement to the technological dimension, transversal projects in governance and citizen engagement will ensure the responsible deployment of technologies, given that they will be derived from collective decision-making, thus preventing abuse in terms of data collection and usage. The combination of a participative and technological approach framed by innovative and agile governance will not only concretely improve the lives of Montrealers, but will bring about profound, sustainable change which may be applied to other contexts.

Appendix B

Result Charts

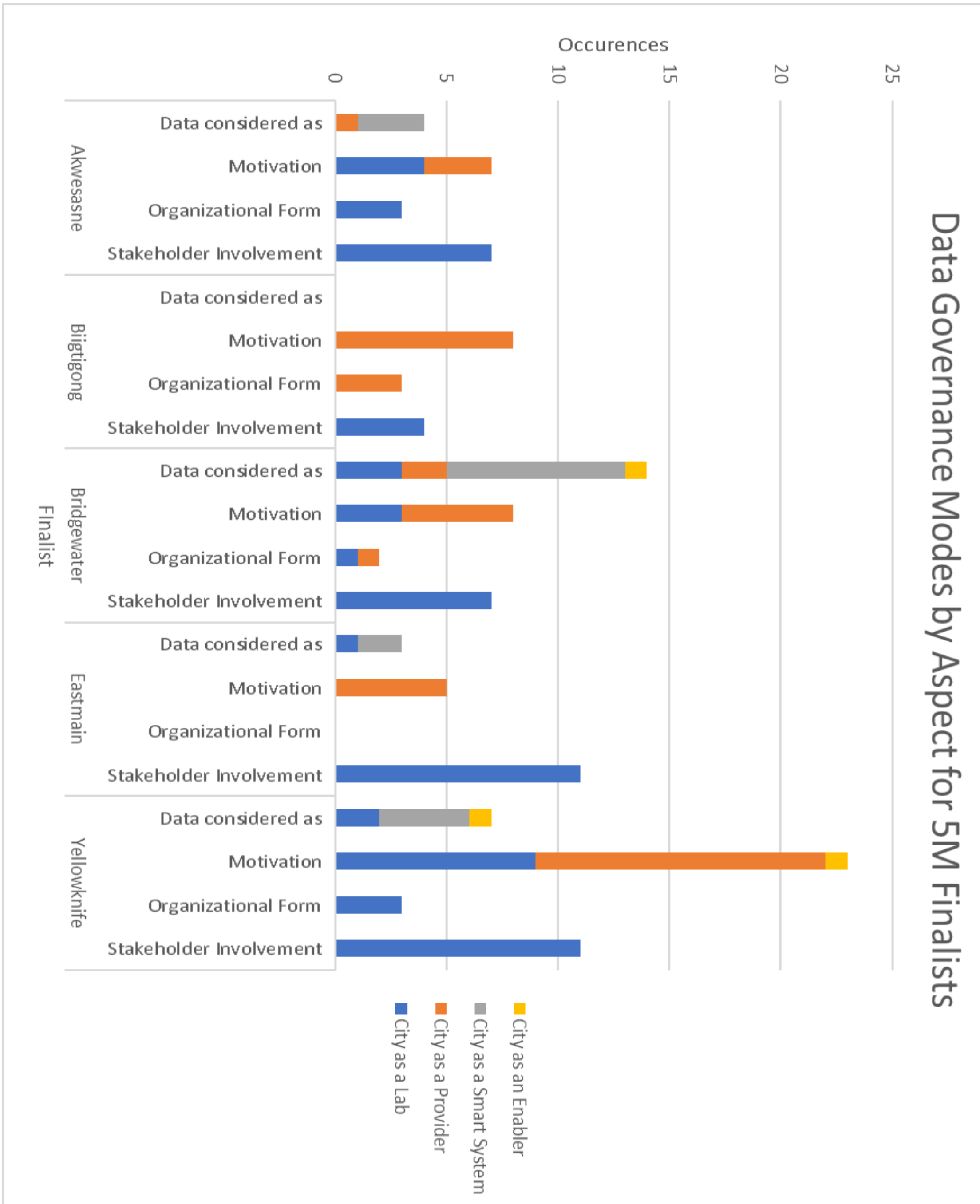

Figure B.1. Data Governance Modes by Aspect for 5M Finalists.

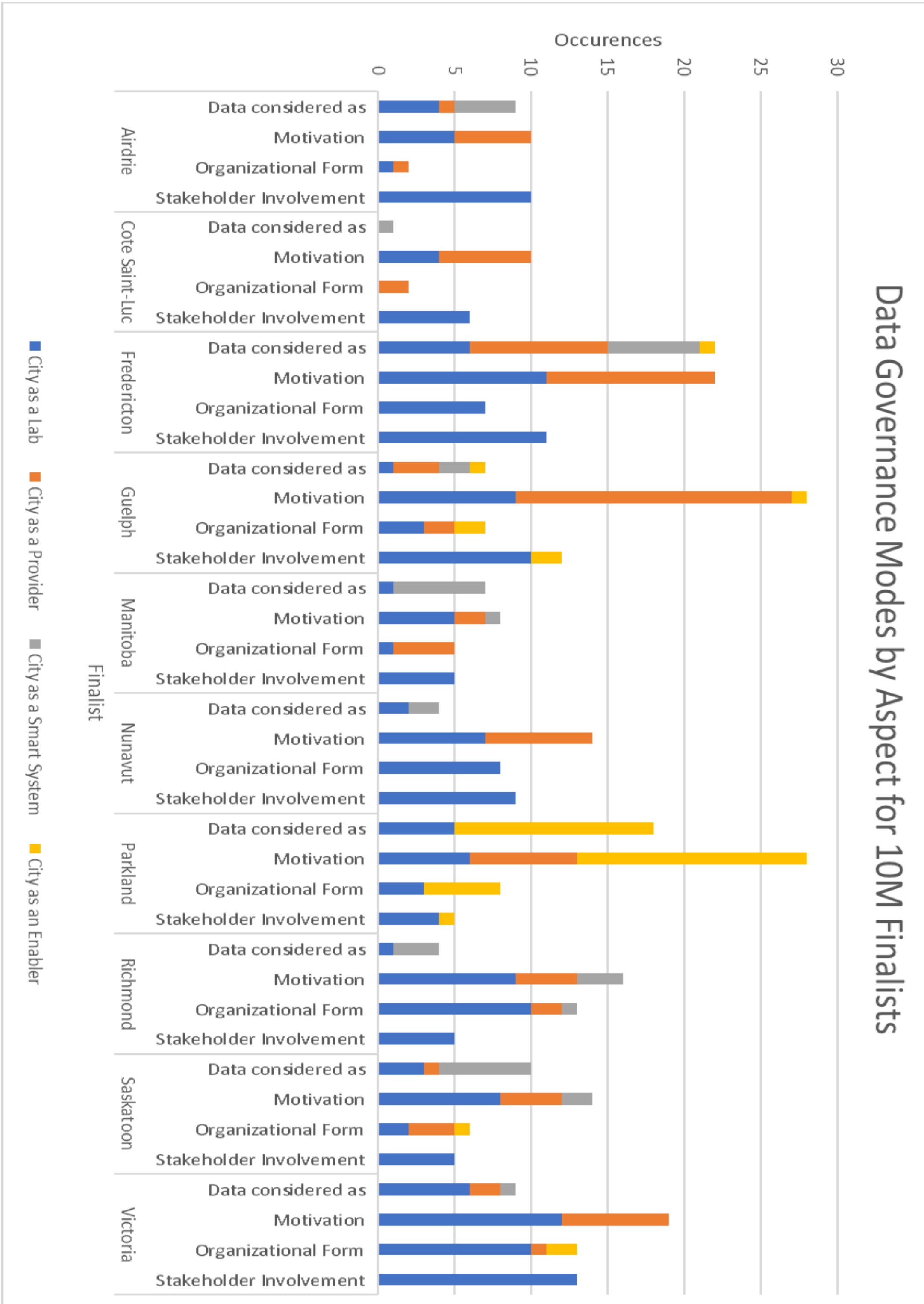

Figure B.2. Data Governance Modes by Aspect for 10M Finalists.

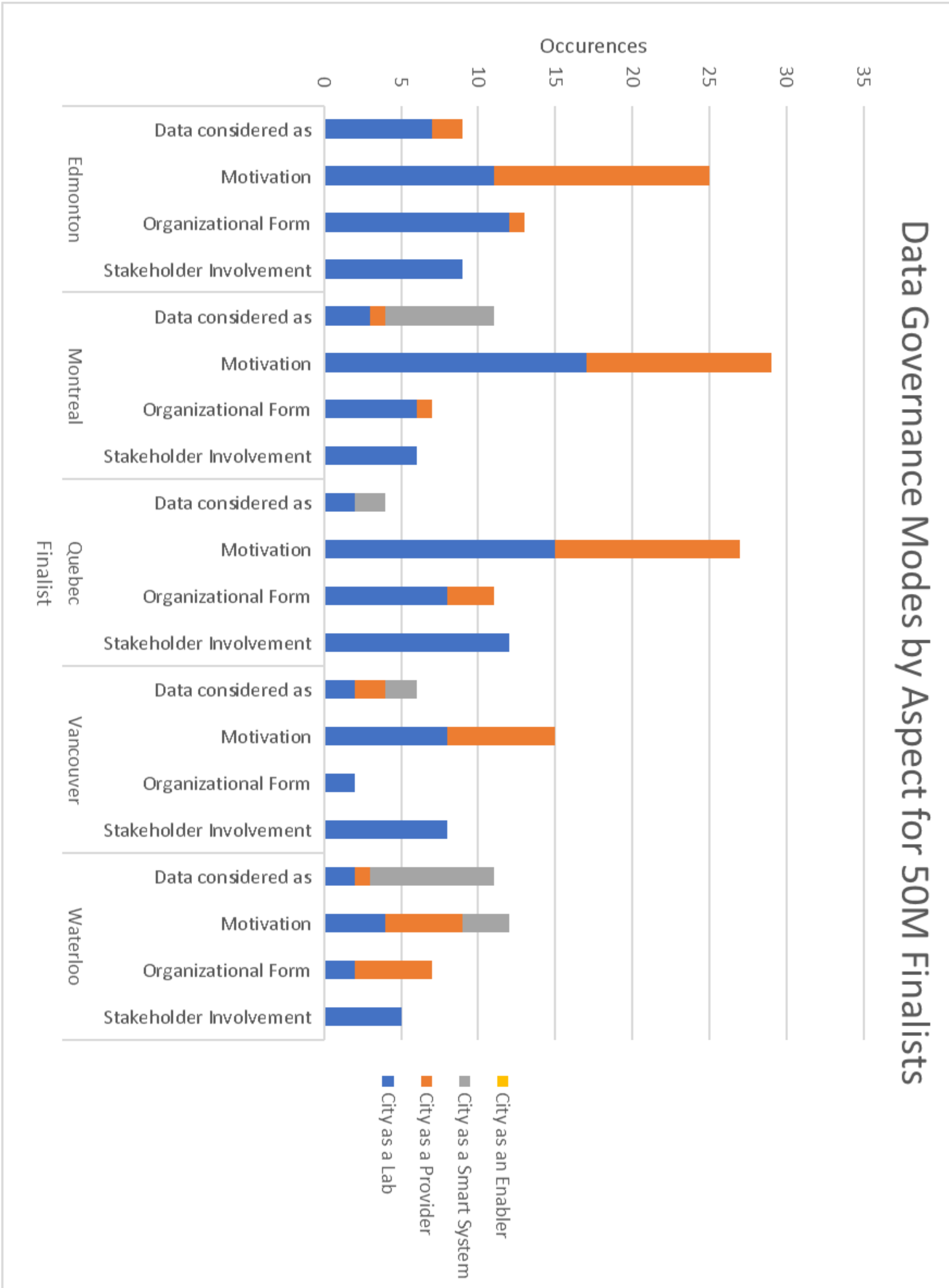

Figure B.3. Data Governance Modes by Aspect for 50M Finalists.

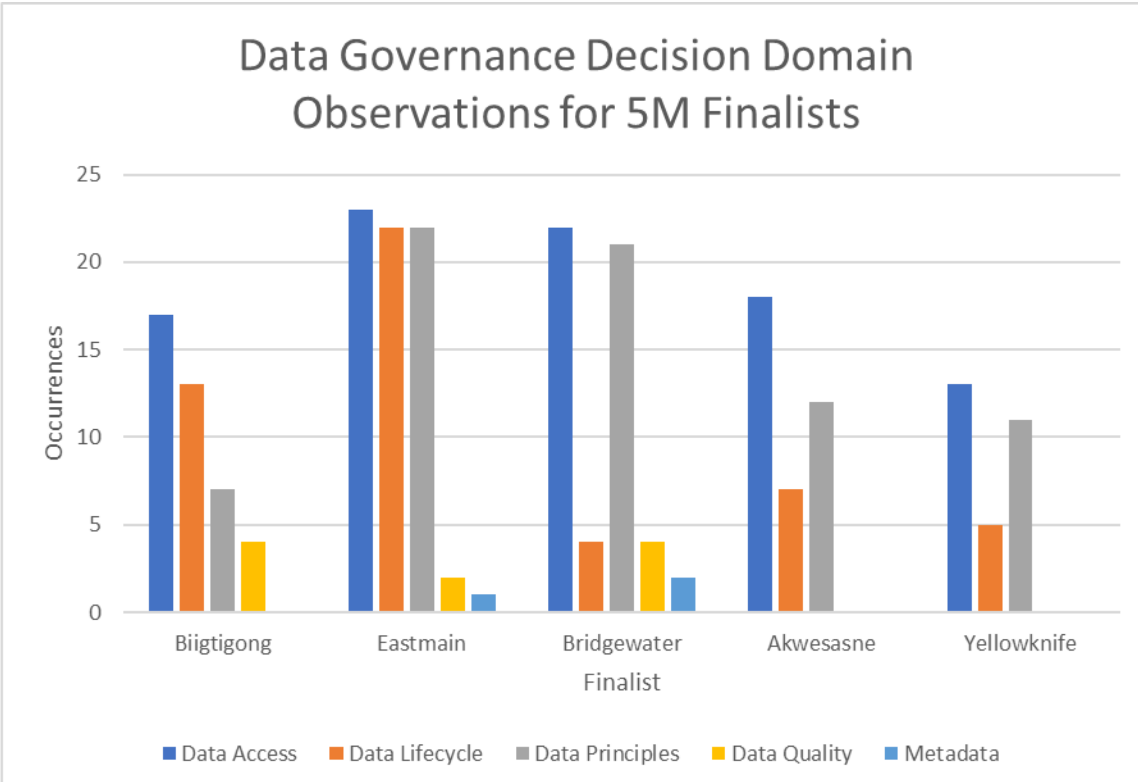

Figure B.4. Data Governance Decision Domain Observations for 5M Finalists.

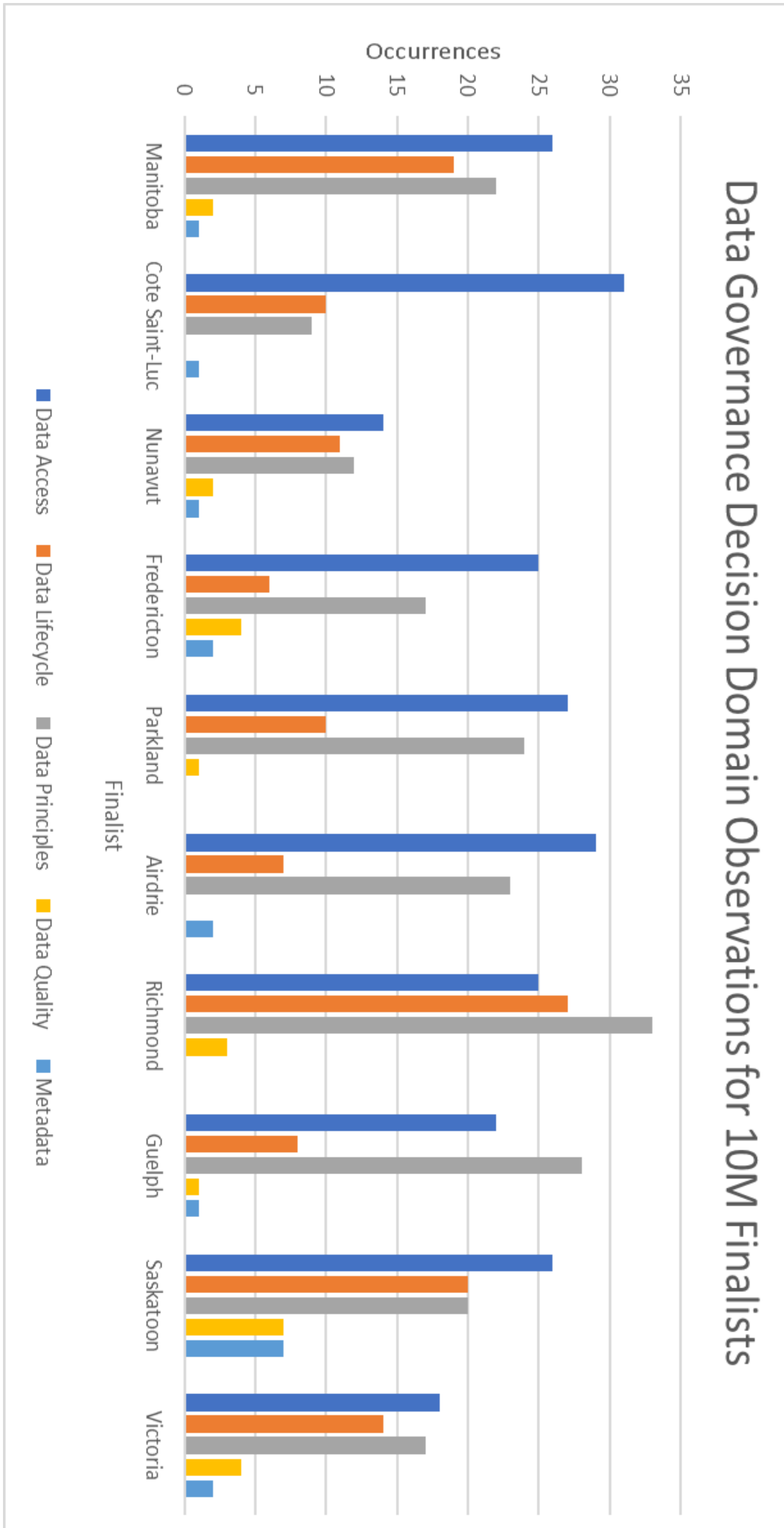

Figure B.5. Data Governance Decision Domain Observations for 10M Finalists.

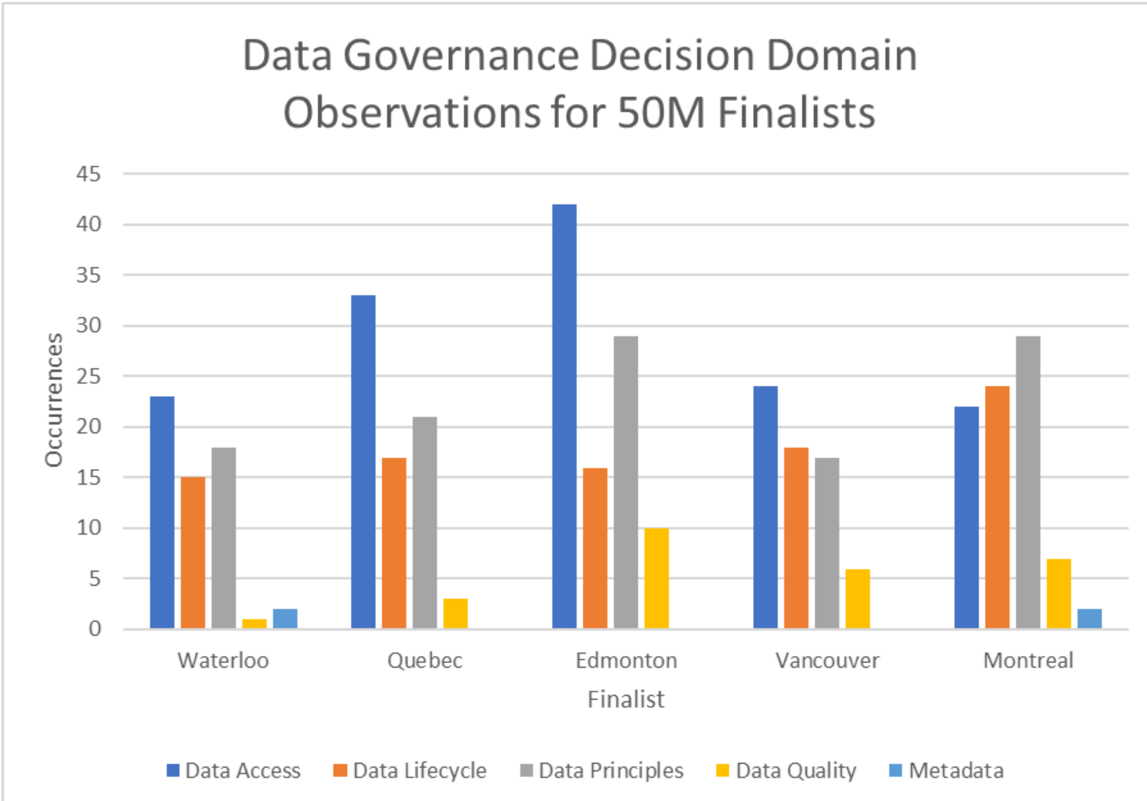

Figure B.6. Data Governance Decision Domain Observations for 50M Finalists.