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UNIVERSITY OF TORONTO

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IMFG focuses on the fiscal health and governance challenges facing large cities and city-regions. Its objective is to spark and inform public debate, and to engage the academic and policy communities around important issues of municipal finance and governance. The Institute conducts original research on issues facing cities in Canada and around the world; promotes high-level discussion among Canada's government, academic, corporate, and community leaders through conferences and roundtables; and supports graduate and post-graduate students to build Canada's cadre of municipal finance and governance experts. It is the only institute in Canada that focuses solely on municipal finance issues in large cities and city-regions.

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Abstract

The rising popularity of smart city technology and digital government has prompted many national governments to attempt to spur municipal governments to adopt new tools aimed at digitalization, modernization, and innovation in a movement collectively known as "smart cities." With few tools available to mandate that municipalities pursue a smart city approach, several national governments have turned to incentive-based competitions, launching state-led contests for their cities to upgrade their capabilities and offering millions of dollars in funding and organizational resources to incentivize communities to participate. Even for cities that do not win, these contests have created opportunities to critically assess their smart city aspirations and revisit long-term planning. Despite the intertwined histories of the smart city concept and urban competitions, limited research exists on the impact and influence of smart city competitions on city processes, plans, and operations. We ask the question "Is the competition model a good method to advance technological adoption in cities?"

This paper addresses this gap by exploring in depth four different government-led smart city challenges – one each in the United Kingdom, the United States, the European Union, and Canada. By examining the program goals, competition mechanics, and publicized outcomes of each, then evaluating and comparing them through an urban change framework, this paper identifies the challenges inherent in a nationally driven, centralized approach to competition funding of municipal programs. It finds that these competitions were very effective at realizing the desired learning outcomes at the individual, organizational, and city levels: they helped generate new ways of thinking about technological solutions, and they supported the building of new relationships to address urban challenges for winners and non-winners alike. However, in terms of institutional and system change outcomes, the results of these competitions were much more limited. They were often most impactful for the city winners who were able to realize projects, and for national governments piloting a novel funding-by-competition model. We conclude by making policy recommendations on how to improve the implementation of this new model for the future.

Keywords: smart city, urban competitions, funding

JEL Codes: O36, O38, H76

Levelling Up Innovation in Local Government: An Evaluation of International Smart City Competitions

1. Introduction

With rapid advancements in technology around the globe, all orders of governments – from national to subnational to local – are trying to spur modernization, digitalization, and innovation in their governance structures and service delivery. This process is known widely as "smart city" design. Becoming a smart city involves transforming a local government's approach to disruptive industries, from reactive policymaking to proactive governance in which technology plays a featured role in governmental plans, programs, and platforms (Zwick and Spicer, 2021). For example, India created a Smart Cities Mission to upgrade its city infrastructure and modernize municipal governments (Government of India, 2021); Songdo, near Seoul, is considered the world's first smart city (Huh et al., 2024); and Singapore is frequently ranked as the smartest city in the world by multiple rating agencies (Teale, 2021).

In many countries, national governments have a limited formal role in the affairs of their cities; responsibility for local decisions generally rests in municipal hands. However, they can use regulatory authority and the powers of the purse to ensure that decisions made at the national level have a sizable impact on urban policy and governance. As discussed in this paper, some national governments have turned to incentive-based programs, launching formal competitions for their cities to upgrade their approach to technology, offering millions of dollars in direct funding and other indirect benefits to winners as incentives for communities to participate. Is this competition model a good way to advance the adoption of technology in cities?

For the winners of these competitions, the benefits are obvious: national resources, both financial and organizational, are deployed to implement smart city projects, with the positive publicity being an additional bonus. However, even for cities that do not win, participation may create an opportunity to critically rethink what is possible and revisit long-term planning, potentially resulting in the kind of governance transformation that embodies the smart city movement.

Though the term "smart city" has been used for decades, a great deal of the popularity surrounding the term can be attributed to the IBM Smarter Cities Challenge, which launched in 2008 with its first winners announced in 2010 (Söderström et al., 2014). Since then, the term has been promoted around the world in places such as Shanghai, Barcelona, London, and many others to target private investment through technological solutions for a range of urban issues – in particular, improved energy and water use, efficient transit, and better government (Kitchin, 2015). "Smart cities" quickly became the accepted umbrella term for tech-savvy municipal governments, but it also broadly linked economic development, urban transformation, and technology together (Townsend, 2013; Söderström et al., 2014). Even though most smart city initiatives are led by the private sector, with the public sector primarily serving as a facilitator of private investment, government-led urban competitions have begun to change the dynamic by putting

local bureaucrats in the driver's seat (Robinson and Biggar, 2021). Government-led competitions have played a key role in helping municipalities understand their capabilities and autonomy within the smart city movement (Zwick and Spicer, 2023). Despite the historical intertwining of the smart city concept and urban competitions, limited research exists on the impact and influence that smart city competitions have had on municipal processes, plans, and operations (Viale Pereira et. al, 2017).

This paper addresses that gap by taking an in-depth dive into four government-led smart city challenges – one each in the United Kingdom, the United States, the European Union, and Canada. Even though individual studies from the United States (Wang et al., 2021), the United Kingdom (Taylor Buck and While, 2017), the European Union (Komninos et al., 2020), and Canada (Zwick and Spicer, 2023) show that urban competitions have spurred substantive policy responses from municipalities within their governmental scope, there is currently a gap in the literature when it comes to looking at these competitions as a part of a larger international movement of state-led innovation in the municipal government sector. By taking a step back and examining the (a) missions, (b) competition mechanics, (c) applications, and (d) publicized outcomes of these programs, this paper offers a unique view into an increasingly popular method of resourcing infrastructure from national governments. It then compares the competitions using a modified version of the Goodspeed (2020) evaluation framework that examines program outcomes on different scales, assessing each competition on a matrix.

There are limitations to this method in that it was conducted as a high-level overview using publicly available sources. Although we were able to find a number of primary sources from each country and a number of cities, as well as many secondary sources (news and academic articles), as demonstrated through the number of citations, this method does not provide the depth of direct interviews with those from different orders of government who participated in the contests as hosts, sponsors, applicants, and winners. To date, as our literature review revealed, no academic research has been published that includes post-mortem interviews with contestants from any of these four competitions. This is an avenue for future research.

While investigating the question of whether incentive-driven contests are the best way to advance technological adoption in cities, this paper identifies the challenges inherent in a nationally driven, centralized approach to competition funding of municipal programs. We find that these competitions were very effective at achieving learning outcomes on an individual, organizational, and city scale: they have helped individuals, government entities, and the public generate new ways of thinking about technological solutions, and have built new relationships to address urban challenges for winners and non-winners alike. When it comes to institutional and system change outcomes, the impacts of these competitions were much more limited; they tended to have significant impact only for the city winners, who were able to implement projects, and for the national governments piloting this novel funding-by-competition model.

The next section of this paper describes the four competition case studies individually. The subsequent section introduces an evaluation framework that allows the cases to be compared. The conclusion offers recommendations on how to improve implementations

of this model for the future, including the following: (a) build a community around the applicants; (b) provide more oversight and support in managing funding and securing private capital; (c) keep competition goals clear and focused; (d) determine key performance indicators from the outset; (e) clarify the role of the public; and (f) support data governance and privacy standards.

2. Case Studies

Table 1 provides an overview of the four different competitions, indicating the location of each one, the department within the central government that was responsible, the period in which the competition occurred, the mission of the competition, the number of applicant cities, the number of finalist cities, and the number of winning cities. All four were nationally driven competitions among cities, designed around an open contest model with explicitly stated rules relating to the theme of smart cities. This, however, is where the similarities end; the competitions differed in many ways, including contest structure, policy focus area, eligibility requirements for participating cities, number of cities involved at each stage, and number of prizes awarded.

2.1 United Kingdom

The Future City Demonstrator competition in the United Kingdom was created with the aim of showcasing the benefits of integrating city systems and finding innovative solutions to address local challenges. The competition was made possible through a 2012 investment of £25 million by the Technology Strategy Board (now Innovate UK), with the aim of improving the quality of life, environmental sustainability, and local economies of participating cities (Cowley and Joss, 2020). The competition began with bids for funded feasibility studies and culminated in the submission of large-scale demonstrator project proposals, with up to £24 million going to the winning project. This smart city competition played an important role in national innovation policymaking, encouraging government agencies to fund more solutions for urban challenges (Technology Strategy Board, 2012).

The competition structure included a two-stage process aimed at fostering innovative urban solutions. During the initial stage, all cities (designated as such by the national government) in the United Kingdom were invited to submit an (unfunded) brief bid for funding to conduct a feasibility study and develop a project proposal. A total of 20 grants of £50,000 were available in this stage to cover eligible costs for developing a final project proposal. In the second stage, cities that had succeeded in securing these first-round grants were to use them to finalize their feasibility studies and submit proposals for a large-scale demonstration project. (Shortened versions of these proposals were to be made publicly available.) The winner of this round would receive the remaining £24 million to implement its project; the funds were required to be spent by the end of the 2013–14 financial year. A portion (up to £1 million) of the winning grant was earmarked for a final outcomes study (Technology Strategy Board, 2012).

The competition accepted 30 bids for the first round of grants, outlining various ambitious proposals for urban development from cities around the United Kingdom. For example: Plymouth, in partnership with local businesses and the local university, aimed

Table 1: Government-Led Smart City Challenges around the World

Challenge Name	Innovate UK's Future City Demonstrator Competition	U.S. DOT Smart Cities Challenge	European Union Digital Cities Challenge	Infrastructure Canada Smart City Challenge
Location	United Kingdom	United States	European Union	Canada
Timeframe	2012–2013	2015–2016	2017–2018	2018–2019
Challenge Sponsor	Innovate UK	U.S. Department of Transportation	European Commission	Infrastructure Canada
Mission Statement	"The project will demonstrate at scale, and in use, the additional value that can be created by integrating city systems. The project will enable businesses to test, in practice, new solutions for connecting and integrating city systems, and will allow UK cities to explore new approaches to delivering a good local economy and excellent quality of life, whilst reducing the environmental footprint and increasing resilience to environmental change." (Technology Strategy Board, 2012; 204)	"In December 2015, we launched our Smart City Challenge, asking mid-sized cities across America to share their ideas for how to create an integrated, first-of-its-kind smart transportation system that would use data, applications, and technology to help people and goods move faster, cheaper, and more efficiently." (U.S. Department of Transportation, 2016a; 2)	"The Digital Cities Challenge is an initiative of coaching and facilitation by the European Commission to help European cities develop and implement policies that focus on smart, sustainable growth through the uptake of advanced technologies by local business." (Digital Cities Challenge, 2019; 15)	"The Smart Cities Challenge is a pan-Canadian competition open to all municipalities, local or regional governments, and Indigenous communities (First Nations, Métis and Inuit). The Challenge empowers communities to adopt a smart cities approach to improve the lives of their residents through innovation, data and connected technology." (Government of Canada, 2020)
Number of Applicant Cities	30	78	92	133
Number of Finalists	20	7	35	20
Number of Winning Cities	1	1	15	4

to integrate transportation, communications, and infrastructure using mobile technology (Rossiter, 2012); Milton Keynes focused on electric cars and smart home technology partnerships *(Milton Keynes Citizen,* 2012). Bristol envisioned itself as the country's creative capital, with plans for a government performance-monitoring app (Berst, 2013); Nottingham focused on public transportation monitoring and a program for elderly residents (*Nottingham Evening Post*, 2012); Coventry established a Technology Strategy Board to boost economic growth through local innovation (Bagot, 2012); Stoke-on-Trent sought to improve the integration of its waste, energy, and water systems (Psyllides, 2012); and Sunderland aimed to integrate government systems for cost-effective public services (*Journal*, 2012). These proposals encouraged 21st-century governance in U.K. cities as they competed to gain access to funding, accreditation, and resources while promoting cross-departmental collaboration and knowledge sharing. Some of the participating cities created in-house departments to promote potential smart projects locally, with the intent to continue seeking grant funding and improve smart capabilities for the city whatever the outcome of the competition.

Glasgow won the competition in 2013, reflecting the city government's commitment to addressing such challenges as resource scarcity, climate change, unemployment, and an aging population. (Bristol secured a runner-up prize of £3 million in separate government funding.) The Glasgow proposal stood out due to its clear focus on addressing social and health priorities (Taylor Buck and While, 2017). Glasgow aimed to create a smart city management system that would include an intelligent operations platform, a data repository, city dashboards, and a citizen engagement app. These tools were designed to enable the integration of city systems and data across multiple agencies, ultimately delivering improved and more responsive city services. Importantly, Glasgow's proposal was designed to serve as a model easily replicable by other urban areas in the United Kingdom; this aligned with the competition's broader goal of showcasing the benefits that integrating city systems can provide (Walt, Doody, et. al., 2014). The city's ability to offer integrated urban solutions highlighted the country's strengths in urban innovation.

Reports show that the competition ultimately led to a £144 million return on investment within Glasgow, using various key economic indicators (Innovate UK, 2017). The city's demonstrator project covered multiple areas, such as energy efficiency, public safety, health, and transport. Notable initiatives included the creation of the city's first centralized data hub, enabling the collection and storage of key urban data related to air pollution, traffic flows, and health statistics (Kuchera, 2016). Additionally, improved active travel systems designed to enhance transport efficiency for cyclists and pedestrians contributed to reaching the Scottish Government's target of having 10 percent of trips on bikes. Smart meters were installed to better monitor and analyze energy use, reducing emissions and addressing fuel poverty (Loxton and Nicoll, 2013). Glasgow also created a social transportation initiative aimed at helping vulnerable citizens access social and educational services. Furthermore, the city implemented intelligent street lighting to reduce energy consumption and improve public safety by collecting data on noise, movement, and air pollution (Innovate UK and Office of the Secretary of State for

Scotland, 2017). "Glasgow was able to operate in a much more innovative, agile, open and flexible way, with much better citizen engagement. A shift towards everybody thinking about 'Our Glasgow'" (Miller, 2018).

2.2 United States

Launched in December 2015, the U.S. Department of Transportation (U.S. DOT) Smart City Challenge emerged as a response to the increasingly digital landscape of urban transportation and the growing integration of technology into city infrastructure. The primary mission of the challenge was to encourage mid-sized cities in the United States to develop innovative smart transportation solutions using data and technology (Foxx, 2016). This initiative was formally aimed at addressing high-priority transportation issues, bridging the digital divide, and serving all residents equitably (U.S. Department of Transportation, 2017). It emphasized the importance of competition, collaboration, and experimentation in fostering innovation in smart city development (Chin and Guthrie, 2023). The goal was to leverage $350 million in public and private funds to propel the implementation of advanced transportation technologies and smart city solutions, with a particular emphasis on inclusivity and addressing the diverse needs of urban populations. (All dollar amounts in this section are USD).

Seventy-eight cities across the United States participated in the Smart City Challenge. The rules of the competition encouraged cities to focus on mobility improvements, sustainable transit services, pedestrian and bicycle infrastructure, and efficient use of parking infrastructure (U.S. Department of Transportation, 2017). Seven finalists – Austin, Columbus, Denver, Kansas City, Pittsburgh, Portland, and San Francisco – were selected to work closely with U.S. DOT to refine their concepts. These cities were each granted $100,000 to use for public outreach, creating pitch videos for the competition committee, and technical assistance in developing a comprehensive smart city plan (U.S. Department of Transportation, 2016b). The challenge encouraged taking a holistic perspective that combined transportation engineering with social considerations, including transportation equity, gentrification, and environmental justice.

Each city's application reflected its unique vision and strategy for addressing urban challenges in transportation and other areas. For instance, San Francisco aimed to shape the autonomous vehicle revolution, emphasizing accessibility, safety, cleanliness, and reliability in transportation (City of San Francisco, 2016). Denver prioritized public-private collaboration to address challenges arising from rapid population growth, traffic congestion, and social disparities (City and County of Denver, 2016). Pittsburgh focused on leveraging smart technology to enhance safety, mobility, and job opportunities through the creation of a SmartPGH Consortium (City of Pittsburgh, 2016). Kansas City highlighted initiatives to make transportation safer, more accessible, and environmentally friendly, building on existing smart city infrastructure (City of Kansas City, 2016). Austin, America's fastest-growing major city, addressed economic segregation and mobility challenges through Smart City pilots, including connected corridors and autonomous vehicles (City of Austin, 2016). Portland aimed to shift toward a multimodal future, addressing transportation inequities through initiatives like UB Mobile PDX, with a focus

on community outreach and innovative technologies (Henderson, 2016). The winning city – Columbus, Ohio – envisioned becoming a hub for intelligent transportation systems (ITS) research and development, with a total investment of $140 million: $40 million from U.S. DOT, $10 million from corporate partner Vulcan, Inc., and $90 million the city had already secured from other private partners. The city government aimed to prioritize universal accessibility, sustainability, and economic growth through public-private partnerships (City of Columbus, 2016).

The winning application from Columbus showcased a unified vision of becoming a leader in smart city technology, with an emphasis on economic opportunities, job growth, and improved access to services through investments in ITS. The city prioritized serving diverse demographics, including youth, seniors, new Americans, and individuals with disabilities (City of Columbus, 2021). It aimed to address environmental sustainability goals such as transportation electrification and greenhouse gas reduction. The focus on public-private partnerships, together with a commitment to enhancing the quality of life for all residents, played a significant role in Columbus's win (City of Columbus, 2016).

The outcome of the competition for Columbus has been substantial, although its vision was not well implemented or well received by residents. The grants encouraged investment in advanced traffic management and expanded public transportation services, and the city leveraged the awarded funds and additional local funding to develop a comprehensive portfolio of mobility technologies. The Pivot app improved public transit navigation, and the ITS investments improved emergency response times and road safety. Yet despite initial excitement and investment, some initiatives faced significant challenges and did not deliver the anticipated results. The deployment of Wi-Fi-enabled kiosks intended to help technology-restricted residents plan transit trips saw limited usage, with only eight trips planned over a year-long period. Some initiatives were repurposed during the COVID-19 pandemic – for example, the Linden LEAP, a self-driving neighbourhood shuttle that had been paused due to safety concerns after an accident, was used to deliver food to those in need (Marshall, 2021).

These investments generated an estimated gross metropolitan product of over $173 million, created 2,366 jobs, and led to a regional economic impact of nearly $720 million. Columbus became the fastest-growing city in the Midwest in terms of electric vehicle adoption and unveiled a Climate Action Plan with a goal of climate neutrality by 2050 (City of Columbus, 2021). The city's collaborative innovation lab continues to focus on preparing the community for workforce changes brought on by automation and AI, ensuring equity and inclusion through human-centred design. The impact extends beyond transportation to address broader social and economic challenges, reflecting the success and importance of the Smart City Challenge in fostering sustainable urban development (Havich, 2021). "Columbus is poised to once again be a leader in transportation and mobility," said Mayor Andrew Ginther (Widness, 2016).

2.3 European Union

The Digital Cities Challenge (DCC), launched by the European Commission of the

European Union in 2017, created a shared approach to enhancing cities' technology and livability through collaboration. The mission of the DCC focused on the digital transformation of cities and the role of smart city development in shaping sustainable growth and innovation. The initiative, which commenced during the European Week of Regions and Cities in October 2017, represented a joint effort by the European Commission and the Committee of the Regions to encourage smaller European cities to embrace digital policy development and foster positive changes (EU Digital Cities Challenge, 2017). Collaboration among cities was used to enhance their productivity and livability through strategic use of the advanced technologies often used in other smart city implementations (Markianidou et al., 2019).

Over 40 European cities participated in a highly selective network. The competition supported digital transformation by hosting strategy conferences and helping to translate the individual cities' strategies into actionable plans tailored to local contexts. Of the cities that applied, only 15 were invited to continue as "challenge cities." The others were split into "fellow cities" and "mentor cities." Fellows could attend the conferences, but did not receive direct support in implementing their strategies; mentor cities were large cities with less need for innovation that were tasked with creating presentations for smaller cities. A key aspect of the DCC's mission was to promote collaboration, working closely with the mentor cities to facilitate the sharing of their greater experience in smart city design. Policymakers from challenge cities were encouraged to partner within both the public and private sectors – connecting with their counterparts in mentor cities and with local technology firms – to advance the use of technology in their modernization efforts.

The DCC followed a structured process that included four key steps. The first step was a Digital Maturity Diagnosis, which involved assessing a city's technological level and identifying starting points for strategic development by defining a long-term digital transformation vision. Next, the city engaged in a Strategy Design step aimed at transforming its vision into a practical idea, aligning operational objectives with high-level ambitions and creating a clear and specific goal for the competition. Each city focused on its distinct strengths to digitally transform. The third step was creating a Roadmap, focusing on practical implementation plans, governance structures, and the identification of specific actions, objectives, and resources. The final step was Monitoring and Evaluation, aimed at developing a framework to measure the progress of the strategy implementation against recommended indicator levels at different time intervals (Markianidou et al., 2019). This methodical approach showed a clear path for the winning cities to take.

The cities involved in the competition covered a diverse range of urban centres, including smaller challenge cities, medium fellow cities, and large mentor cities.

One of the main challenge cities, Sofia (Bulgaria's capital) positioned itself as a gateway between the European Union, the Middle East, and Russian markets. With a flourishing information and communications technology (ICT) sector, Sofia aimed to create a well-coordinated concept for a smart city involving all stakeholders for the betterment of citizens' lives. Granada, Spain, focused on implementing a digital economy – particularly in ICT, biotechnology, and health. Its Granada Human Smart City project, with public-sector collaboration across changing administrations, aimed

to reduce the digitalization gap between residents of different age groups. Ventspils, Latvia, a Baltic Sea port city, diversified its economy through strategic industrialization, targeting growth in ICT. Kavala, Greece, with its service-dominated economy, outlined seven digital-led policies in its operational program, ranging from tourism and culture promotion to citizens' health care (Komninos et al., 2020). Trikala, in central Greece, prioritized openness and citizen engagement, sustainable mobility, and smart tourism as key pillars of its digital transformation strategy (Ziozias and Anthopoulos, 2022).

The competition provided a platform for small cities to showcase their unique attributes, ranging from industrial history and heritage to maritime significance. For example, Iași, a Romanian city, led in digital transformation for enhanced public services, focusing on smart solutions. L'Aquila, Italy, with over 800 years of commercial history, underwent comprehensive reconstruction after a devastating earthquake, emphasizing resilience and innovation. Patras, Greece's "Gateway to the West," collaborated on its "Patras – Smart City" strategic plan for an open, smart city with a focus on digital infrastructure (Komninos et al., 2020).

Many other small cities worked on their smart capabilities through new projects and strategic hiring. Alcoy, Spain, has a rich industrial history, notably in textiles, and worked to evolve into a smart city by appointing a dedicated smart city technician. Algeciras, Spain, a trade link between Europe and Africa, focused on its port, introducing the Algeciras Smart City Master Plan for integrating cutting-edge technologies and enhancing efficiency in transactions.

Others focused on their history to implement new strategies for digitalization. Guimarães, Portugal, a city with a UNESCO World Heritage Site town centre, used technology to improve residents' quality of life, receiving sustainability awards for its work. Pori, Finland, historically an industrial city, underwent a digital transformation, showcasing advancements in artificial intelligence. Greece's second-largest city, Thessaloniki, leveraged its tourism success for sustainable growth, setting a goal of attracting investments in the smart infrastructure industry.

Many cities used their power in terms of size or attachment to a larger city as a way to urbanize. Grand-Orly Seine Bièvre, part of the Greater Paris metropolitan area, collaborated on major projects to adapt public services and boost economic development. Rijeka, Croatia's third-largest city, shifted its economy from heavy industry to science, knowledge, and technology, emphasizing health tourism (Digital Cities Challenge, 2019). Arad, Romania, a vital industrial centre for the country, emphasized sustainable development, urban mobility, and green spaces.

The goals outlined by all these cities in their bids encompassed smart city transformations, leveraging digital platforms for sustainable development and enhancing overall quality of life for residents. The diverse initiatives of these cities reflect a collective commitment to digital transformation and sustainable urban development. The DCC cities evaluated their initiatives using various key performance indicators, as well as SWOT (strengths, weaknesses, opportunities, and threats) analysis. The outcomes varied widely, with some cities facing significant challenges due to budget constraints (there was no monetary compensation involved in the competition) and to shortcomings in their existing

infrastructure, while others successfully implemented many of their strategies.

For example, in Alcoy, the small size of the city budget resulted in its infrastructure falling short compared with that of other cities. However, by making use of a local international data company, Alcoy was able to improve government data distribution and resident access. The local university also provided training support to improve residents' digital skills, although some issues arose among older, less technically adept groups (Galvan et al., 2019). Algeciras faced delays in developing its digital infrastructure because it initially lacked a reliable internet network. In terms of data-driven innovation, a lack of expertise in public service had led to contracting out data services to local firms, with the result that the data, under third-party control, was less accessible for public use (Buján et al., 2019). In Arad, the successes relied on community involvement. The city successfully implemented six out of the ten digital initiatives it had proposed for the challenge, including chatbots, integrated CCTV, open data with interactive maps, and municipal QR codes. COVID-19 caused some delays but also accelerated the digitalization process (Florea and Nagy, 2019). In Patras, existing fibre networks and strong cellular networks encouraged digital infrastructure creation, with a 5G pilot underway. However, high liquidity problems and limited data about the municipality posed challenges (Tsipouri, 2019). Sofia lagged other cities in digital infrastructure; its goals in this competition included creating a full 4G network. Low data awareness and a lack of digital culture hindered its progress, however, and bureaucracy impeded collaboration with other cities (Komninos and Tchonkova, 2019).

The lack of monetary compensation in this competition underscored the importance of addressing financial constraints to ensure more equitable participation and outcomes in future challenges.

2.4 Canada

Canada's Smart City Challenge (SCC) was launched by Infrastructure Canada in 2017. The program's goal was to spur Canadian municipalities to adopt a "smart cities approach," defined broadly as one that "aims to achieve meaningful outcomes for residents by leveraging the fundamental benefits that data and connected technology have to offer" (Infrastructure Canada, 2017). Infrastructure Canada provided four main themes for the competition: (1) openness, which focused mainly on transparency in both decision-making and systems; (2) integration, which emphasized connections between technologies, communities, and government departments; (3) transferability, which included enhanced usability across communities and actors; and (4) collaboration, which emphasized communities working together and with public- and private-sector partners (Infrastructure Canada, 2017).

The application process was thorough, but not overly onerous, and focused on solving a community's unique challenges. Applicant cities were encouraged to engage and consult with their residents before preparing their applications to identify "the most pressing issues their community faces" (Infrastructure Canada, 2017). The belief was that such consultation would help the municipalities better define the scope of their projects. Each applicant was asked to design a "challenge statement" in the form of a single sentence

that defined the outcome it hoped to achieve by implementing its smart city proposal. The statement was intended to be "measurable, ambitious and achievable through the proposed use of data and technology" (Infrastructure Canada, 2017). For instance, a community could propose to use technology to reduce crime below the national average, or to convert a derelict neighbourhood into a centre for economic growth. The purpose of the challenge statement was to provide a goal and benchmark for the project. These statements were intended to operationalize the proposals and indicate a reasonable scope for each project to the prize jury.

In addition to the challenge statement, each application had to include a brief summary of the project and describe how it would benefit members of the community. It also needed to select which of six "focus areas" matched the intended goals of the project: economic opportunities; employment and inclusion; environmental quality; healthy living and recreation; mobility; and safety and security. (An applicant could choose more than one focus area if appropriate.) The focus areas were intended to be general in nature but still provide policy scope for projects in order to help jury members categorize them.

Applicants also needed to categorize their projects in terms of both a technology and a community systems/service area. The application form included a list of 18 different technologies to select from, including artificial technologies, cloud computing, and enterprise solutions, as well as a list of 12 community systems/service areas, such as recreation or culture, roads and transportation, and social services. Applicants could select an unlimited number of categories from each list, and also had the option for both to select "other" and write in additional information. Most of those applying selected economic development (94%) as a community service area, with education and training (84%) and social services (73%) being the next most popular. Of the technologies available to select, the most common choices were mobile applications (95%), geospatial (83%), and open data platforms (80%). Seventy-one municipalities selected "other" for the community systems/service areas and 36 selected "other" for technologies.

The application also included a series of questions about the anticipated outcome of the project, the ways that consultation with the community had shaped the proposal, the ways that the project supported the medium and long-term goals of the community, the community's readiness and ability to implement the project, and the involvement (current and future) of potential partners (Infrastructure Canada, 2017). Applicants were also encouraged to include letters of support from community leaders and to place their proposals online for review by the community (Infrastructure Canada, 2017).

The SCC had three different prize categories: a $5 million prize for communities with populations not exceeding 30,000; two $10 million prizes for communities with populations up to 500,000; and one $50 million prize, which was available to all communities. (All dollar amounts in this section are CAD.) Each applicant city could select only one prize category, based upon its individual eligibility. For instance, a community of 1 million residents could select the $50 million prize, but not the $10 million or $5 million one, while communities of 100,000 could select either the $50 million or the $10 million prize. A community of 10,000 residents was eligible to select

any of the prize categories, as were Indigenous communities of any size. While most of the applications for the $50 million prize were from large municipalities, the existence of categories restricted to smaller communities encouraged more widespread participation. In total, 133 applications representing 199 communities were submitted, from which 20 applications representing 27 communities were selected as finalists. Each of the 20 finalists received a $250,000 grant to develop a fully implementable final proposal that outlined all the design, planning, and project management components of the plan, due at the end of the year (2018) (Infrastructure Canada, 2017). Each final application was expected to present a "strong business case" with measurable outcomes and established project milestones (Infrastructure Canada, 2017).

Winners were selected on May 14, 2019. The Town of Bridgewater, Nova Scotia, won the $5 million prize category for its project focused on reducing energy poverty. One of the two winning proposals in the $10 million category came from several communities in Nunavut that submitted a joint application focused on digital pathways to reducing youth suicide. The other was a joint proposal from the City of Guelph and Wellington County, which sought funding for a circular food economies model. The City of Montréal won the $50 million prize with a proposal that focused on enhancing transportation equity. The 20 finalist applications, including the winning ones, stood out from the rest of the applicant pool in that they tended to focus on policy areas aligned with empowerment, inclusion, and healthy living. They also tended to focus heavily on collaboration.

The format of Infrastructure Canada's SCC differed from government-led competitions that had previously been held elsewhere in the following ways: (1) the rules were left intentionally open ended, allowing for the inclusion of a wide variety of technologies to address nearly any societal problem that an applicant community faced; (2) there was an emphasis on community engagement, which had been an afterthought in government-led urban competitions to date; and (3) part of the SCC's goal was to encourage collaboration between cities in terms of innovation by requiring participants to upload their final plans online for anyone to see in order to increase replicability (Goodman et al., 2020).

Infrastructure Canada was granted funding in the 2022–2023 Canadian federal budget for a second competition, slated to launch in fall 2023, with legislation specifying a focus on climate emergency response through technological implementation (Government of Canada, 2023). At the time of this writing, there has been no further public news on the details or launch of the competition. We can confidently say that the current Canadian administration is interested in continuing with the competition-based funding model, but do not know when, or what the framework of such a competition would be.

3. Evaluation Framework

Finding a framework that can be used to meaningfully evaluate all four of these competitions is challenging. It is true that they share two key characteristics: (1) a focus area of technology and governance rooted in the smart cities discourse, and (2) the use of a competition model with explicit rules, application criteria, and winners. However, as we will show in the next section, that is where the similarities end. Each competition focused

on different policy areas and had different objectives. For instance, the E.U. competition was focused on municipal staff upskilling, while the U.S. competition was specifically for smart transportation infrastructure. The situation regarding measuring outcomes varied widely: depending on the competition, outcome metrics were not envisaged at the beginning of the competition (the United Kingdom), or implementation of the project is still under way (Canada), or outcomes were measured in vague currency terms without a transparent methodology (the United States) – or they were not numerically measurable at all because of the intangible benefits that accrued to winners and applicants alike (the European Union). These disparities make measuring and directly comparing competition outcomes a tricky task.

Given these complications, a useful evaluation framework needs to compare the competitions on a spectrum that accounts for their more amorphous impacts. Our starting point was the Goodspeed Evaluation Framework of Urban Management, which was originally created for a business consulting context through an amalgamation of management and organizational theory, but then modified to apply to the public sector (Goodspeed, 2020). It compares performance at the individual, organizational, and city levels on three outcome categories of learning, institutional change, and system change to form a 3x3 table for gauging the impact of an intervention. Goodspeed's framework is presented in Table 2, followed by a brief discussion of each column.

Table 2: Goodspeed's (2020) Evaluation Framework of Urban Management Change

		Outcome Category		
Level of Performance		**Learning**	**Institutional Change**	**System Change**
	City	Community learning	Community capacity	Goal performance
	Organizational	Group learning	Policies, programs, and practices	General plan, laws, regulations, and implementation decisions
	Individual	Conceptual, normative, and relational learning	Shared mental models	Behaviour change

Learning – Starting with the city level, "community learning" refers to shifts in actions or in basic assumptions that occur because of the intervention. At the organizational level, "group learning" could entail changes that manifest in the organizational climate or environment to work toward greater interest in developing shared knowledge – for example, an increase in creativity. At the individual level, in addition to the acquisition of new information or ideas ("conceptual learning"), it could entail shifts in values or attitudes ("normative learning") or changes to relationships with others through new

connections ("relational learning").

Institutional change – Starting with the city level, "community capacity" refers to the shared institutional environment of players. At the organizational level, it corresponds with changes in government operations ("policies, programs, and practices") for service delivery. At the individual level, it corresponds with significant changes in daily life and public opinion ("shared mental models").

System change – Starting with the city level, "goal performance" corresponds with changes to how outcomes were measured and how those measures were built back into policymaking processes. At the organizational level, this corresponds with the structures in which decisions are made ("general plan, laws, regulations") and resources allocated ("implementation decisions"). At the individual level, the system change category corresponds with behavioural changes in daily life or public attitudinal shifts.

Although the Goodspeed framework is useful in conception, it lacks detail in its application. We have adapted it by creating, based upon the explanations provided in Goodspeed (2020) and sources cited therein, an answerable question (sometimes two) for each box in the 3x3 table. Our version is presented in Table 3.

Table 3: Our Modified Evaluation Framework of Urban Management Change

		Outcome Category		
Level of Performance		**Learning**	**Institutional Change**	**System Change**
	City	Did feedback change the course of action or basic assumptions?	Did it change the broad institutional environment?	Did it change how outcomes were measured? Or how measures were built back into decision-making?
	Organizational	Did it change internal attitudes or preferences?	Did it change internal operations or funding levels?	Did it change administrative structure or resource allocation mechanisms?
	Individual	Did it create new relationships and/or trust?	Did it change durable social structures or decision-making styles?	Did it change daily life? Or result in a public attitudinal shift?

4. Evaluation

Previously, we examined four nation-led municipal innovation challenges intended to spur municipalities into adopting smart city technology strategies, and we introduced an evaluation framework to compare these competitions. In this section, we assess each competition using that evaluation framework. See Table 4 and the subsequent discussion.

Table 4: Outcomes of the Four Smart City Contests on Our Modified Evaluation Framework

		Outcome Category		
Level of Performance		Learning	Institutional Change	System Change
	City	UK: ✔ US: ✔ EU: ✔ CA: ✔	UK: ✘ US: ✘ EU: ✘ CA: ✘	UK: ✔ US: ✔ EU: ✔ CA: ✘
	Organizational	UK: ✔ US: ✔ EU: ✔ CA: ✔	UK: ✔ US: ✘ EU: ✘ CA: ✘	UK: ✘ US: ✘ EU: ✘ CA: ✘
	Individual	UK: ✔ US: ✔ EU: ✔ CA: ✔	UK: ✔ US: ✔ EU: ✔ CA: ✔	UK: ✔ US: ✘ EU: ✘ CA: ✘

Learning – City Level

Did feedback change the course of action or basic assumptions?

YES for all four competitions – but limited to winners and select applicant communities that followed up on their plans. In the United Kingdom, many cities that did not win nevertheless embraced their proposals and integrated them into their planning. In the United States, Columbus implemented its proposal using its competition winnings, and many other applicant cities used their proposals to apply for later funding opportunities and took follow-up action when they had secured it. In the European Union, the training helped cities implement future government platforms, although the connection was less direct. In Canada, the four winners all implemented their proposals, while others considered building them into their long-term plans. In all four competitions, however, many non-winners dropped their proposals altogether once contest funding was not forthcoming.

Learning – Organizational Level

Did it change internal attitudes or preferences?

YES for all four competitions. The U.K. competition, as the first of its kind, helped the idea of smart cities become mainstream, with cities becoming very excited and engaged about the prospect of including technology in urban governance. The U.S. contest brought the idea of smart city technology to midsize cities in the transport sector. The focus of the E.U. competition was bringing new skill sets and information literacy to smaller cities. The Canadian SCC, by not being limited in terms of policy area, helped municipal actors conceptualize more broadly what was possible when it came to smart city design.

Learning – Individual level

Did it create new relationships and/or trust?

YES for all four competitions. Cities benefited from the opportunity the competitions provided for them to engage with the national government, other local municipalities, not-for-profit and for-profit stakeholders, and fellow competitor cities. In all four competitions, public administrators spoke of how building bridges for future dialogue was one of the highest-value adds for winners and non-winners alike.

Institutional Change – City Level

Did it change the broad institutional environment?

NO for all four competitions. Any changes in government structures were limited in nature. The competition model did not lead to a fundamental, broad change in who the major institutions were and how national governments interacted with cities. Smart city innovation continues to be an underfunded option in many governments. Although the funding-through-competition model has been replicated, it is still a very minor part of overall relations and funding structures.

Institutional Change – Organizational Level

Did it change internal operations or funding levels?

YES in the United Kingdom, but NO for others. The United Kingdom launched the Innovation Funding Service (Innovate UK), which integrated the funding-by-competition model into permanent governance; cities then created structures to apply for these funds and compete in future competitions. Each competition is operated by one overall department instead of allocated to individual agencies. The non-U.K. competitions were not standardized into future operations and did not lead to a change in permanent funding levels. Disjointed funding structures persist in much of the smart city concept.

Institutional Change – Individual Level

Did it change durable social structures or decision-making styles?

YES for all four competitions. In the United Kingdom, the Innovation Funding Service has continued to launch many similar competitions. In the United States, the competition was followed up by the Intersection Safety Challenge, which encouraged innovative urban design. In the European Union, the competition was followed up by a very similar Intelligent Cities Challenge. In Canada, the government has funded a second round of the Smart City Challenge focused on climate resilience. These developments demonstrate a decision-making style change in federal-municipal relations in all four governments as they replicated the model of funding through competitions, with the result that municipal administrators now have much more consistent contact with their federal and regional counterparts.

System Change – City Level

Did it change how outcomes were measured? Or how measures were built back into decision-making?

YES for most, but NO for Canada. The national entities that ran the competitions in the United Kingdom, the United States, and the European Union all created, and mandated the adoption of, key performance indicators to measure outcomes; cities in all three states reported that it was the first time that they had systemically measured outcomes and modified operations based on the results. No performance indicators were created for the Canadian competitions.

System Change – Organizational Level

Did it change administrative structure or resource allocation mechanisms?

NO for all four competitions. Any smart city programs that were created because of the competitions were funded and allocated resources through the traditional administrative structures and resource-allocation mechanisms of municipal government. Sustained funding to improve and support smart city infrastructure after its installation continues to be lacking in municipalities.

System Change – Individual Level

Did it change daily life? Or result in a public attitudinal shift?

YES for the United Kingdom, but NO for others. The U.K. competition laid the groundwork for many universities to launch Smart City education and professional training programs, which continue to have an ongoing influence in government operations and daily life. No system change resulted from other competitions, as applicants only interacted with local institutions temporarily for training or advising. University-based smart city training programs do exist

outside of the United Kingdom, such as Syracuse University's Leading Smart Cities with Trust, but this program was not created in response to the national competition nor with funding supplied by the national government.

5. Discussion and Conclusion

This paper has focused on the growing trend of competition-based funding models in public financing, examining and evaluating four competitions in four different states. Though each had its own unique motivations, the overarching premise in all cases was to direct municipalities to adopt a certain line of thinking from national actors about technology and digital strategy by offering rewards of funding and other organizational resources. Many more such competitions have been created around the world to fund smart city creation. Under this model, national governments are using incentives (generally money) to influence local actors toward a policy course of the national government's choosing. These competitions have naturally taken on certain notions from the private sector, such as the inherent benefit of competition and a merit-based allocation of resources.

There are some benefits to this model. One is that it shifts the normal national government funding process from an implicit competition to an explicit one with (more) transparent rules and judging. Infrastructure projects and programs seeking government funding have always faced budget scarcity, with more applicants for the funding than the funding pool allows. Politicians and bureaucrats then decide – often through an opaque process – which projects receive funding and which do not. This process has often created frustration among local policymakers, who have a hard time aligning their projects with political cycles and priorities. A competition-based approach, as highlighted above, has tended to formalize the funding process, stripping it of the politics usually involved in such activities. This reduces the government's level of responsibility in the funding process while encouraging cities to create well-considered plans for their projects that will attract many eyes and result in a competition win. These submissions rarely achieve their full outlined goals and ambitions, however, due to insufficient funding.

We found that national competitions have had continuing effects with more general funding structures. Each has expanded to improve on its successes, creating grant programs for cities of different sizes. Overall, we find that these competitions, which were all pilot programs, have had an outsized positive impact on 'levelling up' local government when considering the limited financial outlay by national governments. It's a model worth continuing to experiment with and build upon.

The U.K. program discussed above, Innovate UK, has been absorbed into a larger research agency known as UK Research and Innovation that is responsible for all new competitions and grant programs. Its Innovate UK subcouncil continues to foster innovation with a yearly investment of £25 million in "groundbreaking" ideas geared toward quick commercialization (UK Research and Innovation, 2023). The new Innovate UK Smart Grant prioritizes small and medium agencies developing innovations with potential for rapid economic returns to the United Kingdom. This competition is intended to help local modernization – and economic growth on both the local and national scales – by focusing on realistic plans for short-term implementation. Many other competitions have taken place over time with the intention of helping the United Kingdom to grow through development (Innovate UK, 2023). The U.K. approach to competition funding

features a technology-based arrangement with more effective distribution monitoring than in most countries.

In the United States, competitions are created by separate government agencies that control funding and monitoring. In January of 2024, U.S. DOT announced the winners of a traffic competition similar to the one discussed above. It focused on enhancing roadway intersection safety by encouraging technologies that identify and address unsafe conditions involving vehicles and vulnerable road users. By funding this Intersection Safety Challenge, the department aimed to make progress toward its broader safety goal of Vision Zero – no traffic deaths (U.S. Department of Transportation, 2024). Many more competitions have been implemented, but none as large as the Smart City Challenge.

The Digital Cities Challenge in the European Union has been almost entirely renewed as the Intelligent Cities Challenge. With the same mentor and mentee city structure, this competition relies on inter-city communication and collaboration as a means to advance smaller European cities. The contest has a focus on the environment, but also encourages innovation in the built environment, tourism, mobility, and culture. While the Challenge ended in 2022, the connections between cities have been maintained for further development (Intelligent Cities Challenge, 2020).

Canada's Smart City Challenge was structured in such a way that even municipalities without much smart city infrastructure or planning completed could readily compete, meaning that it forced municipalities to think through the benefits of smart city design and enter an intense planning phase – which, in many cases, accelerated internal decision-making about smart city planning. Tangible results in this category were confined to winners, however. While the contest itself was sufficient to bolster smart city planning in many communities that were not named finalists or winners, the COVID-19 pandemic stalled many of these efforts. Those selected as winners, however, were able to capitalize and push their projects through the pandemic with the prize money they were awarded.

Despite some obvious benefits, there are some limitations to the competition approach. Although they led to many learning outcomes, the competitions tended to fall short in achieving systemic change. From an organizational change perspective, the impacts were largely confined to winners and, in some cases, finalists. The cities that came closest to success experienced the most benefits. While all municipalities in the competitions tended to experience some partial benefits – such as enhanced learning or knowledge creation regarding smart city technology, or the development of longer-term planning when it comes to smart cities – it remains to be seen if these were worth the local resources devoted to the application process. The development of many projects was also hampered by the COVID-19 pandemic, adding an additional layer of complication to forecasting the wider impact of these competition-based funding models. Often the winners were not able to achieve what the funds were allocated for, and fell short in terms of the public's perception of outcomes. At this point, it appears unlikely that these competitions, as currently designed, can provide for systems-level change beyond cities that are directly funded.

To maximize the benefits and limit the downsides of these types of competitions, governments should consider the following recommendations:

A. Build a community around the applicants – Systemic benefits may be better achieved if the competition is considered less a fight for resources and more a process to create a community around municipal technology solutions. In nearly all cases, there was no long-lasting effort to link these communities together, despite their shared deep commitment to the innovation policy space. Even after a competition ends, more efforts could be made to informally or formally link applicants – especially those that were not selected as finalists. This could be accomplished through a competition-controlled information exchange or best-practices sharing network, or by a conference or series of workshops to further engage policymakers. Longer-term commitments of funding by the national governments, even at a minimal level to sustain community efforts, would have a significant impact.

B. Provide more oversight and support in managing funding and securing private capital – Several winning communities had difficulty managing projects and funding, and encountered particular trouble navigating private funding opportunities. Columbus's experience emphasizes this point particularly well; though the city considered the project a success, its objectives and deliverables were significantly reduced between winning the competition and the project's completion (City of Columbus, 2021). Competition organizers should play a larger role in the post-award delivery process, supporting winners in managing funding. When municipalities win such competitions, it takes time to build internal capacity and infrastructure around the award; in the case of Columbus, the city set up a small internal team, with most of the work performed by consultants. National governments could support this transition better to ensure a smoother implementation. For example, in the United States, creating additional traditional funding streams, thereby reducing uncertainty about future funding, would make it feasible for cities to staff up internally on the implementation side. The United Kingdom could create a national competition agency to incent cities to hire innovation grant writers and coordinators on a permanent basis.

C. Ensure that competition goals are clear and focused – The goals of each competition were shaped around national priorities rather than local ones. This is expected given the source of the funding, but many communities found it challenging to fit their local goals into the competition parameters. National governments should consider co-creating program goals with municipalities or municipal associations in order to ensure a broader alignment in program goals at the two levels. The further step of letting local governments fully create their competition submissions allows for regional challenges to truly be represented.

D. Determine key performance indicators from the outset – Applicants were often unclear about what criteria their applications would be judged on, and about what successful implementation would look like to their contest hosts. National governments should release transparent key performance indicators

at the beginning of competitions as a part of the initial application materials, asking municipalities to submit their best applications that aim to make strides toward improvements in those measures. The judges can then base their decisions on the expected impact and feasibility of the proposed plans in terms of these key performance indicators. For non-winners, implementing key performance indicator systems would be a successful outcome in and of itself.

E. Clarify the role of the public – The end recipients of smart city design are the city's residents. Despite some conditions for local public consultation, none of the competitions made significant efforts to include the public throughout. Perhaps future competitions could include a citizen jury alongside expert judges, or standards could be established to ensure that the type of consultation is meaningful. In any case, competition leaders should determine ways to incorporate the public to a greater extent. Doing so would ensure that there would be continued public pressure to realize systematic change in furthering smart city adoption.

F. Support data governance and privacy standards – There was not a substantial effort in any competition to support municipalities in the development of data governance or privacy standards. These components of smart city design are often overlooked, despite their importance having been highlighted by academics and privacy experts on numerous occasions. The competitions that included various rounds where some municipalities advanced and were given funding to better develop their proposals were opportunities missed to hone data governance and privacy regulations that could be used by winners or adopted by non-winners or finalists as they further develop their own programming.

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