Lessons from Abroad

Smart Cities Developments from the European Region

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Preface

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Participating European Smart Cities

Interviewees reflected a wide range of different municipalities and regions. Here we briefly describe the various cities and examples of the smart city projects that were highlighted.

Aarhus, Denmark

Aarhus is Denmark's second largest city (population 336,000) and has a substantial knowledge and service-based economy. The city has particular strengths in the healthcare and technology fields. One notable smart city project is based on mobility-as-a-service and multimodality with the goal of reducing private car trips and bolstering other forms of transportation.[1] These mobility efforts encompass a range of initiatives, from bike shares to a digital software platform that can help individuals find low-carbon transportation options.

Amsterdam, Netherlands

This capital city has a population of approximately 870,000. Amsterdam has been ranked as one of the world's smartest cities, ranking highly on economy, transportation, and urban planning. Amsterdam Smart City is an open innovation platform that brings together public-private partnerships.[2] One example of a smart city project is the Marineterrein Amsterdam Living Lab. This is designed to allow research and real-world testing of innovative solutions.[3]

Barcelona, Spain

With a population of 1.6 million, Barcelona is Spain's second largest city. It is ranked as a highly livable city and is making efforts to further develop their digital economy. The Barcelona Digital Talent alliance is a smart city initiative that brings together Mobile World Capital Barcelona, industry, and local government to position the city as a hub for digital talent.[4] This group supports the development of the local economy, improves local competitiveness, and helps address the digital skills gap.

Berlin, Germany

Berlin is the German capital and has a population of approximately 3.6 million citizens. It is a major cultural, scientific, and economic hub, with a strong technology and service sector. Berlin has a variety of smart city projects that aim to find new efficiencies, address climate change, and improve economic competitiveness. For example, the Urban Tech Republic is an industrial and research park focused on developing and testing new urban technologies such as environmentally friendly transportation, networked infrastructure, and net-zero energy systems.[5]

Brussels, Belgium

In addition to being the national capital, Brussels is also the administrative centre of the European Union. Brussels is regarded as one of the top financial centres in Western Europe and is a geographic, economic, and cultural hub for the larger region. The Brussels Regional Informatics Centre (BRIC) was highlighted as a smart initiative that helps local administration to coordinate the implementation of new technologies or digital projects.[6]

Dublin, Ireland

Dublin (population 1.2 million) is the capital and largest city in Ireland. Known for its financial and technology companies, Dublin has a variety of Smart Districts that act as testbeds for innovations to be replicated across the city. One smart city project used smart bins to optimize waste collection and provide additional connectivity infrastructure. This project involved installing 110 smart bins that can hold five times the normal waste capacity by utilizing a solar powered compactor, while integrating sensors for real-time data collection.[7]

Eindhoven, Netherlands

Eindhoven is one of the largest cities in the Netherlands (population 235,000). It is known as a technology and design hub due to the presence of Philips and other tech companies. One smart city development is the Brainport Eindhoven region. This is an area where companies, governments, and educational institutions work together to develop new technologies and innovations.[8] Projects address various smart city challenges such as energy transition, mobility, and healthcare, but it is notable for integrating these different technologies holistically in a real-world setting (rather than a test site).

Lisbon, Portugal

Lisbon (population approximately 500,000) is Portugal's capital and largest city. Lisbon has made great strides in ensuring that various departments and projects are coordinating and sharing their data. One of their smart city projects involves the development of a shared platform to bring together different elements such as traffic information, water supplies, and waste management.

London, United Kingdom

London is the capital of the UK, with a population of almost 9 million. Given its size and economy, there is a wide range of smart city projects that include digital inclusion, skills development, digital services, and internet infrastructure investments. One example of these projects is the Digital Talent program, which helps young citizens acquire digital skills needed by employers by providing free training courses.

Milan, Italy

Milan is Italy's second largest city, with a population of 1.35 million. It is a major industrial and financial hub and home to numerous international headquarters. Milan has been ranked as Italy's smartest city for several consecutive years, with high economic, sustainable mobility, and social ratings. One notable development is the retrofitting and refurbishing of buildings to improve energy efficiency to reduce costs and mitigate carbon emissions.[9]

Norway (national perspective over multiple cities)

Innovation Norway is the Norwegian government's official trade representative and combines local industry knowledge with international networks.[10] They are involved with various smart city developments across the country. Norwegian cities are highly regarded for their smart city leadership, and Oslo has been recognized for sustainable mobility as a world leader in electric cars.[11] Norway's experience with digital technologies in the oil and gas industry have also been utilized in smart city developments.

Newcastle, United Kingdom

Newcastle (population 293,000) has been ranked as the UK's smartest city and has been recognized internationally for strengths in digital technology and education institutions.[12] One well-known smart city project is "UK's smartest street," which uses various IoT smart sensors, including lamp posts and waste bins, to integrate real-time data collection. This data is used to help ease congestion, improve parking, and reduce pollution.

Prague, Czech Republic

Prague, the capital of the Czech Republic (population 1.3 million), is known as an innovative city with a strong knowledge-based economy. As part of the city's goals to reduce GHG emissions, it has piloted a smart waste collection system by installing 420 sensors in waste containers to monitor waste levels and optimize collection (avoiding unnecessary trips). This successfully resulted in operational savings and, as a result, the technology is being extended to more than 6000 waste containers.[13]

Stockholm, Sweden

Stockholm (population 975,000) has been named as one of the world's smartest cities and is known for innovation in environmental protection, digital technology, and citizen wellbeing. Stockholm's smart and connected lighting project is an example of a successful smart city project. This interoperable network can provide up to 50% energy savings and 20% operational savings while improving quality of service by detecting outages.[14]

Tallinn, Estonia

Tallinn (population 425,000) is Estonia's capital and is highly regarded for information technology capabilities and business competitiveness. This is unsurprising as Tallinn has a strong tech sector and Estonia is ranked as a global leader in digital government. Tallinn uses an integrated dashboard that provides visibility of issues such as employment, traffic, noise levels, electricity usage, COVID-19 data, and many others.[15]

Tampere, Finland

Tampere is Finland's third largest city, with a population of 238,000. Tampere's strengths in telecommunications technology have been leveraged in a smart city project that uses 5G network infrastructure to enable autonomous vehicle testing. This has led to the successful testing of robotic buses[16] and plans to integrate last-mile shuttle buses with the municipal tram line.[17]

Vienna, Austria

Vienna is the national capital of Austria and is one of Europe's largest cities with a population of approximately 2 million. It is known for its high quality of life and ranks as one of the top cities in the world for innovation and urban planning. Urban Innovation Vienna is an interdisciplinary group that coordinates digital projects and helps to implement smart city strategies. One area of focus is addressing urban energy and climate issues.[18]

Vilnius, Lithuania

Vilnius is the capital city of Lithuania and has a population of 656,000. Vilnius is also the economic centre of country and is ranked highly for ease of doing business and attracting foreign investment. The Sustainable Urban Mobility Plan (SUMP) is a project that aims to reduce the environmental impact of transportation with the aim of reducing car usage by 33% by encouraging public transportation, walking, biking, and micro-mobility.[19]

Zurich, Switzerland

Zurich (population 400,000) is the largest city in Switzerland and is regarded as one of the world's top financial centres. It is ranked as one of the top three smart cities globally, according to the Smart City Index 2020, with particularly high scores in healthcare and safety.[20] Zurich has a history of projects that monitor air quality to improve the quality of life for its citizens. Previously sensors have been distributed throughout the city on trams and buses, and there are also new developments that investigate applications in healthcare to detect coronaviruses.

Tel Aviv, Israel

Tel Aviv (population 435,000) is the economic centre of Israel and is known as a technology and innovation leader. While Israel is not geographically located in Europe, there are significant ties as an EU associated state, with numerous partnerships and agreements. [21] Tel Aviv's smart city developments incorporate the strong entrepreneurial culture and capabilities of local tech start-ups.

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Executive Summary

In Europe, smart city projects make use of digital technologies and public sector innovations to address a wide range of local challenges. This report builds on ICTC's prior research on Canadian and international smart city developments to focus on the experiences of numerous cities in Europe. This European focus reflects the fact that the region is known as a global leader in smart city projects.[22] These findings are primarily based on a series of interviews conducted with subject matter experts and municipal staff in cities with notable smart city initiatives.

As many of these European projects have similar areas of focus (or as ICTC has referred to them, "smart city priority areas"), the projects are consolidated into larger categories, noting specific insights and benefits. In addition to examining projects under the categories of Smart Government, Smart Mobility, Smart Infrastructure, Smart Energy and Environment, Smart Health and Wellbeing, and Smart Regulation, this report addresses a variety of shared insights and themes that have emerged.

Within the context of European smart city projects, this research identifies motivations and best practices, alongside the importance of partnerships, benefits and challenges of smart city development, the impact of the ongoing COVID-19 pandemic, and general labour market impacts.

Across the 20 key informant interviews conducted for this study, the following common principles emerged:

- **Citizen engagement and participation**: It is necessary to help local citizens understand the rationale for "smart" developments and for citizens to have the ability to share their input and concerns *before* they are undertaken.
- **Digital rights of citizens**: While the digitization of municipal services and programs can lead to operational changes, this does not change the innate rights of citizens.

- **Respecting privacy:** There are significant and justified concerns regarding smart city technologies such as cameras, sensors, and data analytics that challenge citizens' privacy expectations.
- **Ethical use of data and AI:** The ethical use of data and AI technologies is a high priority. Algorithmic decision-making and unintended consequences presents new risks.
- **Proactive data sharing:** While respecting individual privacy and local privacy legislation, there is also a need to proactively share the data being collected. For example, in cities such as London, Lisbon, and Prague, there was an emphasis on sharing data within the municipality across other department projects. In other cities, sharing may extend to other groups, for example, with the public, through Open Data initiatives like in Newcastle, or for responsible collaboration with industry partners, like in Zurich. Sharing data can allow the discovery of new insights and identifying potential problems, solutions, or efficiencies.
- **Partnerships and collaboration:** Key to successful implementation of local smart city projects is broader partnership and collaboration between municipalities, industries, research organizations, and other relevant stakeholders.

Interviewees were eager to share lessons and best practices for Canadian communities when developing local smart city projects. Described in depth later in this report, core lessons include the need to involve citizens in the decision-making process, gaining local buy-in, pinpointing local priorities and designing projects to suit those needs, and finding the right balance with new technologies. The latter includes understanding when and if "cutting-edge" technology is actually needed. Here, the overarching view is that smart city projects should go beyond a simple return on investment (ROI), and focus on producing positive environmental, social, and ethical benefits.

While the COVID-19 pandemic was not the core focus in this study, it plays an important role in smart city project development and direction for all municipalities. Cities have been managing an ongoing public health emergency, which has altered pre-existing priorities and disrupted local

budgets, health considerations, public safety, commuting patterns, and economies (from declines in tourism, retail, dining, or office workers). At the same time, this change has accelerated digital delivery of government services and encouraged technology adoption across sectors.

From these disruptions, important labour market patterns and changes have emerged. Interviewees note the growing need for interdisciplinary teams that can navigate complex challenges that cut across multiple domains. Technical skills and project-specific occupations are needed to help policymakers and urban planners consider future citizen needs. Local “champions” who can navigate bureaucracy, regulation, and technical challenges to overcome institutional inertia are also increasingly essential.

Understanding the successes, challenges, and trajectories of smart city developments in Europe presents an opportunity for Canada. As municipalities continue to digitize services and seek to leverage technology to improve the quality of life of citizens, lessons from mature smart ecosystems like those in Europe offer a unique roadmap for delivering smart developments at home.

Introduction

Smart city projects span a wide range of topics and leverage different technologies in Canada and abroad. As highlighted in ICTC's previous report that examined a variety of smart city initiatives, Canadian municipalities have used technology in novel ways to deliver improved citizen outcomes. This report builds on those findings and focuses on the European region, which is often identified as a global leader in the smart city movement. European cities frequently occupy top international smart city rankings.[23]

ICTC partnered with a European consulting firm, Colors Inc., to connect with European cities and learn more about overall motivations and specific smart city projects. Interviews with European municipal representatives offer essential insights into technology types, the benefits and challenges of smart city projects, lessons in implementation, and labour market impacts.

Section I describes the various smart city projects that were explored in this research. While the projects range in scale and maturity, they all provide interesting comparisons (and inspiration) for future Canadian developments. Interviewees often described multiple initiatives within their overall smart city strategy. Given the number of different projects and similarities between the efforts in different cities, these developments have been organized according to ICTC's smart city priority areas (Smart Government, Smart Mobility, Smart Infrastructure, Smart Energy and Environment, Smart Health and Wellbeing, and Smart Regulation).

In **Section II,** broader, overarching themes from different projects are described. Interviews revealed common goals or motivations for cities, such as becoming more efficient, utilizing data better, improving quality of public services, or becoming more sustainable. Section II also explores the financial and social return on investment in these European cities.

Finally, this report summarizes labour market needs and best practices and lessons for Canadian municipalities. It concludes by exploring successes, challenges, and insights that can help shape a framework for future smart city developments in Canada.

Section I: Smart City Priority Areas

The European Commission defines a smart city as “a place where traditional networks and services are made more efficient with the use of digital solutions for the benefit of its inhabitants and business.”[24] In this study, European smart city projects are categorized into six categories or priority areas: Smart Government, Smart Mobility, Smart Infrastructure, Smart Energy and Environment, Smart Health and Wellbeing, and Smart Regulation.

Smart Government

What is a smart government project?

Many municipal initiatives focus on core improvements to public service delivery. Some European municipalities take a broad approach to technology implementation, such as integrating emerging technology trends into local service provision (for example, smartphone apps for the gig economy or transportation); others take a simpler approach, like creating dashboards for different government services. The City of Tallinn developed a dashboard that brings together human capital and employment numbers, COVID-19 statistics, traffic data, and infrastructure data. This data is used to guide the city’s financial decisions. Similarly, a key priority of the City of Lisbon is to integrate government services for data sharing and data analysis.

Other city projects focus on specific services such as sanitation or waste management. Smart waste collection was discussed in several interviews: one example is a project that uses Internet of Things (IoT) sensors and mobile data to find efficiencies in collection routes; another monitors bin capacity to optimize pickups.

Other projects incorporate a variety of technologies, like the Brussels Regional Informatics Centre (BRIC).[25] This project promotes technology adoption in the public sector and works with local administration to optimize efficiency and improve user-friendliness in the region.[26]

Smart Government: Benefits and Challenges

Smart Government projects typically aim to improve efficiency, transparency, reliability in municipal operations, or enhance the quality of services for citizens.[27] Many European city representatives interviewed in this study emphasized data analytics and

dashboards to achieve this goal. The proliferation of powerful and affordable sensors and analysis tools offer numerous benefits: enhancing efficiency in resource utilization (by identifying waste points or failures), improving quality of life through informed public-policy decisions, and greater transparency, to name a few.[28]

Given the perennial challenge of addressing increasing citizen needs and expectations (while facing limited budgets), the adoption of technology is often viewed as a logical way to improve productivity or address cost pressures.[29] In some interviews, municipal governments hoped that greater understanding of emerging digital technologies in the private sector would help staff become more entrepreneurial or generally bolster local economic development opportunities.

However, while increasingly sophisticated tools represent an opportunity, accuracy, quality, and security must be keenly considered. Interviewees highlighted data sharing and regulatory considerations (such as privacy concerns or regulation in the use of public data) as needing attention. Furthermore, achieving local buy-in or coordinating efforts across multiple different departments or domains is essential. For example, staff responsible for monitoring traffic congestion should also be coordinating with waste collection services and infrastructure construction projects, as their efforts may conflict and impact commuting times. Although integration among different municipal groups is necessary to truly achieve the goals of smart government initiatives, cross-department collaboration introduces additional complexity, requiring more robust and effective coordination.

“From when the program started out in 2009 until now, the shift has very much been away from project management to ecosystem building[...]Our role is really a facilitator role to basically put the partners in the same room on a regular basis.” – Cornelia Dinca, Amsterdam Smart City

Labour Market Implications

Projects related to Smart Government have a variety of labour impacts and implications. Interviewees suggested the need for more skilled talent, with data science and data analysis occupations playing essential roles. Other in-demand roles identified include researchers, IT support staff, municipal managers, GIS specialists, software developers, and web developers.

While interviewees cited competition with other public sector bodies and the private

sector for these roles, most alluded to a relatively well-developed local supply stream of talent. Specifically, the presence of local post-secondary institutions or technology companies were identified as key contributors to developing the talent needed to support smart government initiatives—innately, most of the world's leading smart cities are in regions with established knowledge-based workers and highly educated populations.

Smart Mobility

What are smart mobility projects?

Smart mobility projects discussed in this study include pilots of emerging technologies —such as 5G-enabled autonomous vehicle (AV) testing—and software platforms that unify mobility options for trip planning and payment. In Tampere, AV testing is one of four smart city pilots. This pilot aims to achieve level 4 autonomy (not requiring human intervention) in mixed traffic.[31] The pilot uses emerging 5G technologies to aid faster communication between embedded road sensors and remote vehicle controls.[32] Notably, AV projects like this often require integration with existing and/or planned city infrastructure:

"These [autonomous vehicle testing] areas are in the middle of the city or in the middle of one of the suburbs. We started operating with buses, but now we are moving into broader traffic testing. The requirements for both physical and digital infrastructure are quite, quite challenging." – Teppo Rantanen, City of Tampere

Similarly, in Barcelona, the city and not-for-profit organizations[32] have collaborated to develop "living lab" projects. One focuses on the development of network-connected electrified vehicles. Another addresses changing mobility patterns and the resulting infrastructure needs (e.g., curb management, or car-free blocks).

In Brussels, one of the largest smart mobility projects integrates transportation networks under "Mobility-as-a-Service" (MaaS). MaaS typically involves bringing together different transportation options for a seamless accessible system, with a unified payment option and utilizing data collected to quickly respond to changing user needs.[33] Multiple large transportation companies, bus services from the surrounding region, and bike sharing and car sharing companies are working with the city to develop an app for co-ordinated trip planning and ticketing. By making it easier to plan and pay for trips through a unified system, the municipal government aims to improve citizen

experience and encourage more environmentally friendly travel. Similarly, Aarhus has been working on a MaaS software project for several years to integrate public and private transportation options, while situating this software into a larger national platform for travel planning.[34] Meanwhile, Milan's smart city unit and mobility staff are working to gather data to improve bike sharing, car sharing, and EV charging systems. Both projects strive to achieve the same overarching goal while expanding the range of private mobility solutions available to residents.

In Vilnius, sustainable mobility is the goal of a series of initiatives that include the development of new bus lanes and additional dedicated bike paths. IBM awarded Vilnius with a smart cities challenge grant for its ongoing improvement of traffic management infrastructure, additional public transportation investments to improve services, and route planning app.[35]

Mobility efforts can also have regulatory implications. In Vilnius, road-use changes required examining existing local bylaws, such as those associated with changing the size of car lanes (required to accommodate bike lanes or altering traffic patterns). Mobility projects undertaken in Brussels also involved similar considerations but focused on topics like managing different types of transportation markets, GHG emissions, and the handling of user data.

Smart Mobility: Benefits and Challenges

Emerging mobility technologies promise many benefits. For example, AV technology offers the possibility of collision reduction, reduced carbon emissions (through driving efficiencies), improved traffic flow, and significant cost savings both to consumers and businesses.[36]

Overall, cities consider smart mobility projects as facilitating larger and holistic goals for citizen wellbeing. Congestion reduction, for example, overlaps with goals of addressing environmental concerns (e.g., reduction of greenhouse gas emissions) and producing health benefits. Some mobility-related health benefits include promoting a more active lifestyle, reducing pollution, or reducing road injuries through safer infrastructure. Addressing mobility challenges can also improve quality of life by reducing commuting times and introducing more convenient ways to travel.[37] Although many MaaS projects have been hampered by COVID-19 (reduced commuting in general and increased concerns about shared transport), interviewees identified the MaaS model as key to improving the ability for citizens to move throughout the city while also changing overall traffic patterns and preferences (from single-vehicle commuting).

“I think one of the main challenges in the Smart Mobility Project is that it is so obvious that we have to use technology to make mobility better, but it's really hard to do it in practice.” – Teppo Rantanen, City of Tampere

Labour Market Implications

Smart Mobility projects make use of the local talent ecosystem. For example, the Tampere AV testing project benefits from approximately 35,000 post-secondary students in the region, which in turn bolsters the labour market for highly qualified personnel. In addition to post-secondary students and new graduates, hundreds of companies are also involved in smart city projects across Europe, together with state research entities. Yet, with heightened competition for skilled talent across regions and sectors, interviewees often highlighted a shortage of talent for key roles in smart mobility projects.

For Aarhus and Vilnius, the focus on mobility projects that promote carpooling and public or non-motorized transportation created a growing need for civil engineers, urban planners, anthropologists, psychologists, and communications professionals. Anthropologists and psychologists are specifically needed to investigate incentives and behavioural patterns, while communications professionals are required to effectively communicate with the public and secure buy-in.

“We have to [communicate and execute these decisions] step by step. The positions needed are to really talk with people and to interact with them or change their perspective. That’s the key in this approach.” – Anton Nikitin, Smart City Vilnius

Smart Infrastructure

What is Smart Infrastructure?

Infrastructure acts as the backbone of the city as it enables trade, powers businesses, and connects households across regions to higher quality opportunities for employment, education, or healthcare.[38] Furthermore, infrastructure is crucial to enable mobility throughout cities and meet climate change goals. Unsurprisingly, many smart city developments seek new opportunities in this area. These can take many different forms, such as physical hardware installation and capital projects, service delivery infrastructure, and digital infrastructure, and software-based solutions.

Berlin is a key smart infrastructure hub with numerous greenfield and brownfield investments taking place. Some projects integrate broader municipal infrastructure development (for example, the expansion of city water services) with housing departments to build more energy efficient homes. In other cities, infrastructure projects focus on hardware solutions to city challenges. Stockholm's adoption of smart lighting system[39]can communicate technical issues, monitor public street lighting, and measure energy consumption. In both cases, smart infrastructure projects are multi-faceted, integrating multiple types of city services:

"The footprint is one integrated solution, because if you need infrastructure to build your city, you'll need infrastructure for electricity storage and transportation, but you also need that infrastructure for heat storage, or hydrogen, but you also need the same infrastructure to build your own data network. You have to decide whether you have an autonomous network or if you are going to share it. Everything is always glued together." *– Peter Portheine, Eindhoven - Brainport Smart District*

Other times, city infrastructure projects intersect with service delivery. For example, smart waste collection systems in cities such as Prague or Dublin are also tied into traffic management, integrated street sensors, and IoT systems that measure the capacity of waste bins to better coordinate garbage pickup. With thousands of locations across a city, smart bins can find efficiencies in waste management while measuring air quality, hosting telecom equipment, or providing wi-fi connectivity.[40] Infrastructure solutions can be heavily digitized. London's infrastructure mapping initiative involves the use of city infrastructure data and a shared platform (providing a common access point for the city and contractors or vendors) to better coordinate and plan projects; for example, the platform contains an enhanced scheduling feature that allows multiple infrastructure projects to occur in rapid succession or simultaneously. This allows efficient project planning across multiple initiatives such as undertaking excavation work while roads are already shut down for another reason.

Many Norwegian cities have adopted digital twinning, which is an increasingly popular type of digital infrastructure project. By constructing a virtual model of the city, planners can see the impacts of potential changes to infrastructure (or public transportation and other dimensions) across different scenarios. This helps planners and municipal leaders consider different policy options or strategic decisions and assists with gaining buy-in. For example, with digital twinning, city residents can be shown potential project outcomes before they begin.

"You can see the city in a visual way, and you can start to put in information like energy usage or transportation. How does this change over time? When are they emptying the trash bins and what does that mean? What happens if there's a fire somewhere? What if the schools open at 8:00 vs. 9:00? What does that do to commuting traffic? It's a completely new way of understanding the decisions that are taken and helping municipalities make decisions." – Sølve Fauskevåg, Innovation Norway

Smart Infrastructure: Benefits and Challenges

Smart infrastructure benefits can include environmental or energy savings, as seen in Stockholm's smart lighting upgrades. This often coincides with other benefits, such as automated alerts for maintenance issues that save labour costs for municipal operations. Minimizing lighting outages can improve both public safety and services (i.e., residents often do not report burned out streetlights). Similarly, smart waste collection services make use of sensors that monitor garbage bin capacity. This prevents bins from overflowing and optimizes waste collection, avoiding unnecessary dispatch of waste trucks.

London's co-ordinated infrastructure projects (noted above) have provided clear advantages to the previous scheduling system. The new scheduling system ensures that disruptions to citizens and businesses (such as road closures) are minimized. For example, roadwork that address sewer issues is an opportune time to conduct electrical maintenance or install internet lines.

However, these projects are not without challenges. Like all smart city developments, procurement can be an issue as cities balance avoiding vendor lock-in while planning future compatibility or standardization. Furthermore, existing procurement policies can prohibit sole source procurement even when city staff are aware of specific solutions or companies suited for the project at hand. While fair and transparent vendor selection is needed to ensure competition, this can add delays or reduce the number of vendors that can meet specific project needs.

Labour Market Implications

Infrastructure projects have significant labour market implications (i.e., new skills needs and additional hiring) across a range of areas, including software, hardware, or municipal operations. Interviews with European smart city experts identified administrative or technical roles such as IT specialists, GIS specialists, IoT designers, project managers, and data visualization experts. The physical components of these projects also require hands-on installation and maintenance. These roles include

electricians, construction workers, pipefitters, and other specialized installers of new technologies.

The increasing digitalization of municipal infrastructure will also require upskilling and re-training for municipal operations workers, whether involved in sewers, lighting, roadwork, or other maintenance positions. For example, interviewees note exploring training options to pivot sanitation workers to new assignments in related work.

Smart Energy and Environment

What is Smart Energy and Environment?

There is a scientific consensus that human activities are accelerating climate emergencies, evidenced by more frequent environmental anomalies such as floods, forest fires, and heat waves over the last two decades.[41] The energy sector is a large emitter, accounting for over 70% of global GHG emissions,[42] pointing to the critical need for building efficient, sustainable, and reliable energy systems. Projects in Milan and Amsterdam are showing other European cities a path toward greener and more sustainable urban development.

Waste-to-energy plants and ground-source heat-pumps have allowed Milan to successfully improve its energy efficiency over the last decade.[43] Additionally, Milan has joined global initiatives such as Rockefeller Foundation’s 100 Resilient Cities and the Global Covenant of Mayor for Climate and Energy to build resilience and combat climate change through collaborations, financial guidance, and technical support.[44] Amsterdam has also initiated several urban energy projects to achieve ambitious climate goals of cutting 55% of its GHG emissions by 2030 and 95% by 2050. For example, the Uncertainty Reduction in Smart Energy Systems (URSES+) program was created with a mandate to reduce the inherent uncertainty factors in renewable energies. URSES+ consists of eight projects for developing knowledge and tools (energy generation, energy storage, energy usage, energy distribution and management, etc.) for building a reliable, affordable, and sustainable energy system while also dealing with increased variability in renewable energy production.[45]

Benefits and Challenges

Through collaborations and joint initiatives, smart energy projects that develop renewable energy networks and improve existing heating networks have set European

cities onto a greener and more sustainable growth path. For example, Amsterdam is ranked as one of the most eco-friendly cities for its high levels of car-free commuting and renewable energy usage. Meanwhile, Milan ranks 7th globally for the highest concentration of sustainability professionals and possesses a Sustainable Urban Mobility Plan (SUMP) that aims to decrease energy consumption by 12% and GHG emissions from transportation by 13-15%.[46] However, despite current successes and progress, the municipal representatives interviewed noted some technical and social challenges tied to the “green revolution.” Alongside the need for continuous research and development on renewable energy networks, installing new infrastructure or retrofitting existing infrastructure in historic city centres often faces constraints.[47] Additionally, not all stakeholders have the same level of acceptance in adopting new energy systems. For instance, residents may be reluctant to change their energy consumption behaviour or need time to “adapt their (energy) consumption practices.”[48] Lastly, compared to technical advancement in renewable energy networks, regulations and legal frameworks lag. For example, “prosumers” (consumers of conventional energy who have become renewable energy producers) currently lack a legal framework.[49]

Labour Market Impacts

As the field of smart energy integrates power systems, information technology, business management, and renewable energy technology,[50] the growing number of smart energy projects is expected to drive higher demand for talent in fields such as operational technology, information and communications technology (ICT), and environmental science. Key roles include field engineers, system specialists, materials scientists, and environmental scientists.

The cities interviewed noted accessing specific professional skills through private-public partnerships and cross-Europe projects but stressed the importance of cross-functional coordination roles to organize collaboration among stakeholders and share knowledge and lessons.

Smart Health and Wellbeing

What is Smart Health?

Citizen health and wellbeing has been an area of significant interest during the COVID-19 pandemic for obvious reasons. Multiple interviewees touched on the concerns related to limited face-to-face interaction. Other cities like Newcastle, for example,

make use of sensors and data collection to better understand the current density of crowds (or how busy an area is) to allow residents to schedule their visits and avoid peak times.

Some cities take a more holistic approach to smart health. The city of Vilnius has prioritized active mobility as a means of healthy living. Vilnius strongly promotes cycling and walking as a means of urban transportation. In Zurich, a partnership with a local startup monitors air quality in hospitals. This project focuses on early detection of COVID-19, while earlier iterations explored bacteria and virus monitoring more generally.[51] Broader air quality monitoring is a key priority for Zurich. Another such project involves localized measurements of city air quality by attaching sensors to local trams. The data captured is used to identify high pollution areas and assess the impact vehicle particle filters.[52]

Benefits and Challenges

There is a range of desired benefits from health-oriented smart city projects. In the near-term, cities are primarily concerned with avoiding the immediate health consequences of continued COVID-19 transmission. As a result, municipalities across Europe seek to mitigate health risks while ensuring continuity of services and minimal economic disruption. In the longer term, however, cities hope to implement projects and technological solutions that will improve the overall health of the population. This can take many forms: reduced air pollution and improved fitness and activity levels are examples. Vienna has plans to improve overall citizen health through projects that use smart technology to provide early warnings to healthcare providers. One project uses smart watches to transmit basic health data to doctors and provides patients with tools to perform routine medical testing at home. The city hopes that early detection will reduce stress on healthcare infrastructure and workers.

While there are many ways to address local public health issues, initiatives can also be stalled due to competing priorities for funding at national or regional levels of government.

Labour Market Impacts

As with many smart city projects, data is key. In the air quality measurement project, Zurich municipal representatives identified the need for researchers that have specialization in big data analysis, and knowledge of population health and air quality indicators. Notably, this needed to combine various types of data across different fields (for example, public transportation and micro-mobility with existing traffic data was

considered essential for these roles). Like many other innovative cities with highly educated citizens, there is a strong talent pipeline from the university system and local ICT hubs, but competition for this talent is fierce. Moreover, although there is significant demand for technology roles across all types of smart city projects, smart health projects require digitally skilled talent with experience working with patient or population health data, as well as roles that marry digitization skills with social and scientific specialists. Increasingly, multi-disciplinary smart city project teams need to include psychologists, epidemiologists, data scientists, urban planners, economists, and other scientists.

Smart Regulation

What are Smart Regulations?

Inherently, new technologies and ways of thinking about delivering government services are unlikely to be a perfect fit for existing municipal regulations (for example, new modes of transportation and road usage or alternative energy generation and distribution). Almost every interviewee mentioned managing multiple regulations, and some noted that regulations can help or hinder smart city developments.

Tallinn's Data, Digital, and Innovation group often has to navigate existing data protection regulations and, in some cases, developing new ones to achieve its goals for the novel use of digital technologies. For example, as autonomous vehicle technology progresses, it becomes crucial to understand who is responsible when problems or accidents occur. Other examples of municipal initiatives with regulatory concerns include energy transition projects and those that digitize government services. Eindhoven's interviewee noted the challenge of reconciling institutional regulations for building codes with evolving energy legislation.

Some European cities have created interesting structures to navigate potential regulatory roadblocks. Urban Innovation Vienna is a smart city agency, owned indirectly by the city of Vienna[53] but organized as a limited company for operations.[54] As a result of this setup, Urban Innovation Vienna can act as a flexible unit to support the city as a market "matchmaker" to strengthen collaboration with external stakeholders and manage the smart city framework (with quality of life, environmental, and innovation goals)[55] and strategies. This allows the brokering of innovation and the ability to act as a neutral agent to facilitate and implement changes such as providing shared, environmentally friendly micro-mobility options to residential buildings or

developing more sustainable construction practices.[56]

One of Brussels' smart city priorities is urban mobility. As a result, the city developed an overarching mobility agency, Brussels Mobility,[57] to better understand how to regulate the changing smart mobility market and examine different applications (e.g., micro-mobility solutions like scooters for individuals or integrating different rail, bus, and car platforms) while addressing regulations for vehicle speeds and low emission zones.

Benefits and Challenges

Given the role of the regulatory environment in the implementation of smart city projects, agility is key. Municipalities that can prudently update their regulations to allow for more ethical experimentation with digital technologies can make use of the opportunity to improve productivity, quality of service, or find new innovations. For some municipalities, there may be opportunities to modify regulations to better accommodate smart city projects. Where adaptation or iteration proves challenging, cities may benefit from setting up new operating structures to better navigate the local regulatory environment.

Smart Regulation: Labour Market Implications

As regulations govern almost every aspect of smart city development, an awareness of the regulatory environment (and expertise to navigate it) is essential to success. Although specific regulatory roles were not mentioned by interviewees in this study (such as compliance roles, privacy officers, auditors etc.), there is an acute need for strong leaders, champions, and managers who are able to understand regulations and regulatory change.

Section II: Themes Across the Range of Municipalities and Projects

Common themes, motivations, and lessons learned emerged from the interviews with representatives of European smart city projects.

The following describes common principles behind projects, followed by typical challenges, including those related to the COVID-19 pandemic. Next, solutions for overcoming challenges are described with emphasis on best practices and methods of measuring both return on investment (ROI) and social return on investment (SROI) in successful projects.

Binding it Together: Common European Smart City Guiding Principles

Analysis of 20 interviews in this study reveal a series of commonly identified principles that motivate and inform smart city projects (many resonate with commonly held Canadian smart cities development principles,[58] such as data sharing, AI fairness and governance):

- **Citizen engagement and participation**: Interviewees emphasized the need for proper citizen engagement through consultations and surveys. Municipalities underscored the importance of helping citizens understand the rationale or need for smart city projects and offering a platform to share input, questions, and concerns before projects begin.
- **Digital rights of citizens:** Related to citizen engagement, municipalities highlighted a need for knowledge at the intersection of digitization of municipal services and citizen rights. Specifically, while digitization of existing or new services creates operational changes, it should not alter citizen rights. These include the right to provide input on new developments, or the right to opt-in or opt-out of projects where possible.
- **Respecting privacy:** Since many smart city projects leverage public data to some degree, interviews highlighted significant concerns about data privacy. For example, technologies and projects that leverage cameras, sensors, and data analytics increasingly challenge and alter citizen expectations of privacy. New projects must ensure that individual and group privacy rights are respected and protected.

- **Ethical use of data and AI:** AI is increasingly seen as a way for businesses and governments to automate certain activities, create innovative new products, and improve efficiencies and outputs. Yet, interviewees highlighted ethical use of data and AI technologies as a high priority. Algorithmic decision-making can pose risks and often have unintended consequences or inherent biases. Ethical considerations and safeguards throughout the lifecycle of these projects are needed to ensure that new technologies do not exacerbate inequalities.
- **Proactive data sharing:** While respecting individual privacy and privacy legislation is a cornerstone of European smart city projects, there is also a practical need to proactively share some data. For example, data on air quality, traffic, waste collection, etc. shared between or across municipal departments could uncover new opportunities and challenges, and promote open data initiatives that aggregate and share this information with citizens. Many smart city experts have argued that open data is inherent to citizen engagement. Citizens should have access to anonymized data, bolstering engagement and community building.[59]
- **Partnerships and collaboration:** The importance of partnerships and cross-departmental collaboration (and even between municipalities) were identified as key to the implementation of smart city projects. Partnerships and collaboration can extend to include post-secondary institutions, local economic development agencies, not-for-profits, and industry to achieve goals.

Room for Improvement: Common Challenges and Solutions

Discussions with subject matter experts and representatives from European smart cities revealed a wide range of challenges and areas for improvement. These include conceiving projects, communicating benefits, implementation, municipal limitations, operational challenges, and gaining local buy-in. The following is an overview of common challenges faced and examples of how they are being overcome.

Smart Regulation: Labour Market Implications

Ultimately, as with all smart city projects, there are limitations to what municipalities can accomplish on their own. For example, Vienna has a goal of promoting and bolstering EV use but is limited by its internal (municipal) capacity to produce technology that can help drive this change. For example, although some municipal staff have the capacity to leverage technology to engage with the public and attempt to

incentivize certain behaviours, achieving that goal requires the development of custom software, which requires the city to seek partnerships with post-secondary institutions or industry. In other cases, in-house expertise is available, but implementation may prove challenging due to the absence of cross-department coordination. Multi-domain or multi-department smart city initiatives (sometimes even involving multiple cities or levels of government) require a clear mandate or leadership.

“Collaborate, collaborate, collaborate, which is what I'm doing these days—what I'm doing with you and what we have to be doing. Because at the end of the day, cities are all different, but they have the same challenges. You learn from each other a lot. It's very costly to make mistakes in a city.” – João Tremoceiro, Lisbon Center for Urban Smart Management

Often, smart city efforts involved a range of collaboration. For example, Barcelona partnered with local industry players to develop a broad training program that provides foundational digital skills to employees across a range of industries such as banking, automotive manufacturing, and healthcare.

Changing User Behaviour

In other cases, the technologies themselves may be available (such as tools that monitor traffic or connect lighting systems), but the necessary physical infrastructure is lacking, or larger digital infrastructure to fully support these technologies are still in progress. The growing interest across municipalities in autonomous vehicles requires appropriate physical and digital infrastructure to safely test and manage these projects (e.g., 5G, IoT or geo-fencing). Further adoption of autonomous vehicles will inevitably require swift regulatory attention, as well as other alterations of physical infrastructure, including “pavement sensors and markings, road signs, traffic control devices, maintenance protocol, data management, communication systems, and mapping.”[60]

Interviews also raised ethical issues or concerns regarding new technologies, which can ultimately impact use of products or services. Municipalities increasingly balance the need for innovation and improved service provision with privacy and data security. Ethical technology use is a cornerstone of many European smart city projects, sometimes shifting citizen expectation and user behaviour. For example, in Aarhus—where one project focuses on changing commuter behaviour and incentivizing carpooling and other shared transportation options—technological challenges are minimal; the bigger hurdle is changing behaviour or usage patterns. Although part of

this challenge includes people's resistance to changing their commuting patterns (compounded by the pandemic), residents raised questions about how their data would be used and what privacy safeguards would be in place when engaging with shared transportations mediums on the digital platforms that support them.

Smart City Projects and COVID-19

The ongoing COVID-19 pandemic has continued to impact municipalities and their smart city projects. One obvious challenge is the financial impact on local economies due to shifts in economic patterns: downturns in sectors like tourism, hospitality, and retail led to severe contractions in output and labour market changes, while potentially longer-term trends like remote work is altering citizen behavioural patterns and needs. Interviewees said that remote work drastically altered commuting patterns and transit usage, putting pressures on existing or planned smart mobility projects. Two years into the pandemic, cities continue to grapple with COVID -19 impacts on smart city progress, technology development, and the talent pipeline.

Moreover, municipalities recognize that the rapid pace of digitalization may create divergent outcomes. When work and education moved online, the importance of connectivity—access and quality—became paramount. In London, for example, municipal staff worked to prioritize citizen access to internet and computing devices to ensure that vulnerable populations were not isolated. Ongoing efforts in this space include offering 4G data access in the subway system and utilizing a full fibre pipeline across the city along the network (with a hub and spoke model).[61] Most interviewees stressed the importance of safeguarding against an inequitable recovery. The risk of a "digital divide" was highlighted, and municipalities are working to ensure that there is broad access to reliable and affordable internet.

Additionally, interviewees noted potential long-term changes to the construction and operation of urban centres. In London, the city has undertaken activities to address the recovery of "High Street" (downtown retail). Given the disproportionate economic impact of COVID-19 on younger populations, many of whom are often employed in retail, leisure, and restaurant work,[62] the city emphasized training its youth for new opportunities post-pandemic. Initiatives like the Digital Talent program, for example, offers £7 million toward the development of youth skills training and career development services.[63] Related, other projects focus on incentivizing the rebound of impacted sectors like retail. Newcastle, for example, uses smart sensors to transmit

live data on foot traffic and crowd density, with the intent of increasing comfort levels and incentivizing travel to town for these purposes.

Due to the rapid and necessary adjustments required by COVID-19, interviewees note that local governments have become more resilient. In fact, many are embracing the notion of “resilient cities” to weather future crises; this acknowledges that crises will occur and that cities should look at preventive measures alongside resilience strategies that enable them to continue operations through these disruptions.

"Probably like everywhere in the world, COVID-19 really made certain needs more visible in terms of the resilient city. Cities have to be resilient now, not only in preventing everyday life from breaking down—supplies and all that—but also in a digital sense. Even with significant efficiency and performance gains being likely here and there, the more you digitize, the more you have to make sure that digital systems are resilient, and are not hackable, for example. So new risks and trade-offs are mushrooming with technological progress. What happens to the ground floors in a vibrant city if the whole world shifts to home office and e-learning? How will single parents who cannot afford sufficient living space and childcare deal with all of that? Nevertheless, COVID-19 is perceived as an accelerator for digitization that could well facilitate real improvement in many areas."
– Nikolaus Summer, City of Vienna

Municipal Benefits: An Emphasis on SROI

While improved operational efficiencies and fiscal responsibility are clear motivations for smart city development, municipalities place a growing and significant focus on social return on investment. Crucial are the broader or holistic benefits to citizens through improved livability, quality of life, and sustainability.

“The goal of our smart city project is always that the aim to use technology as a means to reach a better quality of life for people.” – Interviewee

Yet, while important, both ROI and SROI can be difficult to quantify. For example, financial or economic benefits to the city are often long-term, with many projects still too new to concretely show outputs.

Furthermore, it can be difficult to quantify the ROI and SROI for projects that have benefits across multiple dimensions. For example, reduced congestion can improve the business environment and the physical environment, cut commuting costs, and avoid

negative health impacts on citizens. As an interviewee noted, implementing new technologies in smart city projects can also help improve the readiness of citizens to embrace other emerging technology opportunities, but the benefit or financial return is not always straightforward to calculate. Similarly, measuring and improving air quality has positive benefits on health (and presumably reduced healthcare costs), but it is more difficult to quantify than other direct measures such as investing in a piece of machinery that pays for itself after a certain number of years.

Examples of Financial ROI

Despite inherent challenges with all measurement of longer-term outcomes, many European cities provided examples of financial benefits or a positive ROI. In London, coordinating infrastructure construction to maximize the work done during excavations showed financial benefits by reducing costs for utility providers. In Dublin and Prague, smart waste bins or IoT connected waste bin collection improved municipal operations and led to cost savings by avoiding unnecessary waste pickups. Furthermore, many of the noted projects also offered opportunities for additional revenue generation through the sale of advertising space.

Other cities championed local tech companies (or supporting a more tech-oriented ecosystem using incubators or tech parks) as an opportunity for economic growth by growing local businesses and attracting investment and foreign talent. Smart city projects provide business benefits to local SMEs by offering opportunities for real-world testing, pilot projects, and co-development or co-creation between private companies and the city as a client. Pilot projects can result in benefits such as allowing the start-up companies or vendors to work on smaller aspects of the overall project with less pressure or risk, and identify issues before full execution.[64]

Pilot projects for cities can also help local companies prove their product or service, making it market-ready for subsequent customers. Pioneering smart city developments or pilot projects were seen as beneficial by both attracting R&D investment as well as improving the city's reputation when competing for company and talent attraction. In other cases, smart city developments can attract significant support and funding from other levels of government or groups, such as the European Commission when dealing with crucial issues of housing or environmental challenges.[65] This can make smart city projects more attractive or financially feasible.

Examples of SROI

Digitalization and other "smart" improvements to municipal operations carry a wide

range of benefits that go beyond financial returns. In some cases, digital services or new technology reduces municipal service disruptions and inconveniences. One city saw approximately 50% fewer complaints about waste collection and overfilled garbage bins because of their automated bin monitoring. In Stockholm, moving to a “smart lighting” system was motivated by a range of benefits: improved lighting illuminate areas with higher crime rates to improve public safety while saving energy by switching off when an area is not being used. City staff estimated this reduces energy consumption by 30 to 50%, which has environmental benefits.

Stockholm’s connected lighting system also improved service, as the municipality no longer relies on public reporting for non-functional lights.

“As soon as that light goes out, we can get the feedback. And that means that we can be faster at fixing the error, which also provides a safe environment for people where the lights are on at a higher service level than before. But those benefits are really hard to measure.” – Björn Lindelöf, Stockholms Stad

Many projects were motivated by sustainability benefits. Decarbonization[66] was frequently a top priority of European cities, whether through reducing car traffic, building retrofits, alternative energy and smart grid solutions, or supporting local green technology development. Interviews identified the reduction of vehicle congestion as having both environmental as well as quality of life benefits for local citizens.

“As we've seen with COVID, focus is less on exponential growth models for our economy. We have to balance between welfare, happiness in society, and otherwise—what we do and how technology puts the pressure on our ecological footprint.” – Peter Portheine, Eindhoven - Brainport Smart District

SROI benefits are not limited to environmental considerations. Social issues and inequities were also a major concern for European cities when measuring SROI. Smart city projects often focus on inclusion and diversity initiatives as well as ensuring that benefits are accessible to all. This can mean considering issues of physical disability or other social challenges like urban poverty. Interviewees frequently note smart city projects must not worsen existing inequalities, and extra care must be taken to ensure that citizens have access to services, which might require improving broadband infrastructure, piloting digital skills training, or even providing devices to vulnerable groups to allow for full participation in society.

Summing Up: Best Practices for Smart City Developments

Cities throughout Europe have responded to growing social, economic, and environmental challenges with a diverse range of solutions. Smart city developments can successfully address local issues through technology-based solutions as well as innovative policy. As Canada continues its own smart city journey, there is an opportunity to learn from European leadership.

By examining and comparing different experiences, several themes and lessons have emerged. Notably, successful smart city developments require flexibility, innovation, and strong champions. Furthermore, communities will need to find efficiencies and new solutions to improve ROI and SROI, but these cannot be solely technology-based. Successful project implementation requires citizen engagement, understanding local needs, collaboration, a range of partnerships, and addressing labour market challenges. In addition to fulfilling the demand for specific occupations, smart city developments will also require a mix of technical and soft skills.

While every project and municipality will have its own unique needs, challenges, and priorities, interviewed representatives provided examples of best practices and lessons learned from their experiences to assist Canadian municipalities on their own smart journeys. These include:

- **Involve your citizens**: Interviewees noted the importance of local citizens and stakeholder participation in projects as they are conceptualized and executed. In some cases, this could build on popular sentiments “from the bottom-up” or use a process of co-creation with an active role of citizens.
- **It’s an Ecosystem**: The success of smart cities and communities requires the involvement of the larger ecosystem. The surrounding landscape of research centres, universities and post-secondary institutions, private industry that provides the technologies and talent—all of these play crucial roles.
- **Think Locally**: Smart city projects must take the unique characteristics and needs of their city into account. Every community has different needs and priorities to consider. Local technology vendors might also be more appropriate suppliers of solutions if they understand the specific needs of the city.

- **Learn from Pilot Projects and Adjust as Needed:** Several interviewees highlighted pilot projects as an effective way to try new smart city technologies. This allows for smaller financial commitments and less disruption or risks to existing services. When done well, pilot projects can be adjusted during the process. Cities benefit from working with vendors and being able to provide feedback, while the vendors can benefit from being able to learn about their client needs to make their products or services more competitive.
- **Listen to Municipal Staff Needs:** Although multistakeholder collaboration is key, municipal staff are at the forefront of smart city developments in areas such as infrastructure or mobility. As a result, successful projects should be done in consultation with staff to understand needs and priorities to ensure the technology meets those criteria.
- **Co-operation and Coordination**: Collaboration was one of the key factors to successful implementation of European smart city projects. This can entail coordinating efforts with other cities in a region to look at common needs and solutions and share best practices; it can also apply to joint efforts across national borders.
- **Find the Right Balance with Industry**: There are obvious benefits of turning to large and experienced innovative technology companies when looking at smart city solutions. These organizations have significant resources and domain expertise to solve complex problems. However, collaboration with industry also requires clear safeguards and controls, including how data is accessed, data ownership, and implementation. This could include safeguards to ensure that data is being stored and used responsibly while following local privacy legislation. The EU's General Data Protection Regulation (GDPR) is one example of data privacy regulation, and some cities such as London noted leveraging private consultants for security and privacy expertise while developing solutions with city staff.
- **Newer or Customized Technology Isn't Necessarily Better:** Smart city projects are not always driven by the adoption of cutting-edge technology. In some cases, it is not necessary to be an early adopter or seek the most "high-tech" solution to solve a problem. Sometimes it is suitable for municipalities to use off-the-shelf or lower-cost existing technologies or even implement solutions that are not inherently digital. For example, Stockholm's traffic department took a pragmatic and low-cost approach to traffic management by using existing mobile technology infrastructure for their smart lighting project.

Appendix: Research Methodology

The research methodology used in the development of this report consisted of a combination of primary and secondary research.

Primary Research

The primary research for this report consisted of a series of 20 key informant interviews and were held with a variety of subject matter experts and representatives from organizations involved in smart city projects across the European region. Participants included municipal employees or employees from related public sector agencies in this field. The cities chosen for this study vary in size and represent countries from a wide geographic region, though they have all been selected due to their leadership in smart cities developments.
These open-ended interviews were designed by ICTC to allow participants to discuss a range of topics including:

- specific smart city projects in the region
- benefits and challenges to implementation
- measures of ROI or SROI
- labour market impacts

These interviews were then conducted in partnership with a European consultant (Colors Inc.) who found suitable representatives to participate in this project. These interviews were conducted largely in English. These interviews were then transferred to ICTC to transcribe and analyze. The findings and themes have been integrated throughout this report. Specific cities have been mentioned to provide examples of these developments, but many have similar projects and goals (though they may be at different stages of completion).

Secondary Research

The secondary research for this study focused on an analysis of existing literature for smart cities development in international settings. This builds on prior ICTC research and literature reviews on the topic to highlight or clarify key themes, trends, and emerging issues.

Limitations of Research:

While ICTC attempted to ensure that the research process for this study was as exhaustive as possible, there are inherent limitations to sample size. Likewise, it is difficult to encapsulate the entirety of smart city developments in different European regions based on limited interviews. Interviewees were experts in their domain but may not have been aware of all smart city projects that are implemented locally. Limited sample size also means that responses must be regarded as insights and cannot necessarily be taken as objective “trends” that represent the European experience. While efforts were made to ensure the selections for the interviews were representative of regional diversity, interviews were subject to availability and to modest miscommunication or misunderstandings where English was not their first language.

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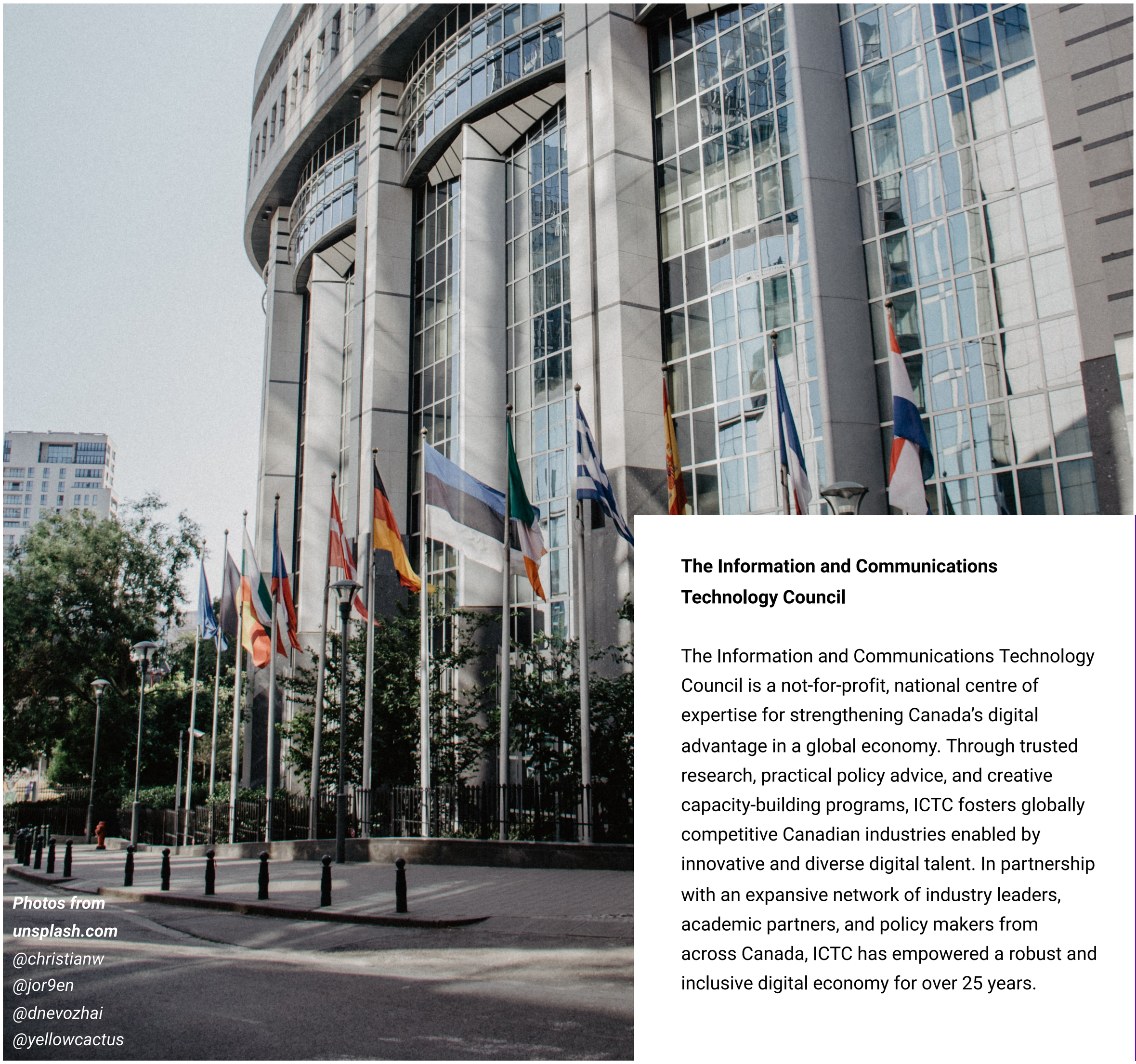

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