



# WORK IN PROGRESS

Emerging Smart  
City Occupations



Research by



The Information and Communications  
Technology Council

Canada 

This project is funded in part by the Government  
of Canada's Sectoral Initiatives Program

# Preface

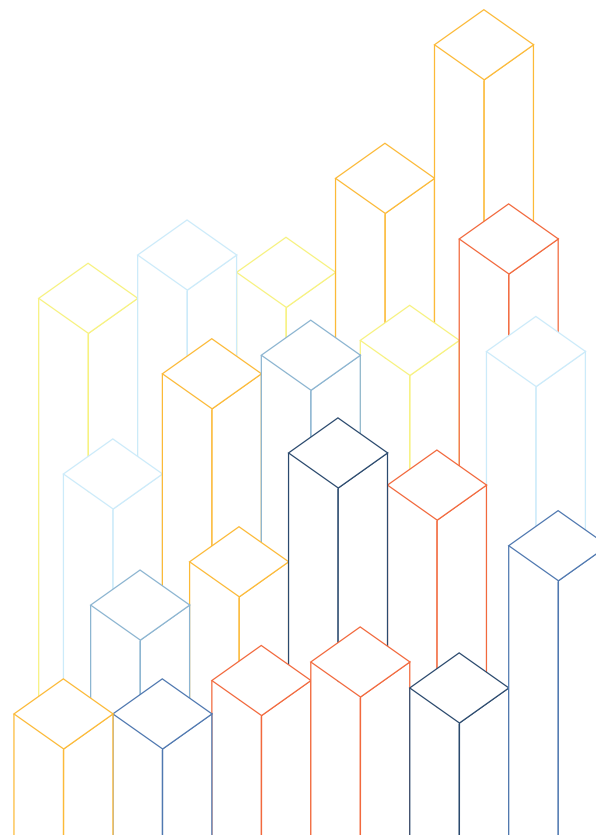
ICTC is a national centre of expertise on the digital economy. With over 25 years of experience in research and program development related to technology, ICTC has the vision of strengthening Canada's digital advantage in the global economy. Through forward-looking research, evidence-based policy advice, and creative capacity building programs, ICTC fosters innovative and globally competitive Canadian industries, empowered by a talented and diverse workforce.

## To cite this report:

*Kotak, A., O'Neill, K. "Work in Progress: Emerging Smart City Occupations" (April 2021), Information and Communications Technology Council (ICTC). Ottawa, Canada.*

*Researched and written by Akshay Kotak (Senior Economist & Research Analyst) and Khiran O'Neill (Research & Policy Analyst), with generous support from Rob Davidson (Director, Data Analytics), Arun Sharvirala (Data Analyst), Rosina Hamoni (Research Analyst), Amal Das (Junior Data Analyst), and the ICTC Digital Think Tank team.*

The opinions and interpretations in this publication are those of the authors and do not necessarily reflect those of the Government of Canada.





## Abstract

Smart cities are rapidly becoming a central component of both urban and technological development. While smart cities are likely to have significant labour market implications, little is known about the associated occupations that are emerging (or are likely to emerge) as smart city technologies become more prevalent. Using mixed methods—key informant interviews, a literature review, and web scraping of job data—this report profiles several such roles, describes their creation and evolution, and the accompanying responsibilities, backgrounds, skills, and teams. Roles are evaluated in five categories (Privacy, Cybersecurity, and Risk Management; Equity, Ethics, and Inclusivity; Innovation and Growth; Infrastructure and Mobility; Sustainability and Resilience), with a focus on professionals in senior positions who are driving smart city development. Across all categories, future skill needs will likely be centred around data and digital literacy combined with strong soft skills. Similarly, progressive career experience and professional or technical degrees will likely remain highly valued.

### Keywords:

- Smart city
- Labour market
- Emerging occupations
- Future of work
- Skills
- Workforce

# Acknowledgements

The contributions made to this report by our key informant interviewees are greatly appreciated. We would like to acknowledge all the contributors to this report, and the following specific individuals:

## Ana Pranjic

Innovation & Experimentation Specialist

## Arnoud Molenaar

Chief Resilience Officer, City of Rotterdam

## Brandon Campbell

Smart Mobility Manager, City of Tampa

## Brion Oaks

Chief Equity Officer, City of Austin

## Carlos Rivero

Chief Data Officer, Commonwealth of Virginia

## Christina Brooks

Chief Equity Officer, Director of Diversity & Inclusion Department, City of Fort Worth

## Christina Willingham

Smart Mobility Division Manager, City of Austin

## Claire Bennett

Corporate Sustainability Officer, City of Kitchener

## Cornelia Sandaluche

Strategy & Innovation Consultation, Innovitech

## Courtney Zinn

Innovation Lab Director, City of Kitchener

## Damien Yee

Chief Learning Officer, Epitome

## David Graham

Chief Innovation Officer, City of Carlsbad

## Ginger Armbruster

Chief Privacy Officer, City of Seattle

## Grant Ervin

Chief Resilience Officer, City of Pittsburgh

## Jason JonMichael

Assistant Director: Smart Mobility, City of Austin

## Nadine Berge

Director, Corporate Compliance and Legal Operations, TC Energy Corporation

## Neil Linden

Chief Privacy Officer (Canada), Scotiabank

## Tim McCreight

former Chief Information Security Officer, City of Calgary



# Table of Contents

|   |           |
|---|-----------|
| <b>Executive Summary</b>  | <b>7</b>  |
| <b>Introduction</b>   | <b>9</b>  |
| <b>Privacy, Cybersecurity, and Risk Management</b>              | <b>11</b> |
| Primary Responsibilities  | 11        |
| Skills and Backgrounds  | 13        |
| Team Structure  | 14        |
| Training Needs and Skills Considerations: A Zoom In on Privacy  | 14        |
| <b>Equity, Ethics, and Inclusivity</b>                          | <b>17</b> |
| Primary Responsibilities  | 18        |
| Skills and Backgrounds  | 19        |
| Team Structure and History                                      | 19        |
| Training Needs and Skills Considerations                        | 20        |
| <b>Innovation and Growth</b>                                    | <b>22</b> |
| Responsibilities: Identify, Experiment, and Implement           | 23        |
| Skills and Backgrounds: Business and Design                     | 24        |
| Team Structure and History                                      | 25        |
| Training Needs and Skills Considerations                        | 25        |
| <b>Infrastructure and Mobility</b>                              | <b>27</b> |
| Overall Responsibilities  | 28        |
| Skills and Backgrounds  | 29        |
| Team Structure  | 30        |
| Training Needs and Skills Considerations: Theory to Application | 31        |
| <b>Sustainability and Resilience</b>                            | <b>33</b> |
| Overall Responsibilities  | 34        |
| Skills and Backgrounds  | 34        |
| Team Structure and History                                      | 35        |
| Training Needs and Skills Considerations                        | 35        |
| <b>Conclusion</b>   | <b>37</b> |
| <b>Appendices</b>   | <b>39</b> |
| I. Research Methodology   | 39        |
| Primary Research  | 39        |
| Secondary Research  | 40        |
| II. Limitations of Research                                     | 40        |



# Executive Summary

Revenues from smart city projects worldwide are projected to grow from \$116 billion (USD) in 2020 to \$241 billion (USD) in 2025.<sup>1</sup> These initiatives, along with globalization, urbanization, and rapid digital disruption, will impact existing jobs and establish a demand for newly defined occupations in smart cities and beyond.

This report profiles “emerging” (currently non-existent or rare) occupations in five subject areas that are likely to arise from smart city and community growth. These occupations were identified through a literature review of emerging smart city roles, key informant interviews, and data of skills associated with the five subject areas (Privacy, Cybersecurity, and Risk Management; Equity, Ethics, and Inclusivity; Innovation and Growth; Infrastructure and Mobility; Sustainability and Resilience). The report explores the purpose, responsibilities, education and skill requirements, potential evolution, and work context of these new and emerging jobs relevant to smart cities. Analysis is provided largely by key informant interviews, leveraging insights and lived experience of individuals in senior-level roles related to smart cities. With interviewees located in cities around the world, these global insights offer a glimpse into the future of Canadian cities as they evolve and become increasingly “smart.” Although more junior-level occupations are likely to emerge in this space, senior-level roles currently drive global smart city developments in the subject areas covered.

*Privacy, Cybersecurity, and Risk Management* roles entail protecting personally identifiable “user” information, ensuring organizational compliance, and managing, coordinating, supporting the use of data, as well as broader municipal security operations. These professionals often require both technological and management training. As data becomes increasingly important to cities and as Canadians become increasingly concerned about their data, this field is likely to continue to grow rapidly.

*Equity, Ethics, and Inclusivity* roles in the context of smart cities entail work across multiple departments and focus on organizational learning and conduct, and on identifying and responding to disparities. A strong grounding in diversity and inclusion, data, and communications is often required for these roles. Many cities are beginning to develop equity-focused departments, particularly as concerns about smart cities and equity garner public attention.

<sup>1</sup> Smart city revenue worldwide 2020-2025," accessed April 29, 2021, <https://www.statista.com/statistics/1111626/worldwide-smart-city-market-revenue/>

*Innovation and Growth* professionals often have skills related to design, with design thinking being a central paradigm of much innovation work.<sup>2</sup> Innovation professionals often merge business and entrepreneurial acumen with technological skills and knowledge. Often described as a field that is in vogue, it is yet unclear whether “innovation” is merely the rebranding of traditional city services, or if it signifies new intent to think differently about those services.

*Infrastructure and Mobility* professionals typically require engineering or transportation technology backgrounds and training. Smart mobility technologies are developing rapidly, so while interviewees noted that much of the work currently being done is related to piloting and testing, they expect to turn toward implementation in the near future. As this occurs, the field may also require more talent with project management and business intelligence skills, alongside others with expertise in artificial intelligence, robotics, and embedded systems.

*Sustainability and Resilience* roles are an outgrowth of environmental sustainability and encompass a range of jobs designed to prepare cities and communities for economic, environmental, social, and institutional shocks.<sup>3</sup> Individuals in these roles often have environmental science backgrounds or knowledge and a capacity for collaborative, relationship-building work. COVID-19 will have potentially divergent impacts on these roles. Channelling energy and funds to address the immediate crisis of the pandemic may reduce funding available for sustainability and resilience roles, which might be considered components of a “luxury” department that is nice to have but not essential. Alternatively, the COVID-19 crisis may have the opposite effect on these roles by making evident the need for cities to be prepared when shocks inevitably occur.

With data being a key resource underpinning smart city services, holistic data literacy is fundamental to many of these roles. This spans everything from data collection, processing, and analysis to design considerations around the ethics, inclusivity, and security of systems that gather, process, and store data. Similarly, digital and technological literacy—whether in the form of technical skills such as coding language proficiency or knowledge of emerging technologies and the economic opportunities they open—will help these professionals manage teams and harness the skills of more technical employees. Finally, despite the rapidly evolving domains and responsibilities for people working in smart cities, key soft skills (stakeholder management, verbal and written communication, leadership) will continue to remain important in the future.

2 Franco Amalfi, “Innovation in government: a building block to smart cities,” GovLoop, August 8, 2019, <https://www.govloop.com/community/blog/innovation-in-government-a-building-block-to-smart-cities/>  
3 OECD, “Resilient Cities,” accessed February 1, 2021, <https://www.oecd.org/regional/resilient-cities.htm>



# Introduction

"Smart city" is a term that broadly describes the interconnection between information and communications technology (ICT), data, and urban life.<sup>4,5</sup> Increasingly, however, discussion of smart cities has tended toward more "human-centric" approaches.<sup>6</sup> That is, attention not only to smart city technologies but also to the users and producers of smart cities. Inspired by such trends, this report highlights one notably human component of smart cities: the occupations that are central to smart cities and the people that perform them. Specifically, this study profiles "emerging" (i.e., currently non-existent or rare), occupations that are likely to arise from smart city and community growth.

COVID-19 has caused many citizens to consider alternatives to urban living. In Canada and around the world, some movement of residents from downtown cores to suburban or even rural locations has been noted.<sup>7,8</sup> Yet cities still offer the civic commons—the "hubs of human activity, interaction, and connection"<sup>9</sup>—that many people have grown to miss during health imposed isolation and that are often at the centre of innovative and resilient responses to emerging challenges.<sup>10</sup> In many ways, the pandemic has strengthened the appetite for developments in connectivity, healthcare provision, smart and clean energy production, and innovative and responsive government services. These developments, along with broader trends in globalization, urbanization, and rapid digital disruption, will impact existing jobs and will establish a demand for newly defined occupations. Although job titles and duties will vary, the uniting feature is that virtually all future jobs will require a base level of digital literacy.<sup>11</sup>

- 4 OECD, "Smart Cities and Inclusive Growth" 2020, [http://www.oecd.org/cfe/cities/OECD\\_Policy\\_Paper\\_Smart\\_Cities\\_and\\_Inclusive\\_Growth.pdf](http://www.oecd.org/cfe/cities/OECD_Policy_Paper_Smart_Cities_and_Inclusive_Growth.pdf)
- 5 Faun Rice, "Transformative Technologies for Smart Canadian Cities," ICTC, 2019, [https://www.ictc-ctic.ca/wp-content/uploads/2019/09/ICTC\\_Smart-Cities-Transformative-Tech\\_Brief\\_Sep30-2019.EN\\_.pdf](https://www.ictc-ctic.ca/wp-content/uploads/2019/09/ICTC_Smart-Cities-Transformative-Tech_Brief_Sep30-2019.EN_.pdf)
- 6 UN Habitat, "People-Centered Smart Cities," 2020, [https://unhabitat.org/sites/default/files/2021/01/fp2-people-centered\\_smart\\_cities\\_04052020.pdf](https://unhabitat.org/sites/default/files/2021/01/fp2-people-centered_smart_cities_04052020.pdf)
- 7 Sarah Marsh, "Escape to the Country: How Covid Is Driving an Exodus from Britain's Cities," The Guardian, September 26, 2020, <http://www.theguardian.com/world/2020/sep/26/escape-country-covid-exodus-britain-cities-pandemic-urban-green-space>.
- 8 Creeson Agecutay and Ross Andersen, "Canadians Leaving Big Cities in Record Numbers: Statistics Canada," CTV News, January 16, 2021, <https://www.ctvnews.ca/canada/canadians-leaving-big-cities-in-record-numbers-statistics-canada-1.5270161>
- 9 KPMG, "Smart City Transformation in a Post-COVID World," 2020, <https://assets.kpmg/content/dam/kpmg/au/pdf/2020/smart-city-transformation-in-post-covid-world.pdf>
- 10 Tracy Hadden Loh Vey Hanna Love, and Jennifer S., "The Qualities That Imperil Urban Places during COVID-19 Are Also the Keys to Recovery," Brookings (blog), March 25, 2020, <https://www.brookings.edu/blog/the-avenue/2020/03/25/the-qualities-that-imperil-urban-places-during-covid-19-are-also-the-keys-to-recovery/>
- 11 Alexandra Cutean, Trevor Quan, and Holly Brown, "Smart City Priority Areas and Labour Readiness for Canadian Cities," ICTC, 2019, [https://www.ictc-ctic.ca/wp-content/uploads/2019/08/ICTC\\_Smart-City-Priority-Areas\\_Brief\\_ENG-8.19.19.pdf](https://www.ictc-ctic.ca/wp-content/uploads/2019/08/ICTC_Smart-City-Priority-Areas_Brief_ENG-8.19.19.pdf)



Specific job titles relevant to future roles in smart cities may change as the field matures. For this reason, key occupations are grouped in the following subject areas:

- Privacy, Cybersecurity, and Risk Management
- Equity, Ethics, and Inclusivity
- Innovation and Growth
- Infrastructure and Mobility
- Sustainability and Resilience

The purpose of these profiles is to better understand the core responsibilities, educational requirements, skill needs, and employment pathways for individuals in these roles, alongside their potential evolution. To this end, each section contains analysis based on a literature review of relevant smart city developments, insights from key informant interviews with individuals in senior-level roles, and data scraping of online job boards across 16 countries.<sup>12</sup>

Nineteen individuals from 13 cities (and four countries)<sup>13</sup> were interviewed for this study. These individuals hold leadership or senior roles related to smart cities. They a) work in roles that are likely to become central in smart cities but currently exist only in different sectors, b) work in smart city roles outside of Canada, c) are leaders in departments that have increasing relevance to smart cities, and/or d) are knowledgeable about careers or emerging roles related to smart cities. Interview discussions focused on understanding the purpose and responsibilities of their roles, their educational and professional backgrounds, the team structures that support their work, their assessment of the evolution of their respective teams in the context of smart city growth, and the types of professionals and skill sets they seek to add to their teams going forward.

This analysis is supplemented with skills data insights obtained by extensive web scraping of online job boards, and labour market analytics from Emsi<sup>14</sup> and Adzuna.<sup>15</sup> The job titles, keywords, and search terms used for this analysis were shortlisted by combining insights from the literature review and from the key informant interviews. Each section below also contains a table articulating the hard (technical) skills, soft (human) skills, and certifications most frequently associated with a variety of roles in the respective subject areas (and not only those of senior management).

**12** Canada, United States, Brazil, United Kingdom, France, Germany, Austria, Italy, Netherlands, Poland, Russia, India, South Africa, Singapore, Australia, New Zealand

**13** Canada: Montreal, Toronto, Kitchener, Calgary; Netherlands: Rotterdam; Singapore; United States: Tampa, Austin, Commonwealth of Virginia, Fort Worth, Carlsbad, Seattle, Pittsburgh.

**14** "Emsi: Labor Market Analytics," Emsi, accessed January 15, 2021, <https://www.economicmodeling.com>

**15** "Adzuna | Jobs in London, the UK & Beyond," Adzuna, accessed December 30, 2020, <https://www.adzuna.co.uk>



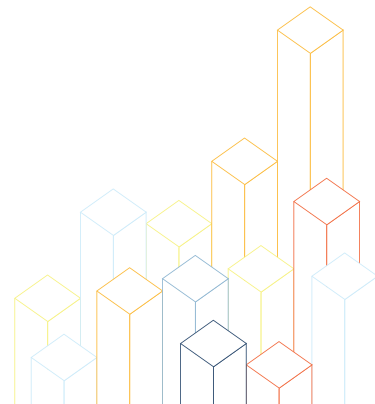
# Privacy, Cybersecurity, and Risk Management

Data collection and use is central to the very concept of smart cities. Numerous forms of public data are already being collected and utilized in cities around the world. This data informs traffic management needs, transportation planning, government service provision, and other aspects that improve functionality and quality of public services. However, as cities become more connected and technology becomes a ubiquitous part of daily life, there is a risk, or at least apprehension, that cities and/or the private entities they work with—intentionally or not—will also collect private citizen data to create citizen profiles.<sup>16</sup> Such apprehension is shared by the public. An estimated 88% of Canadians are concerned "about their privacy in the smart city context,"<sup>17</sup> with the use and sale of personal data being a primary point of concern. As a result, privacy and security cannot be neglected when constructing the frameworks for future cities and communities.

Five key informant interviews were held with chief privacy, information, and data officers in the private sector, municipal government, and regional government.

## Examples of roles in this area

Information Security Officer  
Cybersecurity Manager  
Privacy Analyst  
Chief Privacy Officer  
Chief Data Officer  
Chief Security Officer



## Primary Responsibilities

To develop smart cities in a secure and ethical manner, privacy, cybersecurity, and risk management professionals are crucial. They are also in high demand. For cybersecurity professionals alone, it is estimated that that the talent shortage totals 376,000 in North America.<sup>18</sup>

<sup>16</sup> Liesbet van Zoonen, "Privacy Concerns in Smart Cities," *Government Information Quarterly*, Volume 33, Issue 3, 2016, <https://www.sciencedirect.com/science/article/pii/S0740624X16300818>

<sup>17</sup> Sara Bannerman and Angela Orasch, "Privacy and Smart Cities: A Canadian Survey," <https://smartcityprivacy.ca/survey-results/>

<sup>18</sup> (ISC)2, "2020 Cybersecurity Workforce Study," accessed January 29, 2021, <https://www.isc2.org:443/Research/Workforce-Study>

Such employees are key to preventing cities or communities from being subject to cyberattacks, depending on the role, they may coordinate the physical security of assets and people as well.<sup>19</sup> These professionals also play important roles in designing and implementing “privacy by design”—proactively setting the structure of secure cities and establishing protocols to ensure data and individuals are protected. Their primary roles are to manage the city’s policies, procedures, and data governance, and ensure that the city complies with mandatory privacy laws.<sup>20</sup>

The primary responsibilities of these roles, as identified by interviewees, are:

- Protecting personally identifiable “user” information
- Ensuring organizational compliance and navigating regulatory landscapes (oftentimes requiring cross-department fertilization)
- Managing, coordinating, and supporting the use of data, as well as broader municipal security operations

Increasing public attention to data use and privacy was highlighted by interviewees as both a primary challenge and the very reason that their roles exist. Interviewees stated that balancing data needs with privacy concerns was a key duty and a central challenge because organizations that are able to share and make use of detailed data also have greater responsibility to protect it:

*[There was] an acknowledgement that we were collecting tons of information and data and nobody knew anything about it. So the mayor [...] and city council got together and said we need to deal with this issue of privacy.*

– Ginger Armbruster, Chief Privacy Officer, City of Seattle

<sup>19</sup> Josh Fruhlinger, “What is a CSO? Understanding the critical chief security officer role,” CSO, 2018, <https://www.csoonline.com/article/2122505/what-is-a-cso-understanding-the-critical-chief-security-officer-role.html>

<sup>20</sup> “Selecting a Privacy Officer,” Bennett Jones, April 2, 2005, <https://www.bennettjones.com/Publications-Section/Updates/Selecting-a-Privacy-Officer>

In addition to responsibilities surrounding data privacy, interviewees also cited increasing corporate responsibility, security incidents, and the need for shared resources and data: "When you're trying to have an impact on these types of complex issues, it isn't just up to one department to implement."

## Skills and Backgrounds

Professionals in privacy, cybersecurity, and risk management often have a background in both law and ICT, or business and ICT.<sup>21</sup> Understanding of privacy law, legal policymaking, and computer network security are highly important, so an advanced degree or post-degree certification is often necessary.<sup>22</sup> Certifications such as the Certified Information Privacy Professional (CIPP) would be beneficial for practising privacy work,<sup>23</sup> as are certifications demonstrating technical IT skill sets.<sup>24</sup>

Overall, interviewees were relatively new to their roles, with many only having been in them for one to four years. In general, this was not because interviewees had limited experience, but because the roles themselves had only recently been developed. In fact, a number of the interviewees were the inaugural position-holders and had held numerous senior legal or privacy positions for many years prior.

Largely, interviewees saw their skill sets echoing the requirements of the role itself: a high level of technical proficiency in IT, privacy, and data analysis, alongside a core set of strong soft, or "human" skills. Soft skills highlighted by interviewees were project management, organizational leadership, and governance or delivery-related skills. The latter includes characteristics like the ability to effectively foster change management across an organization, manage collaborative multi-stakeholder projects, and work with user experience in mind. While technical skills were considered necessary, interviewees felt that for their own roles, an ability to understand the bigger picture (impacts of new technology, organizational politics, and city processes) were critical: "I don't need to be able to code, but I need to understand what the impact of certain aspects of technologies will be to privacy and data collection."

**21** "How to become a Chief Information Security Officer," Cyber Security Education, <https://www.cybersecurityeducation.org/careers/chief-information-security-officer/>

**22** ZipRecruiter, "How to Become a Privacy Officer," <https://www.ziprecruiter.com/e/How-to-Become-a-Privacy-Officer>

**23** CIPP, <https://iapp.org/certify/cipp/>

**24** "How to Become a Chief Information Security Officer (CISO)," New Horizons Computer Learning Centers, 2019 <https://www.newhorizons.com/article/how-to-become-a-chief-information-security-officer>


## Team Structure

Many interviewees work in a small team that operates across multiple departments within their organization. Their direct colleagues were experts in cybersecurity and IT, as well as data scientists, auditors, legal staff, and a variety of project managers.


When hiring new talent, interviewees often sought individuals with applied backgrounds, such as lawyers and data scientists. Staff with legal and data knowledge, presentation skills, and dedication to civil service work were in high demand, but many noted significant challenges competing with private industry for skilled talent. One interviewee cited pay as the primary reason for this. If cities are unable to compete for such talent, they might look to hire external consultants or private companies for privacy services. This could also mean that cities are more likely to follow the lead of industry, rather than develop cutting-edge processes and policies themselves.

## Training Needs and Skills Considerations: A Zoom In on Privacy

Privacy roles are central to smart cities. The sentiment that when developing a smart city, “a privacy officer is among the very foundational positions that you need” was consistent among all interviewees. The work of privacy professionals in smart cities has expanded dramatically in recent years, as both data use and concerns have proliferated. Interviewees commented that “Organizations across the spectrum are still very immature from a data perspective,” and yet data—and by extension privacy—are becoming central to organizational operations: “Suddenly we were built into the program... I heard people, just [non-privacy] employees, say, ‘Hey, have you looked at privacy yet?’”



*Before you can implement smart cities technologies, you have to have governance. You have to have a legal framework for how that data is going to flow within your organization.*



– Carlos Rivero, Chief Data Officer, Commonwealth of Virginia

Privacy professionals are needed to guide the work of private companies when working with municipalities on smart city initiatives. For example, privacy professionals may write guidelines for ethical procurement of smart city technologies or ensure that user data is anonymized when a city purchases transit sensors. Privacy professionals are also critical in ensuring the safe use of data in these projects. Interviewees largely describe privacy professionals as "watchdogs" with varying regulatory, legal, and governance-based responsibilities.

*Having a privacy officer who lays down clear guidelines and guardrails of what's appropriate and what's not appropriate and how we should deal with the mass amounts of information that is out there is important. And I think that without it, you will have a bit of a chaotic situation.*

– Neil Linden, Chief Privacy Officer (Canada), Scotiabank

However, despite their importance to smart cities, skilled privacy professionals are difficult to find. Educational pathways to becoming a privacy professional is also a glaring gap. One interviewee said that although private educators offer certificates in the privacy field, universities do not yet offer such training, suggesting that privacy is an under-developed field. Some interviewees suggested that universities should focus more directly on practical privacy education.

*"[Universities] could teach about PIPEDA.<sup>25</sup> [They] could teach about privacy laws and privacy values.*

– Neil Linden, Chief Privacy Officer (Canada), Scotiabank

*We need to look at information security as a profession and ask: how do we establish standards? Universities have an important role to play in setting the stage for the right type of education, while helping to build the information security profession.*

– Tim McCreight, former Chief Information Security Officer, City of Calgary

**Table 1:** Associated Skills and Certifications for Privacy, Cybersecurity, and Risk Management Professionals

| <i><b>Hard Skills</b></i>                      | <i><b>Soft Skills</b></i>       | <i><b>Certifications</b></i>                        |
|--|---------------------------------|---|
| Cybersecurity & Auditing                       | Written & Verbal Communication  | Certified Information Systems Security Professional |
| Risk Analysis & Management                     | Problem Solving & Investigation | Certified Information Security Manager              |
| Incident Response                              | Operations                      | Certified Information System Auditor (CISA)         |
| Security Information & Event Management (SIEM) | Leadership                      | Certified In Risk And Information Systems Control   |
| Security Policies & Controls                   | Management                      | GIAC Certifications                                 |
| Penetration Testing / Ethical Hacking          | Governance                      | Certified Information Privacy Professional          |
| ISO/IEC 27001                                  | Research                        | NIST Cybersecurity Framework (CSF)                  |
| Identity & Access Management                   | Innovation                      | Certified Ethical Hacker                            |
| Privacy Impact Assessment                      | Presentation                    | Project Management Professional Certification       |
| Regulatory Compliance                          |                                 | Cisco Certified Security Professional               |





## Equity, Ethics, and Inclusivity

Because smart cities make use of citizen data and likely impact the quality, equity, and outcomes of service provision, it is necessary that equity, ethics, and inclusion experts help to guide and manage them. In Canada, inclusivity has been highlighted as a key component of smart city success.<sup>26</sup> Any smart city project that would raise concerns about social impacts (for example, due to the collection of data, the potential for human or algorithmic bias, or the need to challenge historic inequities) is an area where an ethics officer would likely be involved.<sup>27</sup> Work in this area is sometimes considered a subset of human resources. Recently however, equity and inclusivity work has emerged as a distinct field, particularly in response to growing concerns about equity and racism.<sup>28</sup> In addition to these concerns, recognition of the digital divide has spurred those who design smart cities to ensure that technology drives, rather than limits, equity, ethical decisions, and inclusion.<sup>29</sup>

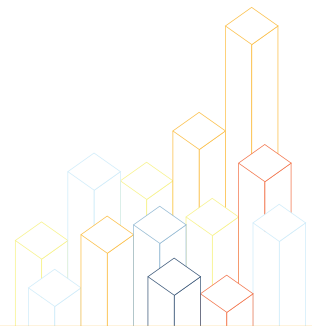
Key informant interviews were held with a chief ethics officer working in the private sector, and two chief equity officers working in cities outside of Canada.

### Examples of roles in this area

Chief Ethics Officer

Equity Officer

Diversity and Inclusion Officer



- <sup>26</sup> Zachary Spicer, Nicole Goodman, "The winner of the Smart Cities Challenge will likely be the city that best aligns technology, efficiency and equity, while not losing sight of residents," Policy Options, 2018, <https://policyoptions.irpp.org/magazines/march-2018/winning-smart-cities-challenge-equity-inclusion/>
- <sup>27</sup> "Rise of The Chief Ethics Officer," Forbes, March 27, 2019, <https://www.forbes.com/sites/insights-intelai/2019/03/27/rise-of-the-chief-ethics-officer/#80b79585aba8>
- <sup>28</sup> Janine Yancey, "Changing Social Norms Are Expanding the Compliance Officer's Role," Corporate Compliance Insights, 2020 <https://www.corporatecomplianceinsights.com/changing-social-norms-expanding-compliance-officers-role/>
- <sup>29</sup> Kathleen O'Dell et al., "Inclusive Smart Cities," Deloitte Insights, 2019, [https://www2.deloitte.com/content/dam/insights/us/articles/5091\\_inclusive-smart-cities/DI\\_inclusive-smart-cities.pdf](https://www2.deloitte.com/content/dam/insights/us/articles/5091_inclusive-smart-cities/DI_inclusive-smart-cities.pdf)

## Primary Responsibilities

Work in this field, according to interviewees, focuses on organizational learning and conduct within the organization, the identification of disparities, and the analysis of data to inform decision-making. The daily work of interviewees consisted of internal meetings, managing teams, supporting organizational learning, and (for the equity officers) using data. Both equity officers said that their roles were heavily, if not entirely, focused on supporting racial equity, with one interviewee noting that “the whole spirit of the work is to really get into how, as a city, we impact all of these racial disparities that we see across many quality-of-life indicators.”

Interviewees noted that ethical and equitable decision-making is not only central to their work but must be central in the development of smart cities as well. One interviewee noted that during the smart city design process, they work to amplify and share the point of view of the most marginalized members of the population. These professionals ensure that “the technology has actually been designed in the frame of those who are most vulnerable and [who] have the lived experience.” To voice the lived experience of marginalized communities, these professionals must collect, analyze, and convey data. One interviewee raised the importance of the human dimension in data collection, noting that data obtained through smart city technology should be used in conjunction with “direct contact with people, and anecdotal information and storytelling.”

Primary responsibilities of these roles, according to interviewees, include:

- Setting organizational guidelines and managing compliance to creating an ethical culture within which organizations operate
- Understanding the social impacts of smart cities and addressing existing inequities
- Gathering, analyzing, and disseminating stakeholder attitudes, particularly those of marginalized populations

*Some individuals have no context about the history of how the government played its part in creating inequitable systems... So [the job requires] making sure that we engage people in a way that keeps them at the table.*

– Christina Brooks, Chief Equity Officer, Director of Diversity & Inclusion Department, City of Fort Worth

Challenges in these roles are often related to managing and influencing public perceptions. One interviewee said, "The challenge with ethics or with conduct or with behaviour... is that societal standards are often higher than what the base-level rules are." Another key challenge is to maintain racial equity as a central topic in discussions about equity.

*We tend to get a lot of pushback around our decision to be intentional and really lead with race.*

– Brion Oaks, Chief Equity Officer, City of Austin

## Skills and Backgrounds

Each interviewee had a master's degree in administration (MBA, public administration, non-profit administration). Working backgrounds varied: one had spent their entire career in banking, one in a health non-profit, and one in various diversity and inclusion roles. In general, background experience in this field is often in one of two areas: law and compliance, or diversity and HR. Increasingly, roles regarding ethical decision-making—as opposed to legal compliance roles that are given the title of ethics officer—may be necessary to manage technological developments related to things like automation and digital identities.

Key skills necessary for these roles, as highlighted by interviewees, include understanding stakeholder needs and viewpoints, analyzing data, and disseminating data. Interviewees also noted the importance of communicating effectively and being comfortable with community engagement. Additionally, in-depth subject matter expertise related to equity issues such as racism or disability is critical in these roles, as are skills related to legal and compliance knowledge, and policy analysis and implementation.

## Team Structure and History

Interviewees had worked in their current roles for between one and four years. These positions were newly established when interviewees filled them, suggesting that attention to ethics and equity—especially in a smart city context—may be growing.

One interviewee, who had begun their role four years ago as the only equity staff member and is now leading a team of 10, noted, "It was a brand-new position [when I started] and the city really had no history of intentionally hiring staff or focusing staff on equity-based work. So it was brand new for us as a city."

Interviewees said that their roles balance both internal and external working relationships. In discussing internal relationships, interviewees described needing to work across their organizations and with many different departments to ensure positive outcomes in terms of ethics and equity for "end users." Equity officers mentioned working with external consultants at educational institutions or non-profits primarily in the area of anti-racism. Other external working relationships included hosting townhall meetings and outreach to the users and recipients of city services.

When looking to build their teams further, hiring depended largely on broader organizational needs, and thus interviewee responses were not uniform. They noted requiring people with strong listening skills, people capable of training others on racial equity, and policy and data analysts.

## **Training Needs and Skills Considerations**

In developing future talent, interviewees noted the value of key soft skills, including flexibility, empathy, and curiosity, as well as interdisciplinary experience. One interviewee recommended an intentional focus on racial equity education and the history of racism. Similarly, interviewees raised the importance of being able to work with diverse groups.

All interviewees expect their team to grow in the next five years largely because they had seen significant team growth from the outset. They also noted that job titles and even responsibilities may change partly because they saw that the field was expanding beyond their own departments, but they also expected that their roles would become more common in the future.

**Table 2:** Associated Skills and Certifications for Equity, Ethics, and Inclusivity Professionals

### *Hard Skills*

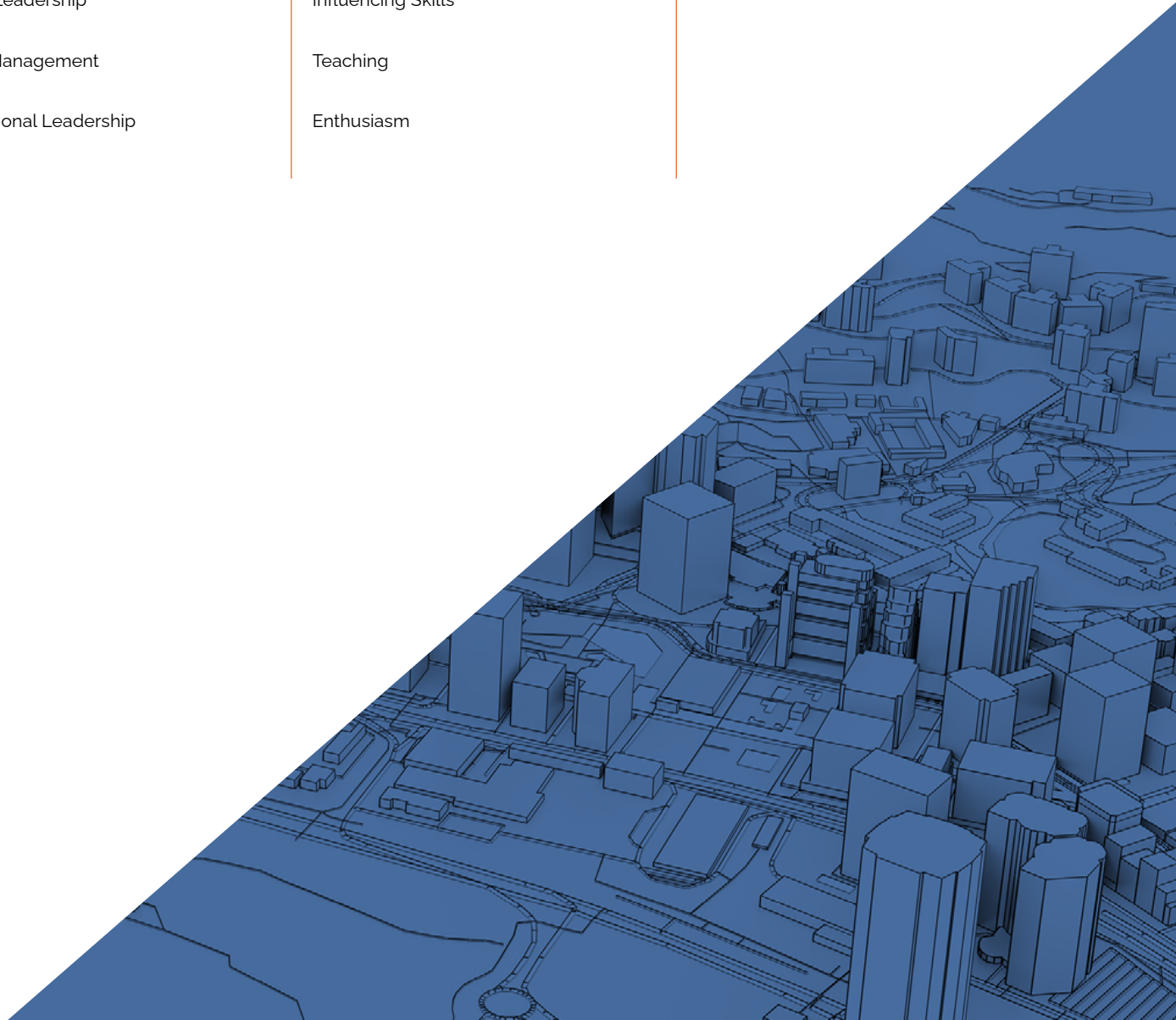
Ethics & Compliance  
Legal & Regulatory Knowledge  
Social Sciences  
Auditing  
Risk Analysis & Management  
Human Services  
Digital Transformation  
Thought Leadership  
Change Management  
Organizational Leadership

### *Soft Skills*

Interpersonal Communications  
Leadership & Management  
Strategic Planning  
Research  
Problem Solving  
Organization  
Integration  
Influencing Skills  
Teaching  
Enthusiasm

### *Certifications*

Master of Business Administration (MBA)  
Juris Doctor  
Certified Human Resources Professional  
Project Management Professional Certification  
Certified Compliance and Ethics Professional  
Change Management Certification  
Bachelor of Science in Business Administration





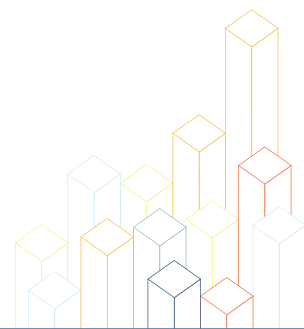
## Innovation and Growth

The following sentiment is starting to take hold: “In both the private and public sectors, organizations that consistently generate and execute new ideas tend to be more effective at achieving their goals.”<sup>30</sup> Organizations are building entire innovation departments and “innovation labs” that seek to provide room for experimentation and iteration.<sup>31</sup> More than ever, the public sector faces pressure to be more creative and innovative, in an effort to emulate the productivity and agility of the private sector. The private sector, meanwhile, will want to capitalize on this increased attention to innovation. Formalized innovation roles are becoming increasingly common in many companies.<sup>32</sup> Smart cities, in particular, benefit from innovation professionals who can propose creative uses for emerging technology and then test and monitor the implementation of such technologies.

Key informant interviews in this sector consisted of two innovation consultants, a Director of an innovation lab, and a Chief Learning Officer.

### Examples of roles in this area

Innovation Officer  
Innovation Consultant



- 30** Olivier Serrat, *Innovation in the Public Sector*, Knowledge Solutions, 2017, [https://link.springer.com/chapter/10.1007/978-981-10-0983-9\\_59](https://link.springer.com/chapter/10.1007/978-981-10-0983-9_59)
- 31** Simone Bhan Ahuja, “Why Innovation Labs Fail, and How to Ensure Yours Doesn’t,” *Harvard Business Review*, 2019, <https://hbr.org/2019/07/why-innovation-labs-fail-and-how-to-ensure-yours-doesnt>
- 32** Thomas Wedell-Wedellsborg, “What it Really Means to Be a Chief Innovation Officer,” *Harvard Business Review*, 2014, <https://hbr.org/2014/12/what-it-really-means-to-be-a-chief-innovation-officer>

## **Responsibilities: Identify, Experiment, and Implement**

The role of innovation professionals is typically seen as disrupting traditional ways of operating and driving their organizations to think creatively.<sup>33</sup> Yet interviewees explained that innovation work does not exist solely in the domain of conceptualization and invention. Rather, it often entails identifying challenges with a user-centric approach, conceptualizing solutions to those challenges, and then testing, piloting, and implements solutions. These interviewees worked in a variety of different areas: testing program implementation for innovative municipal programs, enabling and encouraging collaborative work among smart city stakeholders, managing a workforce analytics company, and exploring the applications of digital technology and data for a municipality.

These professionals saw their work as being oriented around more citizen-centric attitudes toward smart city development. The sentiment that “smart cities need to look not just at the physical part but also the social part” was common, as was the idea that the role required “keeping in mind the different perspectives of the people you want to serve.” One interviewee highlighted the need for community engagement in this context, noting that “a lot of the work is going to be about partnerships and partnering with the community; what actually makes your city smart is somewhat up to the residents.”

Experimentation is a critical component of innovation. Without testing new technologies, their efficacy cannot be properly assessed. Interviewees highlighted these aspects of their work, with one noting that “half of my work is seeking out [...] and exploring new ideas in terms of what projects might be upcoming and what technologies we might want to explore.” Another said, “We mostly do pilot projects. So we test things out. We learn from them. We evaluate them. We tweak them.”

Interviewees also described the central role of implementing new technologies and ideas, rather than just analyzing or testing them: “Being ‘smart’ is not necessarily being digital or technological. It’s finding the best fit in terms of how you’re going to design or implement a solution.”

33 Franco Amalfi, “Innovation in government: a building block to smart cities.” GovLoop, August 8, 2019. <https://www.govloop.com/community/blog/innovation-in-government-a-building-block-to-smart-cities/>

The primary responsibilities of these roles, as identified by interviewees, can be summarized as follows:

- Identifying city challenges and needs by understanding user experience and engaging with community members
- Carrying out tests and experiments to determine the efficacy of various tools and technologies
- Implementing early-stage/pilot projects

Several times, interviewees noted that challenges to their work had to do with the rapid rise of interest in their field. They were often part of a new, young team that was in high demand and had many projects on the go. Interviewees also said that their roles sometimes required a high degree of subject matter expertise, or that they faced challenges adapting to projects in fields that were entirely new to them.

## **Skills and Backgrounds: Business and Design**

Innovation professionals must often be able to merge business and entrepreneurial acumen with technological skills and knowledge. These needs were evidenced in the work history of interviewees, three of whom had diverse forms of business experience (one with a PhD in management, one worked in business development, and one worked as a business analyst for a technology firm). Still, one interviewee noted that “people who end up in my type of work are people who have atypical profiles, who have done a lot of different things,” suggesting that non-linear career paths are common. Unsurprisingly, there are few standardized requirements or credentials required for working in the field of innovation and growth, likely because it is an emerging field and the work often covers a broad range of topics.

People working in innovation often have skills related to design. Design thinking is a central paradigm of much innovation work,<sup>34</sup> and user-centred design is necessary to transform user needs into services. Other skills required for this work includes understanding stakeholder viewpoints and community participation, working collaboratively, and technical literacy either in business or in technology. This was exemplified by this statement: “I can read their code, but I'm not writing anything.”

34 Ibid.



## Team Structure and History

All of the innovation and growth positions in this report had been established in the last four years. Two interviewees mentioned a desire to use data more effectively as a central reason for the creation of their role. Another cited the Canadian Smart Cities Challenge as the reason their department had been created.

In these roles, interviewees often worked with managers in other departments and on a project basis with various subject matter experts. Interviewees worked with IT staff, project managers, geographers/GIS experts, design thinkers, and a variety of subject matter experts. The chief learning officer's role was somewhat unlike that of the other interviewees, although he had similar responsibilities in managing a team, working with a variety of stakeholders outside their own immediate team, and building out and testing new ideas.

Interviewees resoundingly agreed on the importance of practical experience and work-integrated learning for their own teams and for the success of future cities. Twice, co-op and internship programs were highlighted, while one interviewee's department consisted exclusively of co-op students, and another interviewee's entire business focus was to enhance direct workforce skills training.

## Training Needs and Skills Considerations

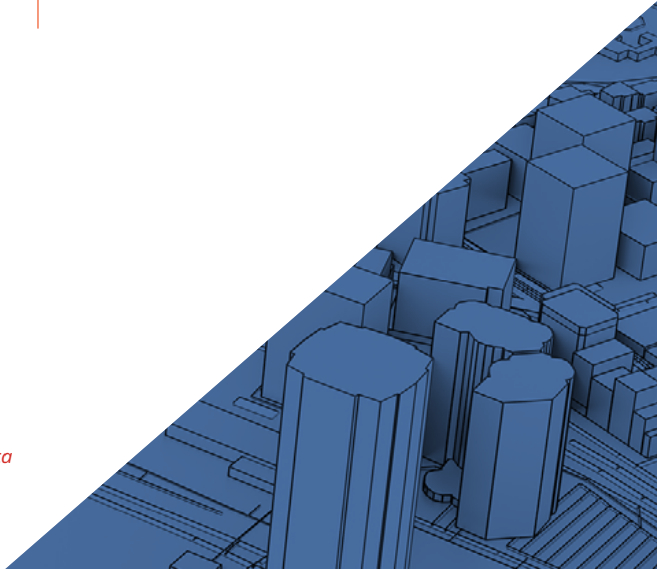
Diversity, business development skills, communication ability, and understanding of user experience were cited as the sorts of skills interviewees felt their team could benefit from. One interviewee noted the emergence of the need for employees to know how to navigate and manage others remotely. Another interviewee noted that they typically hire "developers who have some interest in user experience," but hoped that eventually there would be more people with the reverse skill set—user experience experts who can also work as developers.

Beyond innovation-specific roles, one interviewee described the critical importance of a workforce that is properly adapted to cities of the future, noting that "smart cities require a better understanding of how talent flows in the city. Not just infrastructure—a sustainable city requires a special type of workforce that understands how things work together. It requires a mobile workforce, a core workforce that is adaptable, and even a virtual workforce."

In terms of the development of their team and field, interviewees were optimistic that they were becoming more central to organizational needs. They expected expansion both in team size and the scope of their work. One interviewee argued that tech (now driven by user-centred design, rather than military needs) is becoming simpler, and as such, future skill needs may be less technology-based and more social. They touched on what appears to be a broader theme for innovation experts: the importance of partnerships, softs skills, and integrating the “user” in all smart city work.

**Table 3:** Associated Skills and Certifications for Innovation and Growth Professionals

| <i>Hard Skills</i>               | <i>Soft Skills</i> | <i>Certifications</i>   |
|----------------------------------|--------------------|---|
| Strategic Planning               | Innovation         | Master of Business Administration (MBA)                       |
| New Product/Business Development | Communication      | Project Management Professional Certification                 |
| Project Management               | Leadership         | Bachelor of Science in Business                               |
| Agile Methodology                | Management         | Microsoft Certified Professional                              |
| Business Intelligence            | Research           | International Institute of Business Analysis (IIBA) Certified |
| Data Analysis & Modeling         | Troubleshooting    | Certified Scrum Master  |
| SQL                              | Decision Making    | ITIL Certifications   |
| Python                           | Customer Service   | Change Management Certification                               |
| Growth Strategies                |                    | PMI Professional in Business Analysis                         |
| Data Visualization               |                    |   |
| Microsoft Excel                  |                    |   |



# Infrastructure and Mobility

The last few years have seen significant changes in the way city dwellers commute and get around major metropolitan areas. These changes have been driven by the emergence of new business models that combine the data-driven sharing economy with advancements in transportation technology.<sup>35</sup> Tech-enabled mobility services such as ridesharing, dynamic routing, and micro mobility services like bike, scooter, and car-sharing have seen widespread growth.<sup>36</sup> These have been combined with advancements in the use of technology and data to facilitate efficiencies in curb management (smart parking and metering services),<sup>37</sup> transactions management (digital payments, dynamic and usage-based pricing),<sup>38</sup> and traffic management (AI based advanced traffic management systems).<sup>39</sup> The emergence of mobility as a service,<sup>40</sup> combined with the recent increase in the adoption of teleworking and automated and autonomous vehicles and supporting infrastructure, is expected to radically alter the urban mobility landscape.<sup>41</sup>

Smart mobility and infrastructure is the largest segment of the global smart city market, with a market share of over 60% in 2020.<sup>42</sup> As technologies connect vehicles to roads and other infrastructure within smart cities, it will become vital to update physical and digital infrastructure and develop mobility management systems that harness technology and data to improve service delivery and customer experience. These trends are shaping demand for network and embedded systems engineers; autonomous systems developers; expertise in robotics, artificial intelligence, and machine learning; user experience designers; and business analysts with project management, data science, and business intelligence skills.<sup>43</sup>

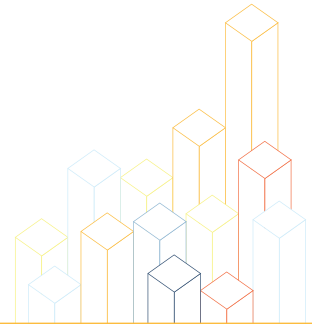
- 35 Bill Eggers et al., "Reducing Congestion and Fostering Faster, Greener, and Cheaper Transportation Options," Deloitte Insights, 2015, [https://www2.deloitte.com/content/dam/insights/us/articles/smart-mobility-trends-study-findings/DUP\\_1027\\_Key-findings.pdf](https://www2.deloitte.com/content/dam/insights/us/articles/smart-mobility-trends-study-findings/DUP_1027_Key-findings.pdf)
- 36 Scott Corwin, Anant Dinamani, and Derek Pankratz, "Toward a Mobility Operating System," Deloitte Insights, 2019, <https://www2.deloitte.com/content/dam/Deloitte/de/Documents/human-capital/review-25-mobility-operating-system.pdf>
- 37 Philipp Willigmann, Sarah Turbek, and Ryan Goldsberry, "The Future of Parking," Deloitte Insights, 2018, [https://www2.deloitte.com/content/dam/insights/us/articles/4745\\_FoM-and-parking/4745\\_FoM-and-parking.pdf](https://www2.deloitte.com/content/dam/insights/us/articles/4745_FoM-and-parking/4745_FoM-and-parking.pdf)
- 38 Ibid.
- 39 Francesca Baker, "The Technology That Could End Traffic Jams," BBC Future, December 12, 2018, <https://www.bbc.com/future/article/20181212-can-artificial-intelligence-end-traffic-jams>
- 40 Warwick Goodall et al., "The Rise of Mobility as a Service," Deloitte Review, 2017, <https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/consumer-business/deloitte-nl-cb-ths-rise-of-mobility-as-a-service.pdf>
- 41 International Transport Forum, "ITF Transport Outlook 2019" (Paris: OECD Publishing, 2019), [https://www.oecd-ilibrary.org/content/publication/transp\\_outlook-en-2019-en](https://www.oecd-ilibrary.org/content/publication/transp_outlook-en-2019-en)
- 42 Statista, "Smart city market revenue worldwide 2020-2025, by segment," accessed April 29, 2021, <https://www.statista.com/statistics/1111642/worldwide-smart-city-market-revenue-segment/>
- 43 Burt Rea et al., "Making the Future of Mobility Work," Deloitte Review, 2017, [https://www2.deloitte.com/content/dam/insights/us/articles/3876\\_Making-the-FoM-work/DUP\\_Making-FoM-work-reprint.pdf](https://www2.deloitte.com/content/dam/insights/us/articles/3876_Making-the-FoM-work/DUP_Making-FoM-work-reprint.pdf)

The insights below are based on interviews with three smart mobility and transportation managers from large urban municipalities outside of Canada.

### Examples of roles in this area

Smart Mobility Manager

Autonomous Vehicle Scientist




## Overall Responsibilities

Mobility is typically a well-established department in most urban municipalities that covers a wide range of services. Smart mobility projects seek to augment and improve these services using information and communications technologies and data. Interviewees' work activities covered the domains of traffic and operations management, curbside management, permitting, parking enforcement and transactions management, and mobility and micro mobility services.


They all emphasized that carrying out pilot projects, often in partnership with private companies and external vendors, provided key learning opportunities for their technical staff and for technology designers, policy makers, and regulators.

*A lot of our learning has come through experience in pilots. Before we decide what we want to pursue on a more widespread scale, we will pilot in the field and go from there. One such experience was when we had our signal shop do the installation of this customized solar power grid. There was a lot of good experiential-based learning for the shop on that, and I think if we [at the city] were to pursue something like that on a broader scale, our team would have a lot of input on how that should be done.*

– Brandon Campbell, Smart Mobility Manager, City of Tampa



*A few years ago [when] scooters appeared across the country, we were one of those cities where they launched thousands of scooters literally overnight. And instead of saying, 'You got to take your scooters away,' we worked with the companies and asked them to provide us data so that we could be better informed about how that impacted safety for our visitors and residents. That was a successful partnership because it allowed the scooter companies to gather high-quality user data in a large transportation environment, and it also gave us a chance to see how users interacted with that technology. There are ways that we learned on both ends. As a government, we're able to talk as a subject matter expert to other cities across the country, and it also allowed the companies to go back and refine their products.*



– Christina Willingham, Smart Mobility Division Manager, City of Austin

The primary responsibilities of these roles, as identified by interviewees, can be summarized as follows:

- Managing day-to-day operations and maintenance of current smart mobility projects and services
- Looking at emerging technologies as well as user adoption, placemaking, and community outreach and education
- Conducting pilot projects of new mobility technologies and services, often as public-private partnerships, to better assess the usability, safety, and inclusivity of these programs, and implementation challenges when scaled up

## **Skills and Backgrounds**

Each of the interviewees had over a decade (over two decades, in one case) of experience in their respective domains of expertise, which included traffic engineering, mobility services, transportation technology, and human resources and project management. Their educational backgrounds spanned both technical (engineering) and social science (curriculum and instruction) domains. Their professional experiences included both the public and private sector (“12 years at a state DOT,” “CTO of a \$2.5 billion infrastructure and transportation] company,” and “12.5 years of experience at city hall.”)

Two interviewees noted that they tend to hire engineers with more general skill sets because they hire consultants when they require more technical expertise. Ideal smart mobility colleagues possess a strong understanding of business, social issues, and equity:

*I need that person to not just understand what equity is but live equity through their lives, which means integrating it into their daily work as well.*

– Jason JonMichael, Assistant Director: Smart Mobility, City of Austin

Interviewees also noted hiring people with an understanding of design thinking, human centred approaches, and project management. Lastly, one interviewee mentioned that their department actively seeks people with five to 10 years of experience because as they possess both experience and a willingness to develop new expertise.

*"[We seek] engineers who can also be businessmen [who] can also be HR people and understand diversity, inclusion, and equity.*

– Christina Willingham, Smart Mobility Division Manager, City of Austin

## Team Structure

These interviewees all managed smart mobility teams that lay within the purview of their respective municipalities' larger transportation or infrastructure and mobility departments. The size and composition of the interviewees' teams varied from a full teams of "traffic and mobility engineers, operators, and technicians, along with project managers, and inspection and permit intake staff" to a smaller, multidisciplinary teams working in an incubator/sandbox environment focused on "various public-private partnerships, emerging technology pilots, placemaking projects, and educational webinars to spread information about different mobility options as well as emerging technologies."

Interviewees also noted that their work frequently entailed liaising with other city departments, especially information technology, energy, asset management, and equity and inclusivity, as well as working with private vendors, external consultants, tech startups, industry consortia, and educational institutions in their local ecosystems.

Interviewees said their departments had all been established within the last five years. They were set up either as a smaller team within the mobility department or had then been carved out as a separate city department.

## **Training Needs and Skills Considerations: Theory to Application**

The skills interviewees sought when building their teams included cross-disciplinary talent with technical skills combined with data analytics knowledge and an awareness of issues around privacy and ethics, and inclusivity and equity in technology design.

In discussing cross-disciplinary talent, interviewees pointed to the need to overlap fields of study that have traditionally been more pursued in isolation. The theme of combining fields of study came up multiple times, with interviewees saying that a greater combination of technical and analytical skills and certifications (for example business along with engineering, or civil engineering and data science) would help prepare people for their department. Interviewees from one department had recently begun working on university partnerships, stating that such initiatives “provide students that key level of life experience that they need in the workforce.”

Interviewees noted that as smart mobility moves from aspiration and theory to application, and their team's work evolves, they will require “people [who] understand business operations, contracts, procurement, and how to put together public-private partnerships.” While they highlighted the need for more technical experts, they also raised the importance of project management, behavioural science, legal, and policy professionals.

Smart mobility technologies are developing rapidly, so while interviewees noted that much of the work currently being done is piloting and testing, they expect to turn toward implementation in the near future. Moving forward, they all anticipated an increase in large projects focused on advanced traffic management systems, connected and autonomous vehicles, and related infrastructure. One interviewee also expected that in a few years their department would start working on pilot projects in other new technologies such as drones and unmanned aerial systems (UAS).

**Table 4:** Associated Skills and Certifications for Smart City Infrastructure and Mobility Professionals

### *Hard Skills*

C/C++

Autonomous Systems

Software Development

Algorithms

Python

Systems Integration

Systems Engineering

MATLAB

Robot Operating Systems

Verification and Validation

Motion Planning

SLAM Algorithms (Simultaneous  
Localization and Mapping)

Embedded Systems

### *Soft Skills*

Communications

Prioritization

Self-Motivation

Troubleshooting  
(Problem Solving)

Management

Leadership

Teamwork

Research

Coordinating

Innovation

Mentorship

Operations

Integration

### *Certifications*

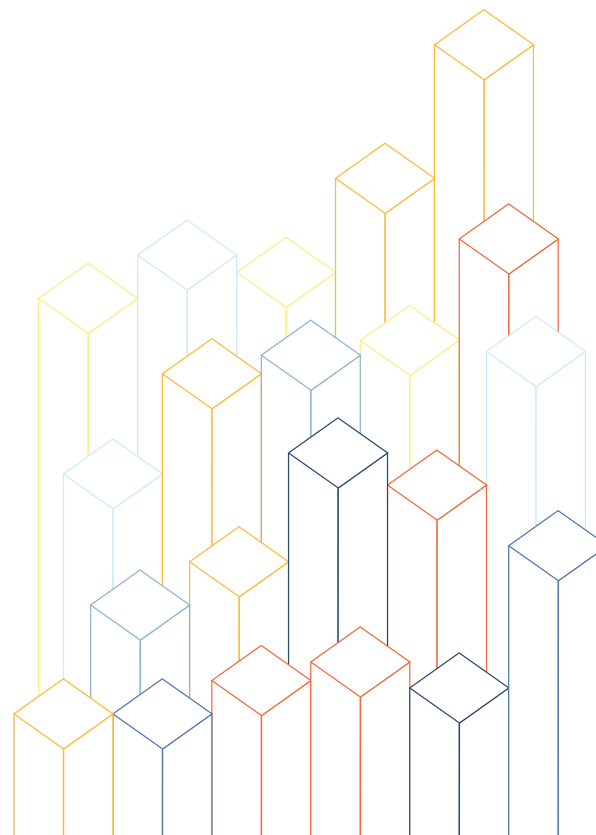
Professional Engineer

Master of Business Administration (MBA)

Project Management Professional Certification

Certified Safety Professional

Microsoft Certified Systems Engineer





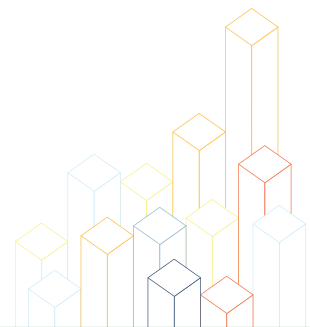
# Sustainability and Resilience

Climate change has repeatedly been cited as the greatest challenge that humanity currently faces,<sup>44</sup> and many of its effects will directly impact cities. As of 2018, the CDP found that more than 85% of cities reported climate hazards.<sup>45,46</sup> Sustainability professionals are necessary to mitigate and adapt to the effects of this significant challenge and limit other environmental harms. Yet environmental sustainability is only one portion of a growing area of need: urban resilience, or “how a city continues to thrive and bounce back from acute shocks and chronic stresses.”<sup>47</sup> Largely borne by work in the field of environmental science and sustainability, the overarching concept of “resilience” has emerged in recent years as a critical component of future cities. Having expanded beyond the early focus on environmental sustainability, resilience now encompasses far more, from disaster response to poverty action to infrastructure management.<sup>48</sup> The COVID-19 pandemic—the acute shock of a generation—may act as a catalyst to drive even greater attention toward urban resilience.<sup>49</sup>

Two Chief Resilience Officers and a Corporate Sustainability Officer were interviewed. All three worked for municipalities, two of which were outside of Canada.

## Examples of roles in this area

Chief Resilience Officer  
Sustainability Consultant  
Resilience Strategist  
Climate Change Professional



- 44 Fanelli, Carlo, and Bryan Evans. “Climate Change and Its Discontents.” *Alternate Routes: A Journal of Critical Social Research* 25. <http://www.alternateroutes.ca/index.php/ar/article/view/20618>
- 45 530 out of 620 cities that disclosed data to CDP
- 46 CDP, “Cities at Risk,” accessed January 28, 2021, <https://www.cdp.net/en/research/global-reports/cities-at-risk>
- 47 Raphael Barishansky, *The Word on Resilience*, <https://www.govtech.com/em/disaster/The-Word-on-Resilience.html>
- 48 Jim McKay, “Chief Resilience Officers: Coming to Your City?,” *Government Technology*, 2014, <https://www.govtech.com/em/disaster/Chief-Resilience-Officers.html>
- 49 PricewaterhouseCoopers, “Building More Resilient Cities to Endure COVID-19 and Future Shocks,” PwC, accessed January 29, 2021, <https://www.pwc.com/m1/en/publications/building-resilient-smart-cities-endure-covid-19-future-shocks.html>

Despite the breadth of responsibilities associated with this area, environmental sustainability often remains a high priority, meaning that many such professionals also work on projects related to climate change, limiting environmental degradation, and managing energy, water, and waste.<sup>50</sup> The importance of harnessing data was the primary relationship noted between sustainability work and smart cities. One interviewee described this as “asking what data do cities, and specifically citizens, need to be resilient and how resilient are the data themselves.”

The primary responsibilities of these roles as identified by interviewees can be summarized as follows:

- » Establishing guidelines and procedures throughout the city/organization to ensure more sustainable operations and services
- » Risk management work such as developing disaster response plans
- » Coordinating these activities across the work of multiple departments and organizations, often including infrastructure and environmental science departments

Two common challenges in sustainability and resilience were raised by interviewees. First, their teams did not necessarily have the funding or capacity to succeed in implementing strategies and policies. Second, interviewees described their roles as fitting within a broader bureaucratic and political landscape, which was at times difficult to navigate. One interviewee brought up the challenge of establishing continuity of resilience work while operating within a regularly evolving city administration.

## Skills and Backgrounds

Many sustainability and resilience professionals have degrees in areas like management, public policy, governance, urban development and design, and sustainability.<sup>51</sup> All three interviewees had long-term experience in sustainability, and education in closely related fields of geography, urban planning, and public policy. These professionals bring varied experience in community organizing, advocacy, consulting, social and environmental policy, and collaborative governance work. In particular, interviewees stressed the importance of previous work experience related to organizing and developing consensus.

<sup>50</sup> Steve Cohen, “The Emerging Sustainability Professional,” Columbia University Earth Institute, 2018, <https://blogs.ei.columbia.edu/2018/02/26/emerging-sustainability-professional/>

<sup>51</sup> Bryna Lipper, “What It Takes to Be a Chief Resilience Officer,” 100 Resilient Cities, September 14, 2015, <http://www.100resilientcities.org/how-to-hire-a-cro/>

Skills and certifications associated with sustainability and resilience roles are listed in the table below. The prevalence of skills related to environmental sustainability in the table demonstrates that the environment remains a primary topic of focus within the broader field of sustainability and resilience.

## **Team Structure and History**

The roles of these interviewees were created in the last five years. Both Chief Resilience Officer positions were established as part of a condition to receive a grant from the Rockefeller Foundation's 100 Resilient Cities program, which ran from 2013-2019 with the objective of helping cities to build resilience to a variety "physical, social, and economic challenges that are a growing part of the 21st century."<sup>52</sup> Among Canadian cities, Vancouver, Calgary, Montreal, and Toronto participated in the program.

Interviewees explained that they work with small teams but across multiple city departments. Roles in their direct teams included media and communications staff, engineers, and policy professionals. Much of their work also involved engineering, maintenance, and infrastructure departments. Sustainability and resilience roles are often in larger environmental sustainability departments.

## **Training Needs and Skills Considerations**

Interviewees wanted to hire more colleagues in a variety of roles, including energy planners, project managers, communications staff, and behavioural change experts. Two themes emerged in terms of how universities could better train people for careers in sustainability and resilience. First, a focus on applying theory and allowing for direct experience. Second, providing business and management training in terms of how organizations function, how interdisciplinary projects work, and how to work with a variety of stakeholders within one's organization. A focus on the importance of collaborative work was again brought up in discussion of the skills needed to succeed in cities of the future.

<sup>52</sup> The Rockefeller Foundation, "100 Resilient Cities," The Rockefeller Foundation (blog), accessed January 29, 2021, <https://www.rockefellerfoundation.org/100-resilient-cities/>

While sustainability and resilience teams have grown in recent years, and the field is expected to continue to grow, interviewees did not expect to see near-term growth in their teams partly due to the impact of COVID-19. While resilience appears to be a rapidly emerging field, there was some sentiment that it remains a “luxury” in city administration. Nonetheless, the rapid rise of interest in resilience and sustainability remains obvious, with one interviewee’s team having grown from one staff member to nine in five years. Another interviewee noted an evolution whereby their role was initially to educate people about sustainability, but soon became about actually implementing policies and projects, moving rapidly from theory to practice.

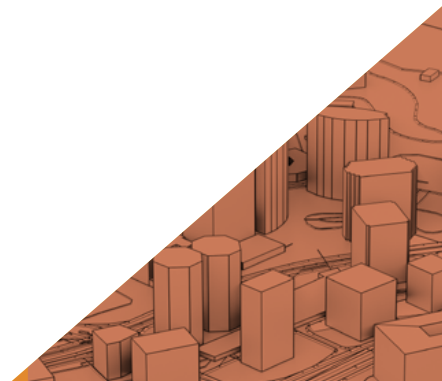
**Table 5:** Associated Skills and Certifications for Sustainability and Resilience Professionals

| <i>Hard Skills</i>                     | <i>Soft Skills</i>     | <i>Certifications</i>                               |
|--|------------------------|---|
| Environmental Science                  | Stakeholder Engagement | LEED Accredited Professional (AP)                   |
| Environmental Resource Management      | Decision Making        | Certified Energy Manager                            |
| Sustainability                         | Organizational Skills  | Certified Environmental Professional                |
| Climate Change Adaptation / Mitigation | Communications         | Environmental Certification                         |
| Waste & Water Management               | Influencing Skills     | Project Management Professional Certification       |
| Sustainable Design                     | Management             | Certified Associate in Project Management           |
| Geographic Information Systems (GIS)   | Research               | LEED Green Associate                                |
| Life Cycle Analysis                    | Leadership             | Building Energy Modeling Professional Certification |
| Project Management                     | Planning               | Professional Engineer                               |
| Thought Leadership                     | Presentation           | Master of Business Administration (MBA)             |



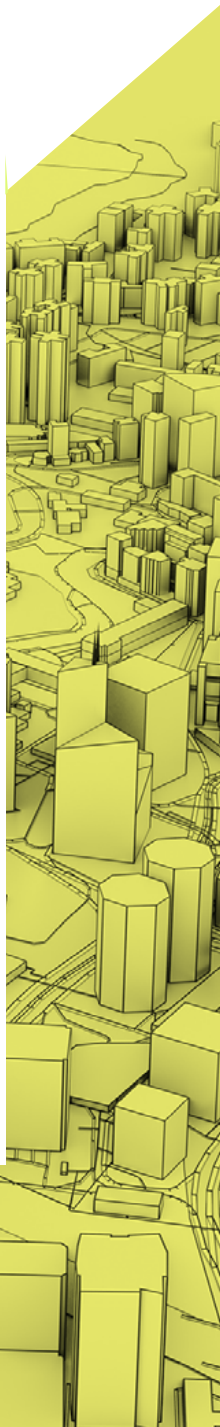
## Conclusion

Given the breadth of factors involved in creating smart cities, a variety of roles are emerging (and are likely to emerge) in smart cities. Nonetheless, across nearly all areas of smart city work and roles profiled in this report, similarities exist in the necessary backgrounds and training. Likely because the roles profiled were predominantly senior ones, progressive career experience and demonstrated management ability remained standard requirements. Training necessary for these roles primarily encompassed both professional degrees such as law, public administration, and MBAs, and technical training such as privacy certifications. Interviewees emphasized the need for future training to be hands-on (for example, through co-ops) and interdisciplinary.



Similarly, a number of key skills are especially common across the roles profiled (and among the colleagues they seek). With data being a key resource underpinning smart city services, the need for holistic data literacy comes to the forefront as a requirement for many smart city roles. This spans everything from data collection, processing, and analysis to design considerations around the ethics, inclusivity, and security of systems that gather, process, and store data. Similarly, digital and technological literacy, whether in the form of technical skills like proficiency with coding languages or through knowledge of emerging technologies and the economic opportunities they open, will help these professionals manage teams and harness the skills of more technical employees. Finally, despite the rapidly evolving domains and responsibilities for people working in smart cities, key soft skills—stakeholder and project management, verbal and written communication, leadership—will continue to remain important in the future.

The roles highlighted in this report are both results of smart city developments and central drivers of these developments. Smart cities rely heavily on user data, resulting in the increasing need for privacy and cybersecurity experts with mixed ICT and management skills to protect increasingly large stores of data. Equity, ethics, and inclusivity professionals are required to ensure that the data used in smart cities is used and collected appropriately, thus minimizing institutionalized racism and other inequities. Infrastructure and mobility is perhaps the most developed field within smart cities, so professionals in this area will not only be necessary in the future but are already heavily involved in advancing smart city projects. At the same time, with smart city technologies becoming increasingly advanced, a human element is needed. For this, innovation experts bring attention to human-centred design, user experience, and the testing of new ideas. Lastly, even if all of these experts are able to make cities smarter, safer, more equitable, more accessible, and more creative, cities must still be able to withstand external forces (for example climate change and the COVID-19 pandemic). For this, sustainability and resilience professionals are necessary. Together, experts in these roles are defining and reshaping the relationships between ICT, data, and urban living.



# Appendices

## I Research Methodology

This report was developed using a combination of primary and secondary research, including key informant interviews, a literature review, and web scraping.

### Primary Research

Primary research entailed key informant interviews with 19 individuals. Interviewees were selected based on holding job titles relevant to those that the literature review suggested were among the most prominent “emerging” roles in smart cities. Interviews were carried out primarily with individuals in leadership positions who:

- work in roles that are likely to become central in smart cities, but currently exist only in different sectors
- are leaders in departments that have increasing relevance to smart cities
- work in smart city roles outside of Canada
- are knowledgeable about careers or emerging roles related to smart cities

ICTC extensively web scraped job boards for emerging roles, so as to determine the most commonly referenced skills and any certifications or qualifications required for such positions. This was combined with labour market insights from Emsi<sup>53</sup> and Adzuna.<sup>54</sup> A shortlist of emerging roles to search for were identified through both a literature review and key informant interviews. Web scraping was done for these roles in 16 different countries:

|  |   |   |
|--|---|---|
|  Canada         |  Austria     |  India        |
|  United States  |  Italy       |  South Africa |
|  Brazil         |  Netherlands |  Singapore    |
|  United Kingdom |  Poland      |  Australia    |
|  France         |  Russia      |  New Zealand  |
|  Germany        |   |   |

53 “Emsi.”

54 “Adzuna | Jobs in London, the UK & Beyond.”

## Secondary Research

Secondary research consisted of a review of literature of smart city roles, largely to guide the kinds of roles that were sought for key informant interviews, and to influence which search terms and keywords to use for web scraping of skills. This included research and data from the following sources:



## II Limitations of Research

Because many of the occupation themes covered in this report are either new or non-existent, the sample of experts in such roles was very small, particularly in Canada. Due to the novelty of many of these roles, data regarding the actual number and characteristics of people in them listed in this report is limited. This report is meant to profile potentially emerging roles, rather than predict the likelihood of such roles becoming commonplace.

This report highlights roles that may become more prevalent in the near future. The longer-term influence of countless unforeseen factors makes more long-term predictions less productive. This report also highlights senior, professional, and leadership roles (rather than more junior ones), given their central role to current developments in smart cities.