

EVALUATING MUNICIPAL CLIMATE ACTION:
AN ANALYSIS OF PERFORMANCE MEASUREMENT MODELS, PRACTICES, AND
INDICATORS

by

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This thesis consists of material which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Statement of Contributions

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Chapter 3

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Chapter 4

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Abstract

This thesis provides interconnected contributions to theory and practice in climate governance, specifically on municipal performance measurement practices. Key concepts, including the evaluation and control step of the strategic management process, the performance measurement process, and the indicator framework and selection process, frame this research. This thesis contains five chapters. The first and last chapters serve as the introduction and conclusion, respectively. The second, third, and fourth chapter are standalone papers. The first paper of this thesis explored the current state of social impact measurement (SIM) by examining common practices that are used to measure the post-intervention social impact of programs and projects. Using a systematic literature review, this study analyzed a decade's worth of global academic literature on SIM. Through deductive and inductive manual coding of articles in NVivo, this study identified key themes and strategies for improving measurement practices. Findings from this paper suggest strategies for improved measurement such as stakeholder engagement throughout the measurement process, utilizing existing operational data, enhancing measurement capacity, and using a combination of qualitative and quantitative data. This study contributes to the SIM field by offering an in-depth understanding of common measurement models and providing clear recommendations for practitioners to improve SIM. The second paper of this thesis used a contingency theory lens to investigate the climate-related performance measurement practices of 31 Canadian municipalities, with a focus on the influence of population size. Using a case study approach, data were gathered through interviews and document analysis.

Data were analyzed through both deductive and inductive coding in NVivo 14. Results indicate that municipalities with larger population sizes prioritize more themes for measurement, employ a broader set of criteria for indicator selection, and report more frequently. Population size does not seem to influence stakeholder involvement in indicator selection or data analysis strategies. By applying contingency theory to Chapter 3, this study examined a situational approach versus the idea of a ‘one-size-fits-all’ solution for local climate-related performance measurement. The final paper explored the climate mitigation indicators currently used in practice and identified those most suitable for measuring local climate-related performance. A document analysis was conducted to identify the climate-related indicators in use by 21 Canadian municipalities, which were categorized and analyzed according to the logic model framework and GHG emissions activity sectors. An indicator evaluation matrix was employed to propose a parsimonious set of 19 new climate mitigation indicators, with the Delphi technique used to achieve consensus among experts. This study found that while a range of indicators exist across the logic model, there is an uneven distribution. The analysis also revealed the emergence of nature-based indicators for local climate mitigation performance measurement. Together, this thesis showcases and defines models and frameworks that municipalities can use to better track their climate performance, while also contributing to the broader academic discourse on measurement practices in the public sector. The findings from this thesis outline streamlined approaches to performance measurement, providing clear pathways for municipalities that are looking to more effectively track progress towards common climate goals.

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Dedication

This thesis is dedicated to my family. Your love and support made this achievement possible.

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List of Abbreviations

AFOLU	– Agriculture forestry and other land-use
AI	– Artificial intelligence
CDP	– Carbon Disclosure Project
ESG	– Environmental, social, and governance
FCM	– Federation of Canadian Municipalities
GRI	– Global Reporting Initiative
GEI	– Greenhouse gas emissions inventory
GHG	– Greenhouse gas emissions
GPC	– Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
IFRS	– International Financial Reporting Standards
IPCC	– Intergovernmental Panel on Climate Change
IPPU	– Industrial processes and product use
IPSASB	– International Public Sector Accounting Standards Board
IRIS+	– Impact Reporting and Investment Standards
NPV	– Net present value
N-ZAP	– Municipal Net-Zero Action Research Partnership
PCP	– Partners for Climate Protection
RQ	– Research question
SAA	– Social accounting and auditing
SDG	– Sustainable Development Goals
SIA	– Social impact assessment
SIM	– Social impact measurement
SLR	– Systematic literature review
SROI	– Social Return on Investment
ToC	– Theory of Change
WG	– Working group

Chapter 1

Introduction

1.1 Background

The promotion of sustainable development is in response to converging challenges faced by humanity (Hawken, 2010). Human activities have pushed the Earth's biosphere into a "zone of uncertainty" regarding climate change, one of nine planetary boundaries that define the limits of a "safe operating space" (Steffen et al., 2015, p. 736). In response, scientists are calling for a deep reduction in greenhouse gas (GHG) emissions in the short- and medium-term to ensure that global temperature increase stays below the 1.5°C target limit by 2100 (IPCC, 2021; Xu & Ramanathan, 2017). Furthermore, humanity must also address issues related to other planetary boundaries, including biodiversity loss and land-use change, which present long-term risks (Rockström et al., 2009; Wu & Wu, 2012).

Sustainability is a systems-based concept recognized for its complexity (Bansal & Song, 2017; R. B. Gibson, 2006). It is a destination or end-state that is achieved through collaboration between multiple actors, often defined by the entity trying to describe it (Gray, 2010; Shaker, 2015). Sustainable development, the vehicle used to reach sustainability, can be defined by our common goals, shared values, and through practice (Kates et al., 2005). The most common definition is from *Our Common Future* which states that “sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987, p. 43).

Milestone global commitments have been formalized to tackle complex and persistent 21st-century problems, including the United Nation's Sustainable Development Goals (SDGs) and the Paris Agreement (Stafford-Smith et al., 2017; Xu & Ramanathan, 2017). However, Stafford-Smith et al. (2017) suggest that the SDGs will fall short if the government and nonstate actors fail on implementation. Beyond the need for long-term financial investments, there is also a need for policy cohesion at the global level. Moreover, there should be cohesion among the various levels of government within a nation (Stafford-Smith et al., 2017). Achieving the SDGs and meeting the targets of the Paris Agreement will require action and accountability from multiple scales of actors across the globe (Chan et al., 2019).

More than half of the global population currently live in urbanized areas, a number projected to rise to nearly 70% by 2050 (UN DESA, 2019). Urban areas are responsible for about 70% of GHG emissions and 75% of global energy use (International Energy Agency, 2021). In response, local governments around the world are increasingly setting emissions reduction targets, developing climate plans in line with the Paris Agreement, and taking action to address climate change (Bertoldi et al., 2018; Roggero et al., 2023).

Measuring sustainability performance at the organizational level is challenging (Gray, 2010). Isil and Hernke (2017) suggest that sustainability should be measured globally, given the complexity and interconnection of our planet and its systems. For this task, the planetary boundaries framework presented by Rockström et al. (2009) and Doughnut Economics presented by Raworth (2017) serve as useful measures of social and ecological sustainability on a macro level. However, there is still the need to account for sustainable development at

different scales, which has its obstacles. At the national level, data deficiencies make it challenging for countries to take stock of their performance and develop a plan for improvement (Diaz-Sarachaga et al., 2018; Schmidt-Traub et al., 2017). At the local level, similar information challenges exist, and a lack of standardized measures makes progress on sustainability and climate commitments difficult to measure and compare (Klopp & Petretta, 2017; Rashidi & Patt, 2018). Despite these challenges, attempts to report progress on the SDGs show stagnation across several goals, including SDG 13: Climate Action, which includes climate mitigation targets aligned with the Paris Agreement (Sachs et al., 2024).

Performance measurement is a fundamental tool for policymakers and other decision-makers to track progress towards targets and goals (Caldas et al., 2020). To achieve objectives like net-zero GHG emissions by 2050, municipalities need systems that drive accountability and continuous improvement (S. Jones, 2019; Van Dooren et al., 2010). Although municipalities have been measuring performance for decades to inform decision-making (Bovaird, 2005; Poister & Streib, 1999), the extent to which climate-related issues are incorporated into performance measurement and the use of this data by decision-makers is less clear (Park & Krause, 2021). Performance measurement is an integral part of climate policy management because it helps to identify performance deficiencies and indicates where further action is required Jones (S. Jones, 2019). This signifies its value to advancing climate-related goals.

Given the urgency of climate action (Steffen et al., 2018) and Canada's stagnant performance on a global stage (Burck et al., 2024; Sachs et al., 2024), this research places emphasis on climate change. It is integral in this type of research to not lose sight of the

interactions and synergies of sustainability issues since social, economic, and ecological factors are all connected to climate change (R. B. Gibson, 2006; Griggs et al., 2014; Nilsson et al., 2016). For this research, performance measurement, municipalities, and climate mitigation are the inter-related focus, but broader links to climate-related and sustainability impacts are also considered.

1.2 Key areas of literature on measurement and indicators

The field of social impact measurement (SIM) has grown as organizations look for methods to meet the needs of their stakeholders and respond to growing external pressures (Arvidson & Lyon, 2014; Frantzen et al., 2018; Vermeulen & Maas, 2020). Globally, SIM is valuable for organizations in different sectors (e.g., social, public) seeking to demonstrate their contributions toward the SDGs (Alomoto et al., 2021). Social impact is measured to assess progress, inform strategic decisions, improve organizational performance, and meet the transparency and accountability demands of funders, investors, and other stakeholders (Aiello et al., 2021; Alomoto et al., 2021; Kah & Akenroye, 2020; Trautwein, 2021). However, despite its significance, the field remains fragmented, with a lack of standardization in measurement models and reporting practices (Rawhouser et al., 2019). In contrast to financial accounting, where standards are well-established, SIM practices are still developing and largely voluntary, leaving organizations to navigate this complexity without clear, universally accepted models (Arvidson & Lyon, 2014; F. Phillips et al., 2018; Rawhouser et al., 2019).

Much like in practice, gaps remain in SIM research, including agreed-upon measurement models and methods (Corvo et al., 2021; Grieco et al., 2015). While nearly 100 measurement models have been identified, there is no clear guidance on which approach is most appropriate in varying contexts, and the diversity of measurement approaches only adds to this uncertainty (Corvo et al., 2021; Joly et al., 2015; Ruff & Olsen, 2018). Additionally, the distinction between SIM and related concepts like social impact assessment, which focuses on pre-intervention analysis, adds further nuance to be examined (Vermeulen & Maas, 2020). As the field evolves, further research is necessary to identify post-intervention impact measurement models that allow for comparability and reliability while also addressing the diverse needs of stakeholders within the local context.

The field of local climate governance is growing as municipalities play a vital role in helping national governments meet their GHG emissions reduction targets under the Paris Agreement (Guyadeen et al., 2019; Linton et al., 2021; Robinson & Gore, 2015). A study by Mondal et al. (2024) used data from 40 European cities to analyze standardized and customized climate-related indicators and their alignment with the SDGs. The standardized indicators analyzed were most connected to SDG 13, Climate Action, followed by SDGs related to industry and infrastructure (SDG 9), sustainable communities (SDG 11), and consumption and production (SDG 12). The customized indicators analyzed show a more holistic approach with a high frequency of indicators related to strong institutions (SDG 16) and partnerships (SDG 17) (Mondal et al., 2024). This study by Mondal et al. (2024) contributes to an emerging field and demonstrates that local governments are going beyond GHG emissions when measuring climate action.

In response to various climate-related policies in the European Union, a comprehensive literature review was completed for the Irish local government sector to identify climate action indicators (D. Clarke, 2021). Several climate mitigation indicators were identified, extending beyond quantifying GHG emissions to include measures related to energy, environment, housing, pollution, transportation, waste, and water (D. Clarke, 2021).

In Canada, municipalities are central to achieving progress on the SDGs and meeting national targets for the Paris Agreement (FCM & ICLEI Canada, 2024; Government of Canada, 2016, 2021). According to Torrie (2015), Canadian municipalities influence about 50% of the country's GHG emissions by improving energy efficiency, promoting urban densification, and advancing transportation mode shift. This influence varies across different sources of GHG emissions, with the most notable contributions coming from freight and personal transportation, residential and commercial building fuel use, and electricity production (Torrie, 2015). Some examples of areas of direct control include municipal buildings and fleets, public transportation, and municipally owned parks and green spaces, which serve as carbon sinks (Zhou et al., 2022). These are considered corporate emissions (A. Clarke & Ordonez-Ponce, 2017). Whereas municipalities indirectly control GHG emissions that are community-wide such as residential and commercial buildings, non-public transportation, and agricultural emissions (A. Clarke & Ordonez-Ponce, 2017; Zhou et al., 2022). Municipalities are essential to driving local decarbonization efforts by developing policies and implementing projects and programs that support building retrofits, electric fleet and transit investment, and the restoration of local carbon sinks (Linton et al., 2021, 2022). Additionally, municipalities support decarbonization through cross-sector collaboration by

leading partnerships for collective action, involving local businesses, institutions, and organizations (Linton et al., 2021).

As organizations increasingly address sustainability and climate-related issues, performance measurement goes beyond financial metrics and now includes non-financial indicators tied to strategic goals (Alhaddi, 2023; Franco-Santos et al., 2012; Mura et al., 2018). In this evolving field, concepts such as sustainability performance measurement and sustainability performance evaluation are becoming more prominent, aimed at managing and measuring the social, economic, and environmental dimensions of performance (Büyükožkan & Karabulut, 2018; Searcy, 2012). Despite growth, many unanswered questions remain, particularly regarding the design of sustainability performance measurement systems and how these systems are applied across different sectors (Pazienza et al., 2023). Additionally, the scope of non-market performance measurements, especially with respect to climate-related issues, remains underexplored (Park & Krause, 2021). Thus, research can be furthered by examining sustainability and climate-related performance measurement practices in municipal governments (Guthrie & Farneti, 2008; Kaur & Lodhia, 2019; Navarro-Galera et al., 2014).

While progress has been made in establishing sustainability and climate-related performance measurement standards and frameworks, they are often centered around the private sector (Adams & Abhayawansa, 2022). As municipalities across Canada increasingly engage in climate action planning that includes monitoring and evaluation commitments, the full extent of local progress remains unclear given the lack of consistent reporting (Feor, Murray, et al., 2023; Guyadeen et al., 2019). As contingency theory suggests, performance

measurement should be adapted to the unique context of each organization (Otley, 1980; Parker, 1997; Waterhouse & Tiessen, 1978), which challenges the possibility of a standardized approach across the Canadian municipal sector.

1.3 Canadian municipal context

In Canada, the landscape of local governments is vast, with approximately 5,000 municipalities spread across the country¹, ranging from remote rural communities to large urban centers, which now represent approximately 75% of the country's population (Statistics Canada, 2017a, 2025). These municipalities play a central role in ensuring the delivery of essential services such as public safety, transportation, waste management, and water systems, as well as in maintaining safe and healthy communities (Library of Parliament, 2021; Z. Taylor & Dobson, 2020). Operating under the jurisdiction of provincial and territorial governments, municipalities are considered “creatures of provincial legislation” (R. Gibson & Dale, 2023, p. 178), though they hold authority over certain policies within their scope. As a result, municipalities have a degree of autonomy when it comes to decisions regarding local services and policies, despite their dependency on provincial oversight (Vidoni, 2021).

Climate change is a sustainability issue and a grand societal challenge that is being addressed at the municipal level through climate action plans, integrated community sustainability plans, energy plans, and strategic plans (Feor, Murray, et al., 2023). This study focuses on the intersection between Canadian municipalities and climate action, framed

¹ Approximately 450 municipalities have a population over 10,000 inhabitants.

within the broader context of Canada's federal system. At the national level, the Canadian government has committed to achieving net-zero emissions by 2050 as part of its climate action plan (Environment and Climate Change Canada, 2021, 2022). Climate change efforts, however, are shaped differently at the provincial and municipal levels (Guyadeen et al., 2019).

Municipalities are seen as essential partners in reducing GHG emissions and contributing to the global climate agenda (A. Clarke & Ordonez-Ponce, 2017; S. Jones, 2019; Linton et al., 2022). A 2024 survey of 256 Canadian municipalities revealed that roughly one-quarter have committed to reaching net-zero for their corporate and/or community-wide GHG emissions by 2050 or sooner (MacDonald et al., 2024). However, this commitment is largely based on direct emissions from sources within the municipal boundary (Scope 1) and indirect energy production emissions consumed within the municipal boundary (Scope 2). Indirect GHG emissions (Scope 3), are emissions that occur outside of the municipal boundary but are the result of activities within the municipal boundary, are not commonly included in Canadian municipalities' GHG emissions inventories (GEI) (C40 Cities Climate Leadership Group et al., 2014; Neveroff, 2023). Essentially, the vast majority of Canadian municipalities examined by Neveroff (2023) do not measure consumption-based emissions, which would ultimately capture Scope 3. Achieving the net-zero target will require significant GHG emissions reductions across internal operations and local activity sectors, including cutting emissions from production, transitioning to renewable energy, shifting transportation modes, and protecting carbon sinks like forests and wetlands (IPCC, 2022; Verma et al., 2023).

Municipal governments are increasingly developing both corporate and community-wide climate mitigation plans that include monitoring and evaluation responsibilities (Feor, Murray, et al., 2023; Guyadeen et al., 2019; Robinson & Gore, 2015). Although municipalities are engaged in climate action, the full extent is unknown since a standardized, mandatory monitoring system does not exist (Brown et al., 2018; Moreno Pires et al., 2014; Robinson & Gore, 2015). Despite this deficiency, there are voluntary platforms available to Canadian municipalities, such as the Partners for Climate Protection (PCP) tool which has grown over the past 25 years to serve more than 500 member municipalities, representing approximately 70% of Canada's population (FCM & ICLEI Canada, 2024; Neveroff, 2023). The PCP program, led by ICLEI—Local Governments for Sustainability Canada (ICLEI Canada) and the Federation of Canadian Municipalities (FCM), supports municipalities by providing free resources such as the Milestone Framework to help local governments across Canada reduce GHG emissions (FCM & ICLEI Canada, 2023).

1.4 Research scope, objectives, and questions

The literature on SIM, local climate governance, and public sector performance measurement reveals various gaps in both theoretical and empirical knowledge. While SIM has grown in importance, a lack of standardized measurement models and reporting practices remains a central issue, creating ambiguity for organizations navigating this fragmented field (Arvidson & Lyon, 2014; Rawhouser et al., 2019). Despite numerous identified measurement models, there is no consensus on the most appropriate approaches for different contexts (Corvo et al., 2021; Grieco et al., 2015). Similarly, the measurement of climate performance

in the public sector, particularly in municipalities, experiences a lack of standardized frameworks, hindering consistent progress tracking in climate-related reporting (Feor, Murray, et al., 2023; Guyadeen et al., 2019; Kaur & Lodhia, 2019).

In the domain of climate change, challenges persist due to inconsistent methodologies for calculating municipal GEIs, data gaps, and difficulties in measuring emissions accurately and in a timely manner (Li et al., 2017; Mia et al., 2019). Research on climate mitigation indicators for local governments remains underdeveloped, limiting the ability to comprehensively assess progress (Mondal et al., 2024). These gaps highlight the need for further research to support the development of a measurement framework with indicators that address the specific needs and contexts of local climate action. In response, the goal of this thesis is to further processes and tools used to support local climate mitigation performance measurement. This research covers different scales including SIM at the project and program levels, and performance measurement processes and indicators at the organization level.

In collaboration with ICLEI Canada and FCM, supported by funding from the Government of Canada, Dr. Amelia Clarke from the University of Waterloo is leading the Municipal Net-Zero Action Research Partnership (N-ZAP) project. N-ZAP's goal is to support Canadian municipalities with the measurement, monitoring, and reporting of GHG emissions reduction and climate mitigation efforts at the local level (University of Waterloo, n.d.-a). The project has five objectives, each one covered by a designated working group. This thesis aligns with working group 2 (WG 2) and the objective of advancing climate mitigation measurement systems and tools for municipalities across Canada (University of Waterloo, n.d.-b). This working group is co-chaired by Dr. Jeffrey Wilson (University of

Waterloo) and Megan Meaney (ICLEI Canada). Therefore, a practical aim of this thesis is to support the development of a climate mitigation themed framework that Canadian municipalities can use to measure progress towards GHG emissions targets, including net-zero, at the local government level. This framework seeks to complement the PCP milestone tool already in use by municipalities across Canada.

This thesis follows a three-paper model with each paper answering one of the following research questions (RQ):

- **RQ1:** What are the most frequent practices for measuring the post-intervention social impact of a program or a project?
- **RQ2:** How do the sustainability and climate-related performance measurement practices of small, medium, and large Canadian municipalities compare?
- **RQ3:** What types of indicators are currently in use by Canadian municipalities, and which indicators are most suitable to measure local climate mitigation performance?

1.5 Theoretical perspective

Academic studies can use theory to formulate propositions and as a lens to analyze findings (Creswell & Creswell, 2018). The high-level proposition that prompted my research questions is whether there is a ‘one-size-fits-all’ solution for Canadian municipalities measuring climate mitigation performance (Park & Krause, 2021; Rejc, 2004). When selecting a theory to analyze findings, the phenomena that is being examined must be considered (Kivunja, 2018). This study explores the phenomena of non-financial performance measurement practices by Canadian municipalities within a local climate mitigation context.

Identifying theories that are specific to the concept of climate-related performance measurement, as opposed to a topic like sustainability reporting, is challenging. In the absence of climate-centric performance measurement theories, environmental accounting theories, environmental management accounting theories, and sustainability reporting theories can be drawn from (O'Dwyer, 2021; Qian et al., 2011). Examples include stakeholder theory, legitimacy theory, institutional theory, and contingency theory; all of which will be discussed in the following section.

Research on the role and value of sustainability reporting is commonly connected to legitimacy theory and stakeholder theory (Alcaraz-Quiles et al., 2015; Giacomini et al., 2018; León-Silva et al., 2020; Magnan & Michelon, 2024; Niemann & Hoppe, 2018; Othman et al., 2017; Roberto et al., 2020). Stakeholder theory posits that organizations are accountable to individuals and groups beyond investors (Donaldson & Preston, 1995). Municipalities face scrutiny and are monitored by multiple stakeholder groups with varying expectations (Freeman, 1984; Othman et al., 2017). Within the context of sustainability reporting, stakeholder theory helps explain how groups with diverse needs can use sustainability information disclosed by the organization to help assess their approval of local government actions (Montesinos & Brusca, 2019).

Legitimacy theory suggests that organizations are dependent on society and require their approval to survive (Suchman, 1995). According to legitimacy theory, municipalities with higher population levels will face a greater demand for better quality information (Marcuccio & Steccolini, 2009). For some municipalities, increased transparency is

especially important if the public has lost trust in the local government, resulting in an increased demand for reliable non-financial information (Montesinos & Brusca, 2019; Navarro-Galera et al., 2014).

Research into the drivers of sustainability reporting (i.e., the reasons organizations report) is connected to institutional theory (Giacomini et al., 2018; Marcuccio & Steccolini, 2009), which postulates that organizations are influenced by external forces, professional standards, and societal norms (DiMaggio & Powell, 1983). Accordingly, research suggests that the uptake of reporting practices is a function of external pressures from regulations and sector norms (Bebbington et al., 2009; DiMaggio & Powell, 1983; Guerrero-Gómez et al., 2021; Raj, 2017).

Although a specific performance measurement process has not been mandated for local governments to convey sustainability and climate information, findings from academic literature suggests a need for disclosures to be made available to stakeholders (e.g., general public, municipal council, other levels of government) in a clear and comprehensible manner (Gherardi et al., 2021; Montesinos & Brusca, 2019). It is also recognized in literature that municipal reporters disseminate sustainability and climate information to different stakeholders in various ways (e.g., stand-alone report, annual report, etc.) (Feor, Murray, et al., 2023; Guerrero-Gómez et al., 2021; B. Williams et al., 2011), indicating that a ‘one-size-fits-all’ approach might not exist. Given that reporting is an integral step of the performance measurement process (Van Dooren et al., 2010), these findings shed some light on the possibility of standardization across the entire cycle.

Unlike the aforementioned theories, contingency theory is not as prevalent in the literature reviewed to date (Giacomini et al., 2018; Marcuccio & Steccolini, 2009; Qian et al., 2011). Indeed, Mura et al. (2018) noted its absence from their sustainability measurement bibliometric analysis despite contingency theory being commonly found in performance measurement and management literature. Given contingency theory's usefulness in informing our understanding of how internal and external factors can influence management decisions, measurement systems, and performance (Amhalhal et al., 2022; Qian et al., 2011; Rejc, 2004), it is the central theory chosen for the second research question of this study.

Contingency theory has had roots in organizational theory literature since the mid-1960s, followed by accounting literature since the mid-1970s (Otley, 1980). Initial studies applied contingency theory to examine organizational structure and its relationship with environmental conditions, including uncertainty, the advancement of technology, and organization size (Thomas, 1986). Galbraith (1973, p. 2) offered early assumptions by suggesting “that there is no one best way to organize” and that further, “any way of organizing is not equally effective under all conditions.” With these assumptions, Galbraith (1973) theorized that the effectiveness of an organization is dependent on it being organized to suit its performance needs and the environmental conditions in which it operates (Schoonhoven, 1981).

Since its inception, contingency theory has been applied to various topic areas ranging from accounting information systems (Gordon & Miller, 1976) to smart technologies in cities (Araral, 2020). A study by Thomas (1986) examined how different contingent variables (e.g. environmental uncertainty and organization size) affect management's

decision-making when selecting financial reporting practices. The author found that organization size influenced certain accounting measurement choices by private sector managers in the United Kingdom (e.g., larger companies capitalized research and development costs whereas smaller companies would expense these costs). Beyond size, competencies of preparers (Marcuccio & Steccolini, 2009) may have also influenced accounting measurement choices; however, this variable was not considered in the study by Thomas (1986). To that point, Marcuccio and Steccolini (2009, p. 160) hypothesized that “the competencies of the preparers will be mirrored in the contents of the reports.” However, their results could only confirm that non-financial report content was influenced by the department preparing it (e.g. a social department put greater emphasis on social performance).

Marcuccio and Steccolini (2009) examined the influence of organization size on voluntary disclosure of non-financial information practices in Italian local authorities and found that larger organizations did not disclose at a higher rate which opposes the contingency approach assumption that greater the size, greater the disclosure level (Adams, 2002). These findings differ from those of Giacomini et al. (2018) who found that sustainability reporting was more common to large municipalities in Italy. Further, the authors established that the size of the organization was associated with the level of human and financial resources; therefore, the larger the local government organization, the more resources they could dedicate to sustainability efforts. This supported the hypothesis that organization size affects the choice to publish a sustainability report (Giacomini et al., 2018; Otley, 1980).

Whether contingency theory is applied to organizational structure or accounting practices, hypotheses are often centered around the idea that organizational size and structures along with external environmental pressures and uncertainties affect management decision-making (Ebrahim, 2019; Giacomini et al., 2018; Marcuccio & Steccolini, 2009; Otley, 1980; Thomas, 1986). Additionally, contingent factors can affect an organization's ability to adapt to change (Battilana & Casciaro, 2012). Findings that support these hypotheses reinforce the idea that there is no 'one-size-fits-all' solution for organizations to increase adoption of non-financial accounting practices (Otley, 1980; Waterhouse & Tiessen, 1978).

Within the literature, contingent factors are often separated into different categories. For example, a study by Marcuccio and Steccolini (2009) on voluntary reporting patterns of local authorities in Italy draws from Adams (2002) to categorize contingent factors by corporate characteristics (e.g., organization size), general contextual factors (e.g., economic context), and internal contextual factors (e.g., competencies of the preparer). Whereas a study by Alcaraz-Quiles et al. (2014) that examines the transparency of sustainability information by regional governments identifies socio-economic factors which includes population size, population age, and fiscal pressure.

Another way to categorize factors is by idiosyncratic variables, specific to the individual local government, and systemic variables, based on national-level context (Guerrero-Gómez et al., 2021). Commonly used idiosyncratic factors include a municipality's population size, education level, population density (Alcaraz-Quiles et al., 2015; Guerrero-Gómez et al., 2021), main industry (Portney, 2013), organizational size, tax

base, and tax rate (Tagesson et al., 2013), whereas the systemic factors include a country's gross domestic product (GDP), its Human Development Index (HDI) ranking, and the administrative culture (Alcaraz-Quiles et al., 2014, 2015; Guerrero-Gómez et al., 2021). Lastly, factors can be organized into two broader categories: internal environment (e.g., organization size, competencies of preparers) and external environment (e.g., broader environmental concerns, provincial/territorial regulations) (Baumann et al., 2015; Bouma & van der Veen, 2002).

Chapter 3 of this thesis applies a contingency theory perspective to examine how a municipality's population size influences its climate-related performance measurement process. The municipalities are grouped into three categories based on their population size. By employing contingency theory to the second paper, this research explores a situational approach within a municipal context, challenging the concept that a standardized performance measurement process is not possible for all public sector organizations (Parker, 1997). Contingency theory is not applied to the other papers in this thesis.

Stakeholder theory, legitimacy theory, and institutional theory were not applied in my thesis as the research focus did not align with the core assumptions of these theories. Stakeholder theory would have been suitable for a study centered on the interests and expectations of diverse users of non-financial performance information (Montesinos & Brusca, 2019). While my research acknowledged both internal and external stakeholders, it did not differentiate between stakeholder groups or examine their specific influences on reporting practices. Similarly, legitimacy theory would have been appropriate for analyzing

public trust, accountability, and the rationale behind climate-related disclosures (Marcuccio & Steccolini, 2009). However, my thesis did not explore the motivations behind municipal performance measurement practices or perceptions of legitimacy. Although institutional theory is relevant to studies on how local governments respond to external pressures (Giacomini et al., 2018), it was not employed since my research focused more narrowly on population size as an initial variable of interest rather than broader context factors, making contingency theory a more appropriate fit.

1.6 Conceptual framework

This thesis is built on evaluation and measurement concepts rooted in strategic and performance management (Bouckaert & Halligan, 2008; Hunger & Wheelen, 2011). The first paper, found in Chapter 2 of this thesis, is grounded in the evaluation and control step of the strategic management process (Hunger & Wheelen, 2011). This study explores the different impact measurement models used in practice to evaluate internal progress on strategic goals and identify the most common ones (Alomoto et al., 2021). Through this research, the logic model, a framework that demonstrates the causal pathway by illustrating how inputs and activities produce outputs and outcomes that lead to impact, was identified as a useful tool for performance measurement (Abeysekera, 2022; Millar et al., 2001). Specifically, the logic model can serve as a foundation for the development of a measurement model or function as a customizable measurement model, provided that it includes indicators and a monitoring plan (Corvo et al., 2021; Grieco et al., 2015). Given that causality is a key concept related to impact measurement and the usefulness of the logic model as a performance measurement

tool (Lombardo et al., 2019; Vermeulen & Maas, 2020), the logic model was used in the third paper of this thesis to analyze indicators as part of the selection process.

The second paper, which can be found in Chapter 3 of this thesis, was framed by following “an ideal-typical model of the performance measurement process” for public sector organizations, as defined by Van Dooren et al., (2010, p. 63). This process involves five stages: prioritizing measurement areas, selecting indicators, obtaining data, interpreting data, and reporting (Van Dooren et al., 2010) Aligned with the evaluation and control process mentioned above, performance measurement is structured as a continuous improvement cycle, with corrective actions taken based on reported results. (Hunger & Wheelen, 2011).

In the final paper, Chapter 4 of this thesis, the indicator framework and selection criteria established by Maclaren (1996a, 1996b) was used to select a parsimonious list of climate mitigation indicators based on climate-related and general criteria. The first paper of this thesis identified the logic model as a tool to capture input, activity, output, and outcome indicators. Paper 3 extends the causal chain to include impact as a fifth indicator type within the logic model framework (Goonesekera & Olazabal, 2022; Huovila et al., 2019). Figure 1-1 demonstrates the conceptual framing of this thesis. Additional details related to these concepts can be found in the corresponding chapter for each paper.

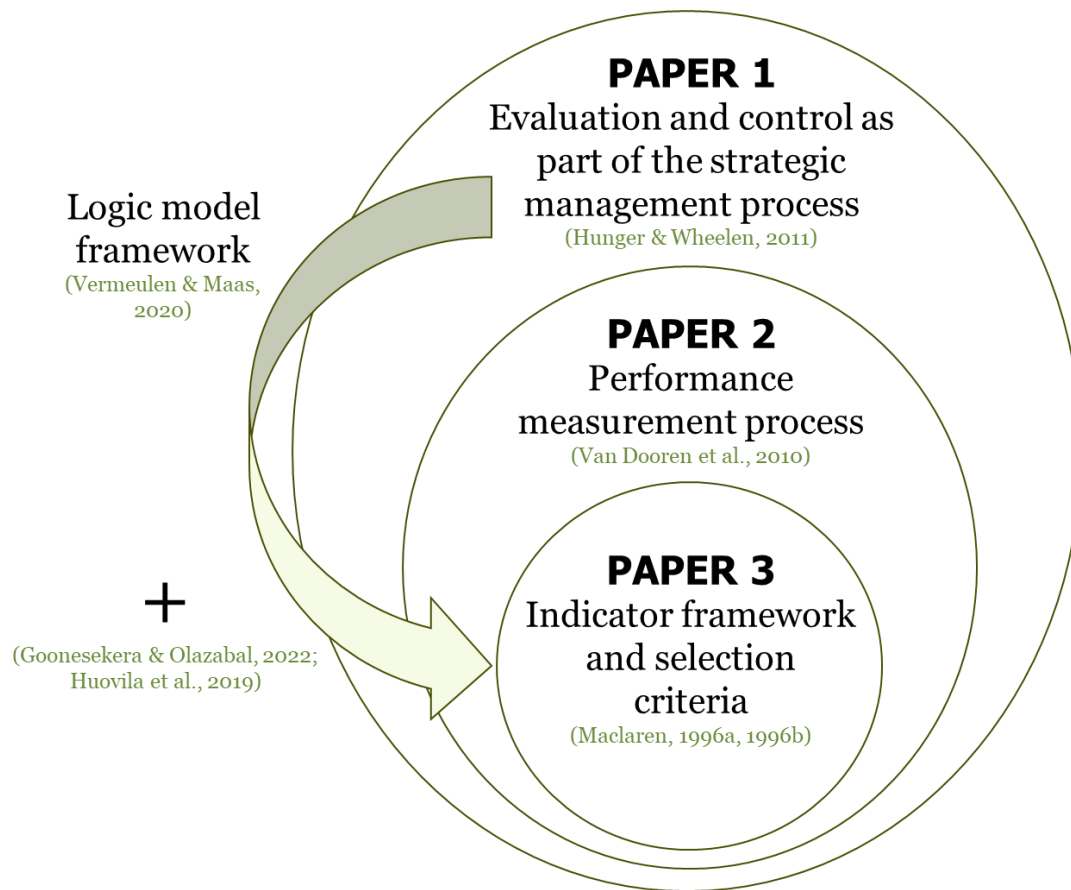


Figure 1-1. Conceptual framework of thesis

1.7 Positionality statement

This research is shaped by my professional experience as a financial auditor, social entrepreneur, and international advisor. It is also shaped by my interest in local communities. For several years, I travelled extensively throughout Latin America, which inspired me to think globally and act locally. In 2018, I ran for public office in Ontario, Canada with a platform built on principles of sustainable development. As a result, I gained new insights on the role of local government and the competing demands of stakeholder groups.

This thesis emerged from two independent, yet interrelated projects under the supervision of Dr. Amelia Clarke. For nearly the entirety of my doctoral studies, I worked as a Research Assistant (RA) for N-ZAP . The objective of my research through N-ZAP was to identify a meaningful selection of climate mitigation indicators to be considered for integration into the PCP tool, which directly aligns with this thesis. In addition to working on the N-ZAP project, I worked as an RA for the Youth and Innovation Project, also under the supervision of Dr. Amelia Clarke, to investigate SIM in practice.

1.8 Methodology

1.8.1 Paper 1 – Social impact measurement: A systematic literature review and future research directions

The first study of this thesis conducted a systematic literature review (SLR) using the PRISMA approach to select and synthesize a broad range of literature on SIM through a predefined search and screening process (Fink, 2005; Moher et al., 2009; Nigri & Michelini, 2019; Parris & Peachey, 2013). PRISMA was selected as a suitable approach to ensure that the SLR followed a series of prescribed steps when selecting which articles to include in the review (Moher et al., 2009). The following research question guided the study: What are the most frequent practices for measuring the post-intervention social impact of a program or a project? Specifically, this study focused on the following: (i) definitions of impact, (ii) measurement models and tools, (iii) indicators, (iv) measurement drivers, (v) challenges to measurement, and (vi) strategies to improve measurement practices.

The literature search was conducted across ProQuest and Scopus, chosen for their global coverage and advanced search functionalities (Elsevier, 2022a; ProQuest, 2022). ProQuest accesses 46 databases, while Scopus covers 80 million documents across 240 disciplines (Elsevier, 2022b; Gusenbauer & Haddaway, 2020). The search criteria included scholarly journal articles and reviews, limited to English-language publications from 2012 to 2022, with no geographic or disciplinary exclusions.

A keyword string was used, yielding 1,937 documents, which were uploaded to Covidence for screening (Covidence, n.d.). Duplicates were removed, leaving 1,407 documents. The article selection process involved several stages. A title scan excluded 1,018 documents, followed by an abstract scan, excluding 273 more articles. A second abstract scan excluded 36 additional articles, and a full paper scan excluded 12 more, leaving 68 articles for coding. Articles were excluded based on criteria (Moher et al., 2009) such as pre-intervention impact assessments, the wrong unit of analysis, or no reference to measurement models. To ensure validity and reliability throughout the article selection process, a series of keywords were tested to develop a search string agreed upon by three researchers. Three researchers established exclusion criteria and two researchers screened the articles to determine which would be included in the study (Creswell & Creswell, 2018).

Drawing from the papers reviewed in this study, we define social impact as the result of a deliberate intervention by an individual, community, or organization with the objective of causing a positive effect on social, environmental, and economic well-being. As such,

environmental impact is explicitly included within our definition of social impact. The SLR followed several key methodological steps.

Data analysis used both deductive and inductive coding with NVivo 20 software. Deductive coding applied a list of descriptive variables, including publication year and journal, methodology, and sector focus (Nigri & Michelini, 2019). Inductive coding identified emerging themes, guided by sub-questions on definitions, measurement models, indicators, and challenges (Popay et al., 2006; Xiao & Watson, 2017). The study also conducted an additional analysis of measurement models mentioned in five or more papers to describe their prevalence and application in practice (Grieco et al., 2015). The inductive coding process was guided by sub-questions established by three researchers and a batch test of approximately 5% of the papers was carried out to ensure consistency (Creswell & Creswell, 2018).

The full paper, titled *Social impact measurement: A systematic literature review and future research directions*, can be found in Chapter 2 of this thesis. Additional details related to the methods used in this study are included in Chapter 2. The SLR was presented at the Administrative Sciences Association of Canada (ASAC) 2023 Conference. Our paper was published in the conference proceedings and subsequently in the journal *World* in December 2023. This study is showcased as an Editor's Choice Article on the journal's website, see Appendix A.

1.8.2 Paper 2 – The impact of population size on climate performance measurement practices

The second study employed a descriptive method to investigate the sustainability and climate-related performance measurement practices across 31 Canadian municipalities of varying sizes (Yin, 2018). Municipalities were categorized by population size (small <10,000; medium 10,000–150,000; large >150,000) to examine the influence of size on the performance measurement process. A purposeful sampling strategy was used to select cases from 297 municipalities that had achieved the first milestone of the PCP program, which involves creating a GEI at the corporate or community level (FCM & ICLEI Canada, 2024; Patton, 1990). See Appendix B for the full list of 297 PCP member municipalities that achieved Milestone 1 as of June 2023. The list was provided by ICLEI Canada. The sample was reduced to 128 municipalities by omitting municipalities that did not have public facing indicators on their websites. Following this reduction, there remained 27 small, 79 medium, and 22 large municipalities to draw from. The screening process was conducted by three RAs, including the author of this thesis, and one intern working on the N-ZAP project.

Prior to recruiting study participants, we received ethics clearance from the Office of Research Ethics at the University of Waterloo. See Appendix C for the notification of ethics clearance. Municipalities were recruited across all three population size groupings with the aim of recruiting 12 municipalities per size group and reaching a diversity criteria that considered the following:

- English-speaking and French-speaking municipalities.
- Representation from Canadian provinces and territories in proportion to population size.
- Representation from urban and rural municipalities.
- Representation from different types of municipalities (cities, towns, regions, etc.)

To ensure diversity in the sample, municipalities were selected to reflect a range of geographic locations and municipal types. This approach was intended to support a more representative selection of municipalities across the country. By including English- and French-speaking regions, as well as urban, suburban, and rural areas, the sample aimed to reflect the broader municipal landscape. This diversity was important to help focus the study on the role of population size in shaping performance measurement practices, rather than letting other contextual factors influence the findings.

During the recruitment process, 54 municipalities were contacted directly and a total of 31 agreed to participate, for a response rate of 57%. The small municipalities (<10,000) were the most challenging to recruit with a positive response rate of 39%, whereas the medium and large municipalities had a 65% and 79% response rate respectively. To meet the diversity criteria outlined above and to confirm 12 municipalities for each size group, a small sample of non-PCP members were recruited. These municipalities were identified through their participation with N-ZAP (MacDonald et al., 2024). For the 23 municipalities that did not participate in this study, some did not respond to the email requests, while others did not have the capacity. Additionally, some indicated that based on the interview questions, they did not think they had information to contribute to this study.

Interviews were conducted by two RAs working on the N-ZAP project. The author of this thesis conducted the interviews with English-speaking participants, for a total of 26 interviews. The remaining interviews were conducted in French by an RA hired by Université du Québec à Montréal, one of 12 academic institutions working on the N-ZAP project. The interview recruitment process followed several steps outlined in an interview guide, as seen in Appendix D.1.

All recruitment materials were written in English and translated to French by the French-speaking RA. The initial recruitment email was sent to pre-selected municipalities by the RAs on behalf of the N-ZAP project. Within the recruitment email, target participants were asked to schedule an interview through Acuity Scheduling². See Appendix D.2 for the English recruitment email. Target participants were provided with the information letter for this study within the recruitment email. See Appendix D.3 for the English information letter.

If the initial recruitment email did not result in an interview being scheduled, a follow-up email was sent (approximately 2 weeks after the initial recruitment email). The follow-up email was sent by the same RA who sent the initial recruitment email. See Appendix D.4 for the English follow-up email. When necessary, a follow-up phone call was made. Once an interview was scheduled, the participants were provided with the full list of questions to review in advance of the interview. The interview questions were developed

² <https://acuityscheduling.com/>

with input from municipal experts and academics (Tanguay et al., 2010). See Appendix D.5 for the list of English interview questions.

Interviews took place over Zoom and lasted approximately 60 minutes. Following the interview, a thank-you email was sent along with a request for the participants to share a list of their sustainability and climate-related indicators currently in use, see Appendix D. 6. A total of 31 municipalities were successfully recruited and interviewed from all 10 provinces across Canada. Municipalities from Canadian territories were not successfully recruited. See Figure 1-2 for a map of participating municipalities across Canada.

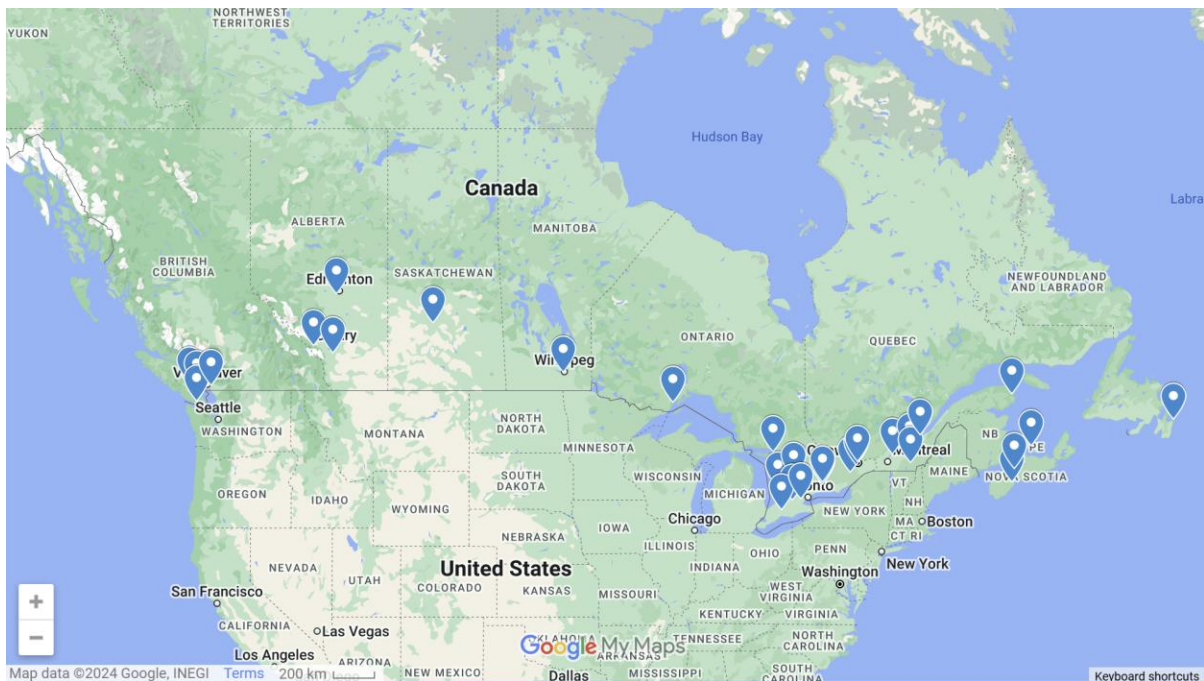


Figure 1-2. Map of participating Canadian municipalities

A total of 37 participants across 31 municipalities were interviewed between November 2023 and March 2024. Interviews were recorded, transcribed, and translated (for French interviews), then coded manually in NVivo 14 using both deductive and inductive

methods. Deductive codes were pre-defined from the literature, while inductive codes were generated using the Gioia method, which included first- and second-order analysis (Gioia et al., 2013). See Appendix E for a list of first and second order codes by performance measurement process step (Van Dooren et al., 2010). A comparative analysis was conducted to examine performance measurement practices across the three municipality size groups (Baxter & Jack, 2010).

The full paper, titled *The impact of population size on climate performance measurement practices*, can be found in Chapter 3 of this thesis. Additional details on the methods used for this study are available there. This study was accepted for presentation and proceedings at the ASAC 2025 Conference and received the Honorable Mention Award. This paper has been submitted to a journal and is currently undergoing its second round of reviews.

1.8.3 Paper 3 – Selecting climate mitigation indicators to measure municipal progress towards net-zero emissions

The final study of this thesis used a document analysis method to identify climate-related performance indicators currently in use by municipalities in Canada, specifically focusing on climate mitigation. Document analysis was chosen for its effectiveness in identifying indicator sets in use by the selected municipalities (Goonesekera & Olazabal, 2022; Merino-Saum et al., 2020). The study followed a series of steps adapted from related studies (Goonesekera & Olazabal, 2022; Huovila et al., 2019), with the goal of creating a parsimonious list of proposed indicators for use by municipalities across Canada.

The sample, which is the same as from paper 2, consisted of 31 municipalities from all 10 Canadian provinces. Indicator sets were collected through supplementary documents shared by participants after interviews, during which they were asked to provide their sustainability and climate change indicators. Indicators labeled as "suggested," "recommended," or "potential" were excluded from the analysis, leaving 21 of the 31 municipalities from the original sample with actual indicators being used in practice at the time of the interview. A total of 618 individual sustainability and climate-related indicators were catalogued from the documents of 21 municipalities³. The French indicators were translated to English using Google Translate.

The 618 indicators underwent a multi-reviewer screening process to exclude indicators that did not qualify as climate mitigation indicators based on a set definition⁴. To enhance the reliability and validity of the study, the screening process included five steps that involved independent scans and consensus meetings by three reviewers (Creswell & Creswell, 2018).

Following the screening process, a total of 255 indicators were analyzed. The analysis involved two parts. The first part included manual deductive coding of the indicators using

³ We acknowledge that the indicators found in the supplementary materials used for this study are not likely an exhaustive list of indicators that the municipalities use. In other words, a municipality could monitor and evaluate other plans within their organization; however, these documents were not provided by the participant as climate or sustainability indicators and were therefore not included in this study.

⁴ We define a climate mitigation indicator as a measure used to capture the change in status of performance connected either directly or indirectly to GHG emission sources and sinks (Filonchyk et al., 2024; Linton et al., 2022; MacDonald et al., 2024).

the logic model framework (Goonesekera & Olazabal, 2022; Huovila et al., 2019) and categorization by climate mitigation themes (MacDonald et al., 2024). The second part involved refining the indicators by removing those already included in the PCP tool (FCM & ICLEI Canada, 2021) and consolidating others using the Gioia method of order analysis (Gioia et al., 2013). See Appendix F for a sample of the order analysis coding of indicators subject to consolidation. Following the coding process, a shortlist of indicators was established. See Appendix G for the shortlist of 26 indicators. The final list of indicators were selected using an indicator evaluation matrix (Maclaren, 1996a). See Appendix H for the questionnaire used to gather input from WG2. The Delphi technique was used throughout the study period to achieve consensus on the indicator selection criteria and to select the parsimonious list of proposed indicators (Frare et al., 2020; Yousuf, 2007). See Appendix I for a list of working group members, meeting dates, and topics covered.

The full paper, titled *Selecting climate mitigation indicators to measure municipal progress towards net-zero*, can be found in Chapter 4 of this thesis. For more details on the methods, see Chapter 4. This paper will be submitted to a journal in summer 2025.

1.9 Main findings

The three papers that form my thesis are interconnected through their shared goal of improving the measurement of non-financial performance, specifically within the context of local climate mitigation. Paper 1 provides a theoretical foundation for understanding the broader field of SIM, offering insights into stakeholder engagement, data quality, and measurement models. While not directly focused on climate action, these themes are relevant

to the later papers, which examine similar topics as they relate to the measurement of local sustainability and climate-related performance.

Paper 2 builds on these ideas by examining the processes used in practice to measure sustainability and climate-related performance. The findings from the second paper show that municipalities informally apply criteria when selecting indicators and that while they collect data from various sources, they all rely on internal operational data. The second paper also reinforces that municipalities report on their performance in different frequencies to different audiences, with the population size of the municipality having some influence on these practices. This connects with contingency theory which postulates that there may not be a 'one-size-fits-all' approach to organizational systems and structures (Otley, 1980; Waterhouse & Tiessen, 1978).

The final paper narrows its scope by focusing on the indicators currently used by Canadian municipalities measuring climate mitigation performance. The proposed shortlist of indicators offers empirical findings within a Canadian municipal context to address some of the challenges identified in the first two papers of this thesis. These findings provide municipalities with a proposed set of indicators that can be broadly applied across the country. This contributes to the goal of improving measurement practices and ensuring that municipalities have the tools they need to track progress on local climate action.

1.10 Layout of the thesis

This thesis follows a three-paper model that is designed to offer interconnected contributions to theory and practice while yielding three stand-alone papers that can be

published independently. At a high level, this thesis offers important insights into measurement models, practices, and indicators, contributing to the advancement of climate governance at the municipal level. Because of the unified contributions offered by this thesis, there is some overlap across the three papers. The three papers are bookended with introduction and conclusion chapters, which also include some repetition from the stand-alone papers. This repetition is inevitable due to the three-paper and bookend format of this thesis.

The remainder of this thesis is organized as follows: Chapter 2 (paper 1) identifies and analyzes commonly used SIM models, explores various approaches to measurement, and discusses strategies for improving measurement practices. Chapter 3 (paper 2) uses the performance measurement process framework to present empirical evidence on the climate-related practices of Canadian municipalities. Using a contingency theory lens, the chapter highlights the influence of population size on the performance measurement process. Chapter 4 (paper 3) is framed by an indicator selection framework and analyzes 255 climate mitigation indicators used by Canadian municipalities. It presents empirical findings across local GHG emissions activity sectors and proposes a common set of climate mitigation indicators for use in practice. The final chapter of this thesis showcases the overall contributions to scholarship and practice, offers theoretical and practical implications, and mentions the limitations of the thesis before offering concluding remarks.

Chapter 2 – Paper 1

Title: Social impact measurement: A systematic literature review and future research directions

Abstract: This paper explores the current state of the social impact measurement (SIM) field to better understand common practices in measuring the post-intervention social impact of a program or project and to identify strategies to improve measurement in practice. This study employed a systematic literature review. Articles were manually coded deductively and inductively in NVivo to complete a descriptive and thematic analysis of the literature. The thematic analysis provided an in-depth understanding of the SIM field. We found that similarities existed across the definitions of social impact (e.g., environmental impact is part of social impact). Additionally, social return on investment (SROI) is the most common measurement model and theory of change was identified as a core concept across SIM literature. Strategies are presented for practitioners to consider when measuring social impact, including: (i) engage stakeholders throughout the process, (ii) mobilize existing operational data, (iii) increase measurement capacity, and (iv) use both qualitative and quantitative data. This study reveals the nuances of SIM based on academic literature published across the globe over the span of a decade. It places emphasis on the post-intervention stage and identifies strategies to improve the application of measurement models in practice. Lastly, it outlines future research directions.

Keywords: assessment; ESG; evaluation; indicators; Sustainable Development Goals; SROI

2.1 Introduction

With growing interest in the measurement of social impact, organizations are seeking methods that suit their needs and address pressures from internal and external stakeholders (Arvidson & Lyon, 2014; Frantzen et al., 2018; Vermeulen & Maas, 2020). On a broader scale, organizations measure social impact to demonstrate their contribution to the achievement of the Sustainable Development Goals (SDGs) (Alomoto et al., 2021). This is especially important as we have reached the halfway mark of the SDG 2015–2030 timeline; according to Sachs et al. (2022), global performance has been stagnant without progress since 2019.

At an organization level, social impact is measured to evaluate internal progress on goals and to inform strategic decision making (Alomoto et al., 2021; Elauria et al., 2017). Additionally, funders and investors may require organizations to increase the transparency, accountability, and legitimacy of the impact of their programs, projects, and activities through measurement and reporting practices (Aiello et al., 2021; Nguyen et al., 2015; Trautwein, 2021). Post-intervention measurement is necessary to evaluate the actual versus proposed impact. Additionally, it is important to investigate the measurement of social impact at the project and program levels because this is where implementation often occurs (Aiello et al., 2021). This is particularly relevant when the interventions are material to an organization's performance and the achievement of common goals, such as SDGs (Fiandrino et al., 2022).

Given the maturity of financial accounting, there are well-established national and international rules that organizations must follow when producing financial statements for external users (F. Phillips et al., 2018). Over the years, financial reporting has evolved into corporate reporting, which includes financial and non-financial information (Uyar, 2016). When it comes to the multiple dimensions of sustainability (ecological, social, and economic factors), reporting systems and rules are not as mature, nor is there international consensus, partly due to the varying needs of stakeholder groups and the complexity of disclosures (Elkington, 1999; Laine et al., 2021). Although there are calls for and progress towards harmonizing sustainability reporting standards, the benefit of comparability should not come at the cost of completeness (Ng et al., 2022). Measuring and reporting on social impact at the organization level remains largely voluntary (Arvidson & Lyon, 2014). Much like the variety of sustainability reporting standards and frameworks that exist, there are a multitude of models for measuring social impact with a lack of standardization in practice (Rawhouser et al., 2019). With the emergence of environmental, social, and governance (ESG) disclosures, there appears to be greater emphasis on how sustainability issues impact the organization rather than on how the organization might impact progress towards sustainability (Adams & Abhayawansa, 2022).

In this field of research, there are varying definitions and interchangeable uses of key terminology (Aiello et al., 2021; Hadad & Gauca, 2014; Maas & Liket, 2011). Given our focus on post-intervention measurement to understand the impact that programs and projects have on society and the environment, this study defines social impact as the result of a

deliberate intervention by an individual, community, or organization with the objective of causing a positive effect on social, environmental, and economic well-being (Costa & Pesci, 2016; Kah & Akenroye, 2020; Vermeulen & Maas, 2020).

Although “evaluation”, “assessment”, and “measurement” are used interchangeably in social impact literature (Vermeulen & Maas, 2020), we chose the term social impact measurement (SIM), which is based on the work by McLoughlin et al. (2009) and is defined as “the process of defining, monitoring and employing measures to demonstrate benefits created for the target beneficiaries and communities through evidence of social outcomes and/or impacts” (Nguyen et al., 2015, p. 225). This distinction attempts to differentiate social impact assessment (SIA), a pre-intervention planning tool designed to proactively assess the impact a project could have on the community and environment prior to its implementation, from post-intervention measurement tools (Gallou & Fouseki, 2019; Grieco et al., 2015). As our study focused on post-intervention impact, which occurs once implementation is underway, we used SIM to differentiate and to add some clarity around how the practice of measuring social impact at different stages could be defined.

Reporting, a key stage of the performance measurement process (A. Taylor & Taylor, 2014), is used to provide descriptive information about a project, program, or an organization (Mura et al., 2018) and relies on measurement processes that are verifiable through independent evaluation (Laine et al., 2021). Therefore, advancing our understanding of SIM could lead to improved reporting and disclosures of the social impact and benefits created through deliberate interventions.

While there are similarities between evaluation and SIM, the two fields diverge in key areas such as evaluative approaches and analytic methods (Vo & Christie, 2018). Furthermore, it is recognized that SIM emerged from the field of evaluation, leading to two separate areas of research (Vermeulen & Maas, 2020). SIM research provides valuable insights, including the analysis of measurement models (Corvo et al., 2021; Grieco et al., 2015), case studies based on the application of models (Jackson & McManus, 2019; Lombardo et al., 2019), and recommendations for future research (Rawhouser et al., 2019). Despite a growing body of literature, there is no consensus on which measurement model should be applied when measuring social impact. With almost 100 identified measurement models (Corvo et al., 2021), a lack of standardization (Joly et al., 2015), and evaluation complexities (Ruff & Olsen, 2018), implementing SIM practices can be challenging for organizations in all sectors.

The purpose of this study is to capture the current state of the SIM field and to answer the following research question: What are the most frequent practices for measuring the post-intervention social impact of a program or a project? Specifically, we analyzed the following: (i) definitions of impact, (ii) measurement models and tools, (iii) indicators, (iv) measurement drivers, (v) challenges to measurement, and (vi) strategies to improve measurement practices. We employed a systematic literature review (SLR) approach to identify and analyze common themes organized by subtopics. Despite similarities in the topic, our study differs from other reviews (e.g., Corvo et al., (2021)) in terms of focus. Beyond identifying measurement models, we sought to better understand what drives post-

intervention measurement practices at the project and program level, the challenges assessors face, and strategies to help overcome those challenges.

This study begins by describing the methods used to complete the SLR, followed by the literature analysis and results which are divided into two parts: descriptive analysis and thematic analysis. The paper concludes with an overview of the implications for practitioners, identified gaps in the literature, and future research directions.

2.2 Materials and methods

An SLR was selected as an appropriate method to answer the research question (Nigri & Michelini, 2019). This method allowed us to synthesize a broad range of literature that was identified through a pre-defined search and screening criteria (Fink, 2005; Parris & Peachey, 2013). This study followed a narrative synthesis approach by applying a thematic analysis technique to organize main ideas and themes found in SIM literature (Popay et al., 2006). To achieve the objectives of this study, the following methodological steps were performed.

2.2.1 Document sources

The literature search was conducted across two sources, ProQuest and Scopus, with the aim of capturing a diverse range of articles across multiple disciplines. Both sources provide access to literature from around the world and have advanced search functions to narrow searches to specific publication dates, source types, document types, and languages (Elsevier, 2022b; ProQuest, 2022). ProQuest is a multidisciplinary platform that searches up to 46 databases (e.g., ABI/INFORM), producing results from various subject areas (ProQuest, 2022). Scopus searches over 80 million documents across 240 disciplines

ensuring a breadth of content coverage and offers a comparable source to Web of Science (WoS) with respect to subjects covered and size (Elsevier, 2022a; Gusenbauer & Haddaway, 2020). Therefore, by using both ProQuest and Scopus, a wide variety of literature from multiple disciplines and geographic locations was sourced for screening.

2.2.2 Search criteria

To capture a wide selection of SIM literature, inclusion and exclusion criteria were applied (Parris & Peachey, 2013). The initial advanced search on ProQuest limited the results to scholarly journals whereas the Scopus search was refined to only include documents labelled as articles and reviews. The document search was limited to English sources published during a 10-year period (January 2012–March 2022), as done by others (Searcy, 2012), to identify recent literature since our focus is on the current state of SIM research. No geographic or discipline exclusions were applied to the search criteria.

2.2.3 Keyword search and screening results

A series of keywords were tested based on the scope of the study and the research question. After several test searches, the following string was selected for the document search in ProQuest and Scopus on 29 March 2022:

Title only (“environment* impact” OR “soci* impact” OR “communit* impact” OR “sustainab* impact”) AND title-abstract-keywords (assessment OR measurement OR evaluation OR “monetary measure”) AND title-abstract-keywords (project OR program OR placement OR organization OR “civil society” OR initiative).

The search in ProQuest and Scopus produced 812 and 1125 document results, respectively. The 1937 documents were subsequently uploaded to Covidence, a systematic review management platform designed to support the scanning process (Covidence, n.d.).

Upon uploading, duplicates were removed, leaving a total of 1407 documents. At this stage, the documents were consolidated and there was no differentiation between the document results from ProQuest and Scopus.

The selection process was initiated by a title scan of the 1407 documents that resulted in the exclusion of 1018 based on fit. The second stage of the selection process was an abstract scan performed by the first reviewer which excluded an additional 273 articles. The remaining 116 articles were either labelled as “yes” or “maybe” by the first reviewer. An additional abstract scan by the second reviewer resulted in the exclusion of an additional 36 articles. The final stage of the selection process was a full paper scan of the 80 remaining articles resulting in 12 more exclusions, leaving 68 articles for deductive and inductive coding.

Articles were excluded based on fit using screening guidance criteria. Specifically, articles were excluded for the following reasons: (i) a focus on pre-intervention impact assessment, life cycle assessment, or social life cycle assessment, (ii) the wrong unit of analysis or subject focus (e.g., individual health or research, and not environment or society), (iii) the environmental or social impact was not the result of a deliberate intervention but an activity/process of industrial operations or the result of the environmental impact of a disaster, and (iv) there was no specific reference to the use or analysis of measurement models or tools, including indicators. Figure 2-1 outlines the search and screening results of the article selection process using the PRISMA model (Moher et al., 2009).

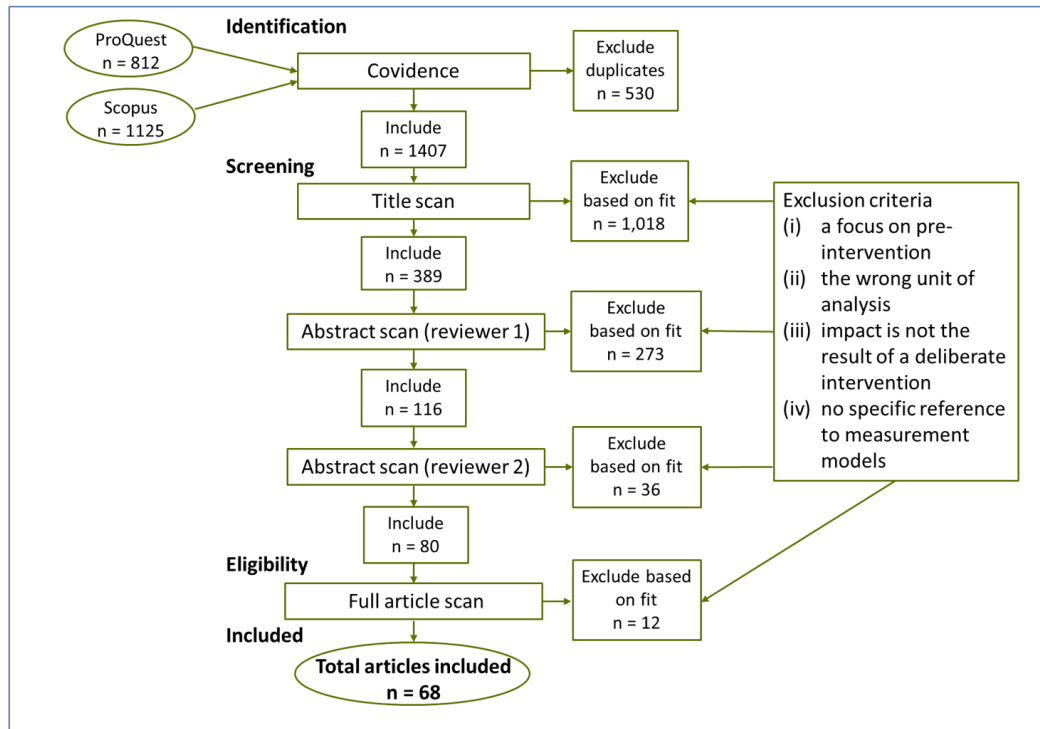


Figure 2-1. Article selection process using the PRISMA model adapted from Moher et al. (2009)

2.2.4 Data analysis

The 68 articles selected through the process outlined in Figure 1 were manually coded deductively and inductively by a single reviewer using NVivo 20 software. Deductive coding was conducted using a predetermined list of descriptive variables to gain a general understanding of the current state of research on the topic of SIM. The variables include reference data (i.e., year of publication and journal), methodology data (i.e., research approach, location of study, and theory), and contextual data (i.e., sector focus) (Nigri & Michelini, 2019).

The inductive approach was applied to identify common themes that emerged across the literature during the full-text review process. These findings were subsequently

synthesized to form a narrative of the SIM research landscape and to answer the research question (Popay et al., 2006). The inductive coding was guided by the following sub-questions developed based on the research question and the authors' knowledge of SIM:

- What definitions are provided for social, environmental, sustainable, and community impact?
- What common measurement methods are discussed and applied?
- What are the indicators used for measurement?
- What are the measurement drivers?
- What are the challenges to measurement?
- What are the strategies for improved measurement?

The thematic analysis was guided by the research question and sub-questions developed for the inductive coding process (Popay et al., 2006; Xiao & Watson, 2017). Using the sub-questions, we created the following top-level codes: definitions of impact, measurement models (models refers to both frameworks and methods (Grieco et al., 2015)), indicators, drivers for measurement, challenges to measurement, and strategies to improve measurement practices. The content from each full paper scan was organized by top-level codes and the child codes that were identified inductively. Subsequently, the content captured within each code was synthesized based on similarities and differences, ultimately describing key themes across the literature (Gioia et al., 2013; Popay et al., 2006). Unique to Section 2.3.2.2 on measurement models, this study conducted a query search for each child code captured in all of the selected articles. This additional step was completed to confirm the number of articles that each measurement model was discussed or applied in. All of the measurement models discussed or applied (beyond mentioning the name of the model in a

table or appendix in the paper being reviewed) in five or more papers were analyzed to help answer our research question.

2.3 Results

2.3.1 Descriptive results

The string search employed for this SLR produced 68 usable articles, 47 empirical studies, and 21 conceptual studies. The articles examined were from multiple disciplines, as seen by the journals of publication listed in Appendix J. While most journals had only one corresponding article, five articles were published in the journal *Sustainability*, two in the journal *Environmental Impact Assessment Review*, and two in the *Journal of Social Entrepreneurship*.

Research in the field of SIM has grown over the period examined in this study, with a high of 18 articles published in 2021. As shown in Figure 2-2, growth has been steady since 2018, with 70% of the articles in this study published since then. The results for 2022 were based on papers published between January–March due to the timeframe used during the initial search, as noted in Section 2.2.

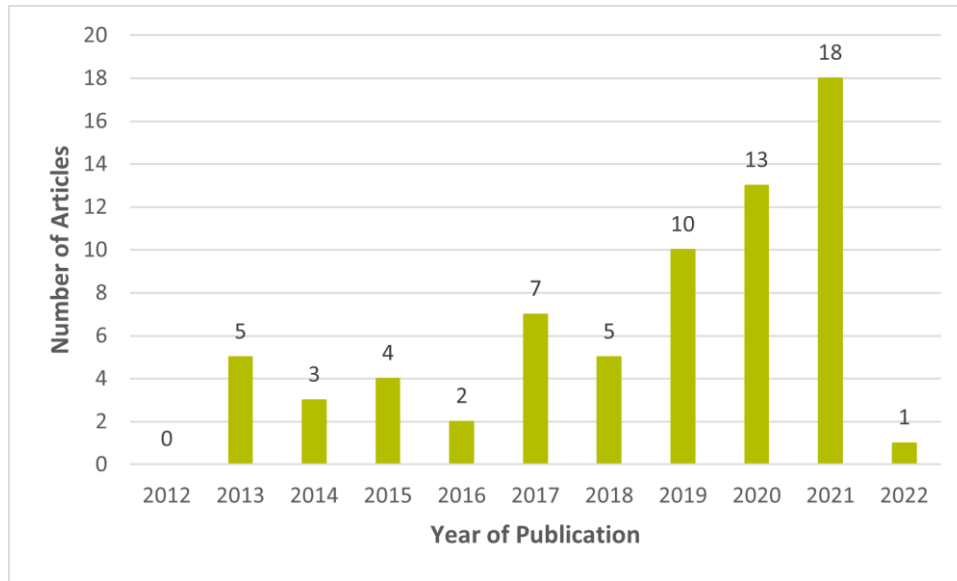


Figure 2-2. Number of articles by year

The 68 articles examined in this study applied a range of research methods, with qualitative (26 articles) as the most common, followed by mixed methods (18 articles) and literature reviews (18 articles). Quantitative methods were applied in three articles. The remaining articles included two perspectives and a debate.

Focusing only on the empirical studies ($n = 47$), the country of research (i.e., study area) spanned across five continents, with Europe having the greatest representation with 18 articles. This was double the amount of North America, which was second in volume with a total of nine articles. Approximately 10% of the studies applied a global scope by capturing multiple countries from different continents in their research (see Figure 2-3). Despite no geographic locations being excluded from the search criteria, not all continents were represented in the results. For example, the search did not yield any studies from South America.

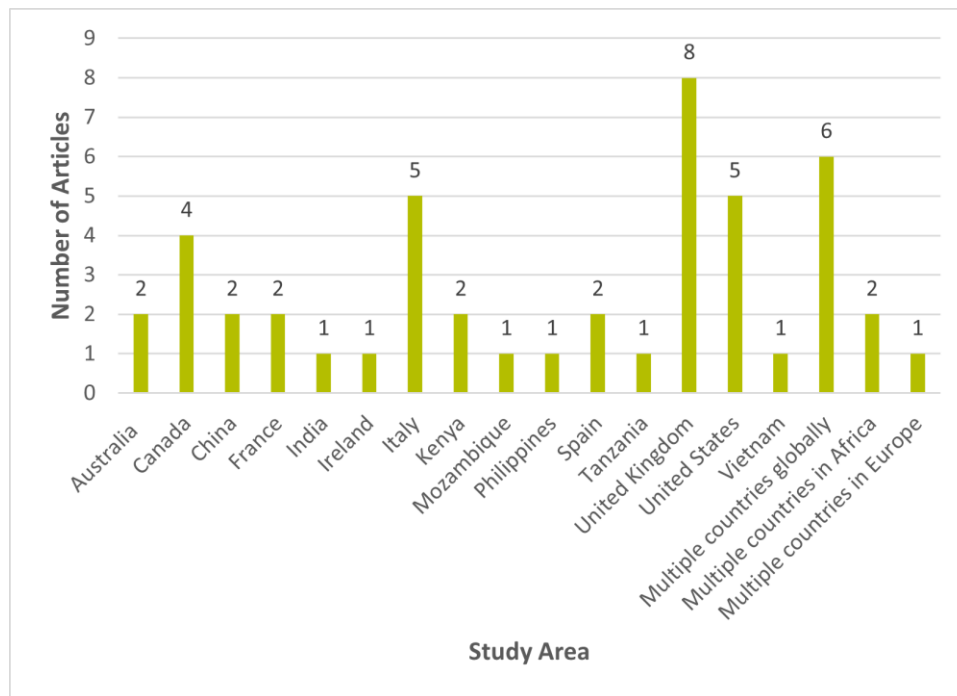


Figure 2-3. Number of publications by study area

Contextual data from the articles were analyzed to gain an understanding of the sector focus for the different studies. Common categories presented themselves, often falling under the umbrella of the public sector and civil society. For example, social enterprise appeared across several different articles as the focal organization type (Barraket & Yousefpour, 2013; Costa & Andreaus, 2020; Liston-Heyes & Liu, 2021). Similarly, many articles focused on impact investing (Caselli, 2020; S. D. Phillips & Johnson, 2021; Tsotsotso, 2021), sometimes in relation to the topic of social impact bonds (Tse & Warner, 2020; J. W. Williams, 2021). Other notable sectors or sub-sectors included research/education (Belcher et al., 2020; Kim Man Lee et al., 2021), food/agriculture (Elauria et al., 2017; Hughes et al., 2020), cities (Bottero et al., 2020; Wilson et al., 2013), healthcare (Njah et al., 2021; Ricciuti & Bufali, 2019), and sport (Lee et al., 2013; Lombardo et al., 2019).

Although theoretical perspectives were not evident in all of the articles reviewed, some studies discussed or applied different theories. Several theories were identified across the literature with multiple-constituency theory mentioned in three articles, whereas institutional theory and legitimacy theory were mentioned in two articles each. An additional 14 theories were mentioned in the literature, including agency theory and social impact accounting theory.

For example, Costa and Pesci (2016) adopted the term multi-constituency theory, which they recognized as an alternative name to multi-stakeholder theory from Kanter and Brinkerhoff (1981). The authors used this theory to bolster the idea that idiosyncratic measurements, rather than a standardized approach to SIM, may be more suitable to capture different stakeholders' perspectives. A study by Liston-Heyes and Liu (2021) used institutional theory to test hypotheses, and found that social enterprises (SEs) located in London, UK, were more likely to adopt SIM due to normative isomorphic pressures. This study also used legitimacy theory to establish that SEs were more likely to measure social impact when stakeholders were involved in decision making (Liston-Heyes & Liu, 2021).

2.3.2 Thematic analysis

The full review of 68 articles produced several themes guided by the six sub-questions presented in Section 2.4, and included (i) definitions of impact, (ii) measurement models and tools, (iii) indicators, (iv) measurement drivers, (v) challenges to measurement, and (vi) strategies to improve measurement practices.

2.3.2.1 Definitions of impact

Over 30% of the papers reviewed (21 of 68) referred to how social impact is defined. As noted by other authors, there is no set definition for social impact and its interpretation varies across the literature (Aiello et al., 2021; Hadad & Gauca, 2014). Among the articles reviewed, three commonly referenced definitions of social impact stood out:

- “Social impacts include all social and cultural consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs, and generally cope as members of society” (Burdge & Vanclay, 1996, p. 59) as cited in (Dufour, 2019; Kah & Akenroye, 2020; Pawluczuk et al., 2020).
- “The portion of the total outcome that happened as a result of the activity of an organization, above and beyond what would have happened anyway” (Clark et al., 2004, p. 7) as cited in (Cerioni & Marasca, 2021; Corvo et al., 2021; Vermeulen & Maas, 2020).
- “A logic chain of results in which organizational inputs and activities lead to a series of outputs, outcomes, and ultimately to a set of societal impacts” (Ebrahim & Rangan, 2010, p. 3) as cited in (Costa & Pesci, 2016; Kah & Akenroye, 2020; Kim Man Lee et al., 2021; Vermeulen & Maas, 2020).

When examining these definitions chronologically, Burdge and Vanclay (1996, p. 59) did not specify organizations impacting society, instead speaking more broadly to the “consequences to human populations of any public or private actions”. Further, the authors

provided a stronger alignment with the definition of sustainable development, which is defined in the Brundtland Report as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987, p. 41). The latter definitions focus on organizational activities leading to outcomes that ultimately impact society (Clark et al., 2004; Ebrahim & Rangan, 2010). Unique to Clark et al. (2004) was the recognition of deadweight (the impact that would have occurred without any intervention), an important variable when determining the causal effects of inputs and activities on outputs and outcomes (Ferraro & Hanauer, 2014). Similar to the definition by Burdge and Vanclay (1996), Jones and Valero-Silva (2021, p. 364) drew a connection to sustainable development by suggesting that “there are two core elements to social impact: firstly, a focus on a wider set of objectives commonly referred to as the ‘triple bottom line’ (Elkington, 1999) of social, economic and environmental impacts; secondly, the concept of well-being (Stiglitz et al., 2009)”.

Drawing from the papers reviewed in this study, we defined social impact as the result of a deliberate intervention by an individual, community, or organization with the objective of causing a positive effect on social, environmental, and economic well-being. As such, environmental impact is explicitly included within our definition of social impact.

Given the reference to multiple forms of impact (e.g., environmental or economic) within the social impact definitions noted across the literature (Costa & Pesci, 2016; A. Jones & Valero-Silva, 2021), definitions for other types of impact were less common. For example, the few papers that placed emphasis on community or collective impact did not provide

explicit definitions (Armstrong et al., 2021; Meringolo et al., 2019). Conversely, the study by Bottero et al. (2020), which experimented with a community impact evaluation method, defined financial, fiscal, economic, social, cultural, and environmental impact as part of their urban regeneration assessment matrix.

2.3.2.2 Measurement models and tools

Much like the semantics around measurement terminology, landing on a term that clearly describes the process used to measure impact is also challenging. Grieco et al. (2015, p. 1180) used the word “model” to “indicate those instruments entrepreneurs can rely on in measuring their social impact”. Similarly, Corvo et al. (2021, p. 6) used “model” to “mean a named, documented process that is used to assess either the actual social and/or environmental impact”. Therefore, this study followed suit and used the term “model”.

Studies by Corvo et al. (2021) and Grieco et al. (2015) analyzed measurement models found in the literature and organized them into clusters based on common characteristics to categorize the different ways social impact can be measured. Through this process, Grieco et al. (2015) identified four clusters: (1) simple social quantitative—quantitative data, focus on social impact, and a retrospective timeframe; (2) holistic complex—quali-quantitative data, holistic impact, and an ongoing/retrospective timeframe; (3) qualitative screening—qualitative data, holistic impact, and a retrospective timeframe; and (4) management—quali-quantitative data, holistic/triple bottom line impact, and an ongoing timeframe.

The study by Corvo et al. (2021) aimed to capture recent work in their systematic approach to identify measurement models that have emerged since the time of the study by

Grieco et al. (2015). In doing so, Corvo et al. (2021) analyzed six studies that mapped SIA models and identified the three most common cluster categories: (1) performance/management models relate to the evaluation of performance goals using logic frameworks, project management, and managerial certifications; (2) auditing/quality models support stakeholder accountability by assessing the process an organization follows to carry out activities and the results of those activities; and (3) monetization models aim to quantify impact and convert results into monetary terms. As a second part of their study, Corvo et al. (2021) identified 22 new models that were not captured in the previous mapping study by Grieco et al. (2015, p. 11), leading the authors to suggest that a fourth cluster could exist related to sustainability “determined by the emergence of new systems in finance requiring specific metrics and in relation to the global agenda towards sustainable development”.

Building on these works, our study identified several similar models relevant to post-intervention and organized them in two different ways. For SIM models that were discussed or applied in five or more papers, we provided a description in the following section and a summary of the characteristics, including the categorization of models based on the descriptions presented by Corvo et al. (2021) and Greico et al. (2015). For SIM models that appeared in less than five papers, a list of 68 models is presented in Appendix K. That list also contains the four models discussed below.

2.3.2.2.1 Social return on investment (SROI)

SROI was the most common measurement model discussed in the literature and is described as an evaluation technique used to measure the value of social impact achieved

through an intervention (Cerioni & Marasca, 2021). This measurement model can also be used as a forecast tool to predict future social value through impact (Lombardo et al., 2019). SROI is referred to as a monetization model that employs a six-stage process to calculate the social return on financial investment, drawing from concepts that are familiar within the social impact tradition and the field of finance, including cost–benefit analysis (Corvo et al., 2021; Dey & Gibbon, 2017; Hadad & Gauca, 2014; Lombardo et al., 2019). SROI is calculated by computing the value of impact of each intervention outcome using a series of four estimated variables: (1) deadweight, the outcome that would have occurred without the intervention; (2) displacement, the negative effect caused by the intervention; (3) attribution, the contribution from other organizations to the impact; and (4) drop-off, the depletion of impact over time. Impact is then computed by calculating the net present value (NPV) of each outcome using a formula that includes the aforementioned estimated variables. Once the NPV of outcomes (numerator) is calculated, it is divided by the NPV of the investment (denominator) to provide the SROI value (Lombardo et al., 2019).

A participatory approach is applied with SROI and the model requires both technical expertise and access to large volumes of data (Corvo et al., 2021; Costa & Pesci, 2016). Despite a well-established methodological approach to impact measurement, SROI is not fully standardized for comparability (i.e., indicators are unique and developed by the practitioner with support from stakeholders) (Mulloth & Rumi, 2021). Further, limitations exist due to the level of personal judgement applied during the measurement process (Lombardo et al., 2019). Lastly, practitioners applying the SROI model should have a general

understanding of theory of change (ToC) and logic model development as these tools are applied in the early stages of the SROI process (Lombardo et al., 2019).

Although Grieco et al. (2015) categorized SROI in the “simple social quantitative” cluster, a study by Jackson and McManus (2019) noted the complexity, time commitment, and level of expertise required to carry out the measurement process. This was, in part, due to the level of qualitative and quantitative analysis required (Jackson & McManus, 2019). Additionally, Jackson and McManus (2019) stated that while the stakeholder engagement process was time consuming, it ultimately contributed to the quality of the assessment. While Dufour (2019) also recognized the complexity and time intensiveness of SROI, the author acknowledged that the creators of the model made efforts to provide resource support, including a comprehensive guide (J. Nicholls et al., 2012).

2.3.2.2.2 Impact reporting and investment standards (IRIS+)

IRIS+ provides a standardized set of open-access metrics that can be used by an organization or its stakeholders to measure impact (Cerioni & Marasca, 2021; Mulloth & Rumi, 2021). Although IRIS+ provides users with a standardized approach that allows for comparability between organizations, limitations exist pertaining to the applicability of the metrics (Mulloth & Rumi, 2021). For example, the case study by Mulloth and Rumi (2021, p. 17) found that “the current range of metrics are limited in scope, and [the organization’s founder] did not feel that the 40 applicable metrics captured the social impact of [their organization] in a comprehensive way, particularly because 32 of the 40 metrics were descriptive metrics of the organization’s characteristics, rather than its impact”. Further,

according to Phillips and Johnson (2021), the adoption of IRIS+ as an impact measurement tool has not received much uptake in some countries. For example, the authors noted that based on their study, the IRIS+ metrics were not used in the Canadian social impact investing community.

2.3.2.2.3 Global Reporting Initiative (GRI)

GRI is a complex reporting framework that provides disclosure guidelines across four categories: environment, social, economic, and governance to support the measurement process (Grieco et al., 2015). In an analysis of measurement models relevant to their case study, Mulloth and Rumi (2021, p. 5) noted the customizable nature of GRI standards, as organizations “were given free range to determine which topics to apply to their organizations”. However, GRI standards did not score well on the relevance criteria for a micro-enterprise development organization seeking to measure their social impact (Mulloth & Rumi, 2021). This could be due to the generalizability of the GRI standard, which is applicable across sectors, organization sizes, and business models (Mulloth & Rumi, 2021; Trautwein, 2021). Although some authors identified GRI as a measurement model as it provides measurement guidelines (Corvo et al., 2021; Grieco et al., 2015; Mulloth & Rumi, 2021), it is debatable given GRI’s emphasis on reporting, rather than the measurement aspect of non-financial performance (Cerioni & Marasca, 2021).

2.3.2.2.4 Social accounting and audit (SAA)

SAA follows a holistic approach to produce a report that demonstrates the social, environmental, and economic impacts of an organization (Grieco et al., 2015; Hadad &

Gauca, 2014). The SAA process requires an organization to define its impact mission, engage stakeholders, and collect qualitative and quantitative data for reporting purposes (Hadad & Gauca, 2014). Although regulations do not exist, reports can be audited (Hadad & Gauca, 2014) and SAA is a useful model for funding agencies seeking accounts of impact (Liston-Heyes & Liu, 2021).

Table 2-1 provides descriptive characteristic details of each measurement model discussed, including the type of measurement tool employed, applicable sectors, scale of application, and the categorization of models, based on the descriptions presented by Greico et al. (2015) and Corvo et al. (2021).

Table 2-1. Measurement model descriptions

Measurement Model	Data Collection Method	Measurement Tools	Sector	Application Scale	(Greico et al., 2015) Cluster	(Corvo et al., 2021) Cluster	Mentioned in # of Articles
Social return on investment (SROI) (Social Value UK, 2023)	Interviews, questionnaires	Outcome indicators are developed by the assessor and informed by stakeholders	Multiple sectors	Project, program, organization	Simple Social Quantitative	Monetization	24
Impact Reporting and Investment Standards (IRIS+) (GIIN, 2023)	Not specified	A catalog of output and outcome metrics are provided by IRIS+	Impact investing focus made available to multiple sectors	Organization	Holistic Complex	Performance/management and sustainability	7
Global Reporting Initiative (GRI) (Global Reporting Initiative (GRI), 2023)	Not specified	Disclosures are provided by GRI. Indicators are included within some of the disclosures.	Multiple sectors	Organization	Holistic Complex	Performance/management and sustainability	6

Measurement Model	Data Collection Method	Measurement Tools	Sector	Application Scale	(Grieco et al., 2015) Cluster	(Corvo et al., 2021) Cluster	Mentioned in # of Articles
Social accounting and audit (SAA) (Hadad & Gauca, 2014)	Interviews, questionnaires, focus groups	Output and outcome indicators are developed by the organization and informed by stakeholders	Multiple sectors	Project, program, organization	Holistic Complex	Auditing/ quality	5

ToC is recognized as an analytic framework that is designed to document the change process of an intervention; it was commonly discussed across the literature reviewed in this study (Cerioni & Marasca, 2021; Costa & Pesci, 2016; A. Jones & Valero-Silva, 2021; Lombardo et al., 2019; Mulloth & Rumi, 2021; Njah et al., 2021; Vermeulen & Maas, 2020). As ToC is a participatory framework that documents the impact pathway and captures the causal relationships between inputs and outcomes, stakeholder involvement is integral to the process (Belcher et al., 2020; Cerioni & Marasca, 2021; Lombardo et al., 2019). Although ToC is closely tied to logic model development, it is not recognized as a measurement model (Corvo et al., 2021; Grieco et al., 2015), but instead as a tool to help establish the impact (or change) that is sought to be measured (Lombardo et al., 2019; Vermeulen & Maas, 2020), whereas the logic model framework seeks to demonstrate the different stages of the change process by identifying the inputs, activities, outputs, and outcomes that lead to impact. The logic model framework can serve as a foundation for measurement model development or it can be used as a customizable measurement model, provided it includes indicators and a monitoring plan (Corvo et al., 2021; Costa & Andreus, 2020; Dufour, 2019; Frantzen et al., 2018; Grieco et al., 2015; Tsotsotso, 2021; Vermeulen & Maas, 2020).

2.3.2.3 Indicators

The terms metrics and indicators are used interchangeably in the literature and tend to carry similar meanings. As noted in Table 2-1, some measurement models used the term metrics while others used indicators. For this study, we used the term indicator, which is defined as a means to measure the level of change resulting from a planned intervention designed to create a social impact. Some models provide a suite of indicators for practitioners to choose from (e.g., IRIS+), while others require the indicators to be developed by the practitioner, often with input from stakeholders (e.g., SROI). Regardless of the model, selecting the right indicators is an important part of the SIM process and is dependent on the availability of data (Bottero et al., 2020; Corvo et al., 2021).

The literature highlighted two different approaches when measuring impact: standardized and customized. Armstrong et al. (2021, p. 9) stated that a “universal metric is a method of measuring impact that is applicable and comparable in all situations”, offering reduced cost and complexity for the assessor. Despite these benefits, Lazzarini (2018, p. 135) pointed out that “standardized tools do not address the issue of causality, that is, whether changes in the target populations of these firms (if any) were caused by the actions that the firms themselves conceived and implemented”. The option is to measure social impact either through a standardized approach that promotes comparability of indicators or by developing customized indicators based on stakeholder needs (Costa & Pesci, 2016).

Ruff and Olsen (2018, p. 404) presented a slightly different perspective by proposing that SIM models could apply a “bounded flexibility” approach to indicator selection, which

“creates comparability by focusing on the commonality of the construct itself rather than on differences in the indicators used to define and measure it”. This approach can be applied by selecting a common element of the construct being measured (e.g., “new jobs”), where the “organizations choose the definitions, counts, and measures that are most relevant to them from a prescribed (bounded) set of options” (Ruff & Olsen, 2018, p. 404). The UN SDGs, for example, provide a good selection of common indicators that practitioners can use as a starting point when developing their own customized SIM indicators (Ruff & Olsen, 2018). This provides the opportunity for comparability, the appeal of a standardized approach, while allowing practitioners and stakeholders to measure in a way that suits their unique needs. In other words, there is room for both the standardization and customization of indicators when measuring social impact.

Throughout the literature reviewed, SDG indicators were the most discussed. For example, Lazzarini (2018) expressed that SDGs indicators have recently been used by entrepreneurs and impact investors seeking to measure impact. Additionally, Aiello et al. (2021) stated that SDGs are a main reference point when measuring the social impact of research at the international level. Similarly, Alomoto et al. (2021) mentioned SDGs as an international reference point used to guide the development of measurement models. These ideas were supported by Kah and Akenroye (2020, p. 384), who shed light on the common reference to SDGs, stating that “[f]rom a global perspective, there is a renewed opportunity for organisations to capture their contributions to the United Nations Sustainable Development Goals (UN SDGs) agenda”.

The literature did not provide extensive insights into the types of indicators used; however, two notable themes emerged. First, the concept of performance indicators, which were used in measurement models such as IRIS+ (Mulloth & Rumi, 2021). According to Tse and Warner (2020), performance indicators are essential when measuring social impact bonds as a financing mechanism for social service delivery. Additionally, Calvo-Mora et al. (2018, p. 1270) explained that “performance indicators are internal measures that the organisation uses to supervise, understand, predict, and improve the performance of the management of its impact in society and to predict its perception”.

Second, there was the discussion around the use of output indicators and outcome indicators, which is related to logic model development (A. Jones & Valero-Silva, 2021; Lombardo et al., 2019; Vermeulen & Maas, 2020). Williams (2021, p. 8) stated that “‘outputs’ are transactional and retrospective in nature, ‘outcomes’ are transformational and future-oriented”. Specifically, outputs are quantifiable results of a program’s performance (e.g., number of participants enrolled in a program), whereas the term outcome is used to describe a change that occurred as a result of the output (e.g., the program participant benefited from their enrollment) (J. W. Williams, 2021). Costa and Andreus (2020) provided a similar framing, suggesting that output indicators captured an immediate or short-term result of an input, whereas outcomes related to the medium or long-term results of the intervention. Additionally, the authors mentioned that output indicators could be directly accessed by the organization, making output data easier to gather, whereas outcome

indicators sometimes require additional data from outside the organization (e.g., from a beneficiary) (Costa & Andreus, 2020).

A study by Jackson and McManus (2019) outlined the SROI process and provided examples from an organization that applied the model to measure the social impact of its program. The authors reinforced the importance of outcome indicators being defined by stakeholders. Additionally, they provided example indicators for both outputs and outcomes, demonstrating that outcome indicators were based on numerous output indicators combined (Jackson & McManus, 2019). This suggests that a single output does not necessarily lead to an outcome. For example, the number of participants receiving training (output) does not necessarily lead to the participant improving their sense of purpose (outcome). Therefore, when seeking to measure impact, although outcome indicators are more complex, they will provide more meaningful information on how the outputs have led to change.

2.3.2.4 Measurement drivers

Although the reasons for measurement differed, the common themes that emerged across the literature were organized into two different categories. First, there were internal drivers, including the pursuit of continuous improvement for organizational performance. Second, there were external pressures, which included demands from funders, investors, and other stakeholders. Table 2-2 is organized by internal and external drivers, with details about how SIM supports practitioners. The external drivers are separated based on stakeholder group type. Stakeholder group one included measurement demand from funders and investors, whereas the second group highlighted pressure from other stakeholders.

Table 2-2. Measurement drivers and benefits

Drivers	SIM Supports the Practitioner in The Following
Internal: Improve organizational performance/continuous improvement	• Achieving the sustainable development goals (SDGs) (Alomoto et al., 2021) and other social impact objectives (Solórzano-García et al., 2019). • Improving understanding of how to allocate resources (Grieco et al., 2015). • Developing internal learning tools (Nguyen et al., 2015) that can inform future projects (O’Byrne et al., 2022) and support decision making (Elauria et al., 2017). • Identifying upscaling opportunities and improve cost-effectiveness of inputs and activities (Vermeulen & Maas, 2020). • Contributing to an organization’s strategy (Cerioni & Marasca, 2021). • Increasing staff morale (Arvidson & Lyon, 2014).
External: Demand from funders and investors	• Supporting policymakers seeking to invest in social impact (Caselli, 2020). • Promoting evidence-based reporting to demonstrate the value created for communities (Nguyen et al., 2015). • Assessing sustainability performance to invest purposefully (Trautwein, 2021). • Generating social impact data for grant applications and providing evidence of impact (Arvidson & Lyon, 2014), including to meet compliance demands (Barraket & Yousefpour, 2013). • Having competitive advantage when seeking contracts (Arvidson & Lyon, 2014) and funding (Costa & Pesci, 2016). • Demonstrating the impact of corporate social responsibility (CSR) initiatives funded by an organization (Barnett et al., 2020).
External: Pressure from other stakeholders	• Supporting decision making (Alomoto et al., 2021) with relevant data (Harrington et al., 2021). • Challenging traditional economic thinking and political decision making (Trautwein, 2021). • Legitimizing activities by gaining insights into organizational performance (Vermeulen & Maas, 2020). • Demonstrating the societal impact of activities (Aiello et al., 2021). • Demonstrating the results of strategic efforts (Arvidson & Lyon, 2014). • Increasing transparency, accountability, and legitimacy (Kah & Akenroye, 2020; Nguyen et al., 2015). • Enhancing promotional efforts (Arvidson & Lyon, 2014). • Complying with legislation (Cerioni & Marasca, 2021).

2.3.2.5 Challenges to measurement

Despite the different drivers and many benefits of SIM, challenges persist. Several articles reviewed in this study mentioned the challenges that evaluators and organizations faced when seeking to measure social impact. The most common challenges identified across

the literature, with 15 articles each, were related to the complexity of measuring social impact and the absence of standardized measurement models and tools. Additional challenges discussed included the lack of data or data systems (11 articles) and insufficient financial, human, and time resources (7 articles).

2.3.2.6 Strategies to improve measurement practices

Even though the strategies identified in the literature did not mirror all the challenges mentioned in Section 2.3.2.5, the themes that emerged could serve as useful insights to those seeking to measure or support the measurement of social impact.

The first theme was stakeholders, one that was commonly referenced in the literature, with Barraket and Yousefpour (2013) emphasizing the importance of understanding stakeholder needs when measuring social impact. Costa and Pesci (2016) suggested that this could be achieved by engaging with stakeholders and including their input when selecting indicators. Additionally, Dufour (2019) identified stakeholder involvement as a key aspect of SIM, recognizing their role in informing the evaluation process through active participation. Lastly, a study by Mackenzie and Davies (Mackenzie & Davies, 2019) followed a co-design approach to develop an indicator framework with stakeholders to measure the impact of food sharing initiatives.

The second theme was connected to the lack of data and data systems challenge. To address this, Ruff and Olsen (2018) proposed the use of operational data when measuring social impact. However, Ruff and Olsen (2018, p. 404) stated that the usefulness of operational data when measuring social impact is dependent on “causal mechanisms, theory,

and alternative explanations”, all of which are part of the SROI model (Cerioni & Marasca, 2021). This means that while operational data can be useful for measuring social impact, not all operational data will be applicable. As Ruff and Olsen (2018) suggested, the selection of operational data used in the measurement process must be well thought out, so that it captures causality and deadweight (i.e., outcome that would have occurred without the intervention) (Lombardo et al., 2019).

The third theme, related to the lack of resources challenge, was organizations facing a lack of capacity to effectively measure social impact (Frantzen et al., 2018). Pawluczuk et al. (2019) recognized that additional time allocated for the evaluation process to be conducted effectively is required. It is suggested that specialized external experts can help organizations with capacity challenges, although this will require additional financial resources. Ruff and Olsen (2018, p. 403) made the case for customized measurement through the engagement of “a cadre of impact analysts capable of interpreting reports”. Additionally, Polonsky et al. (2016, p. 94) suggested that “to maximise transparency and impartiality, one potential solution is that social impact could be assessed by independent third parties, allowing these evaluation organisations to develop specialised skills in this area and spread this expertise across NPOs and funding bodies”. Whether an organization develops the internal capacity to measure social impact or brings in external parties to support their efforts, increasing the capacity to collect, analyze, and interpret data will improve SIM.

While important, access to data and the ability to manage it is not the only part of the data challenge. To compute indicators, practitioners need access to the right kind of data. The

fourth theme that emerged was the quality of data and its usefulness. The value of storytelling to enhance the measurement of social impact was referenced across the literature (S. D. Phillips & Johnson, 2021; Polonsky et al., 2016). However, qualitative data alone are not enough. Polonsky et al. (2016) identified storytelling as a qualitative measure to supplement quantitative data when measuring the social value created by an initiative. Ferraro and Hanauer (2014), who although hesitant, weighed in on the quantitative versus qualitative debate as it related to causality. The authors stated that “it would be hard (but not impossible) to establish a credible claim of causality using only qualitative data, whereas we believe one can establish a credible claim with only quantitative data” (Ferraro & Hanauer, 2014, p. 505). In other words, practitioners should use mixed-methods, not solely relying on qualitative data.

The final theme was SROI, the measurement model most commonly cited in SIM literature. As such, it is a model that can be used as a starting place for practitioners looking to implement a model for SIM. While SROI has its benefits (i.e., promotes engagement with stakeholders, includes quantitative and qualitative analysis, useful organizational learning tool), it also has some drawbacks (Jackson & McManus, 2019; Ricciuti & Bufali, 2019). Most notably, it is complex, time consuming, resource intensive, and it does not guarantee comparability. Despite these drawbacks, SROI remains a viable measurement model for those seeking a solution that offers uniformity to its SIM approach, with the flexibility to customize indicators based on idiosyncratic needs (Lombardo et al., 2019; Mulloth & Rumi, 2021). It is important to note that the SROI model does not offer indicator uniformity.

Instead, it is the responsibility of the practitioner to develop or select indicators that align with the social impact they are seeking to measure.

2.4 Discussion and conclusions

This study conducted an SLR to identify and analyze relevant research published in the last 10 years to answer the following research question: What are the most frequent practices for measuring post-intervention social impact of a program or a project? Specifically, this research focused on post-intervention impact measurement at the project and program level. We found that existing literature spanned across multiple disciplines, and empirical research has been conducted across the globe with greater focus on European and North American countries. Our thematic analysis provided an understanding of key definitions, commonly used measurement models, different types of indicators, measurement drivers, challenges to impact measurement, and strategies to improve measurement practices.

By defining social impact, we were able to identify key concepts that related to the topic. Primarily, these included deliberate intervention, causality, and positive outcomes related to social, environmental, and economic well-being. Further, we narrowed down terminology that referred to the process of measuring social impact by using the term SIM, which differentiates the practice in question from SIA, a planning tool designed to proactively assess impact. By applying a thematic analysis to the selected literature, this study identified strategies that practitioners can follow to enhance their evaluation efforts and areas for future research to further advance the SIM field.

2.4.1 Implications for practitioners

The results of this research are relevant for practitioners who wish to measure the post-intervention social impact of planned projects and programs. To improve SIM practices, our study suggests that practitioners should consider the following:

1. Engaging stakeholders throughout every stage of the SIM process, most importantly in the planning stages, in particular when it comes to identifying outcome indicators.
2. Gaining an understanding of data that are available and working to develop a plan on how to use this data to measure post-intervention social impact, as well as identifying any data gaps that exist.
3. Working to increase organizational capacity in the competencies necessary to gather useful data as well as analyze and manage this data, or engage with third-party experts.
4. Collecting both quantitative and qualitative data, given the relevance of both types when measuring social impact.
5. Exploring SROI for use, or adapting elements of it to use, as an SIM model. A comprehensive guide has been published for practitioners seeking to utilize the SROI measurement model (J. Nicholls et al., 2012). As there may not be a ‘one-size-fits-all’ measurement model, practitioners may choose to adapt the SROI model to suit their needs or seek out an alternative model to measure social impact.
6. Using the SDGs indicators as they stand or as a starting point for developing their own customized indicators. While comparability and the ability to aggregate data are

- important, practitioners and stakeholders may require flexibility to customize indicators that represent unique contexts when measuring social impact.
7. When selecting or developing indicators, practitioners should ensure their indicators include both output and outcome indicators.
 8. The presence of ToC across the literature suggests its relevance in the SIM field. ToC is especially important to practitioners applying the SROI model as it is applied in the early stages of the measurement process.
 9. Funders and policymakers often have a significant impact on whether organizations have the capacity to be able to spend the time and resources needed to effectively design and implement their chosen SIM model. As such, it is essential, should they hope to see social impact measured effectively, that funders and policymakers invest in the capacity of organizations to implement the above recommendations.

2.4.2 Limitations and future research

This study revealed gaps in SIM literature. Additionally, the limitations of this study led to unexplored topics in the SIM field. For example, by focusing the literature search to only include documents labelled as articles and reviews, book chapters and grey literature were not captured. Further, by filtering to only include English sources, publications in other languages were not included in the article selection process. The exclusion criteria for article selection were established to examine the current state of the field of SIM. This scoping naturally limited the breadth and depth of articles included in this review. The study was also limited by the deductive coding categories and the scoping of the inductive coding using sub-

questions. As such, the following suggestions are presented for consideration as areas for future research:

1. The search criteria used in this SLR resulted in the absence of study areas from certain countries and continents. For example, while the articles used in this SLR included study areas from across the globe, countries in Central America and South America were not represented, despite no geographic exclusions being applied to the search criteria. Future research can help to address this gap by including non-English sources in the original article search or by including specific geographic regions as keywords in the string search.
2. To source a wide variety of literature from multiple disciplines and geographic locations, the articles included in the screening process for this SLR were sourced from ProQuest and Scopus. While the databases used in this study are comparable to WoS with respect to the number of journals indexed and categories of research covered, future SLRs on SIM should consider increasing the number of document sources to include additional databases like WoS. By including multiple databases in the initial search, future research may capture additional research disciplines or countries, adding to the diversity of the study.
3. The keywords searched when sourcing documents and the use of exclusion criteria during the article selection process posed limitations to the breadth of the literature reviewed in this study. For example, this SLR focused on the broader impact of a project or program intervention on society and the environment. Thus, specific areas

such as health and well-being impact, which are relevant to social impact, were not included within the keyword search of this study. Impact measurement plays an important role in determining the success of healthcare projects, programs, and organizations (Caló et al., 2018). As such, studies in the field of health offer valuable contributions to the academic discussion on SIM and merit being explored through future research.

4. By using sub-questions for our thematic analysis, we did not capture certain topics. For example, we did not analyze content related to empirical evidence on the shortcomings of the measurement models used in practice. Further, the thematic analysis of measurement models was based on the models that appeared with the greatest frequency, leading to the less common measurement models not being explored in this study. Future research could address these gaps.
5. Despite a large variety of measurement models identified in this study, the literature reviewed did not present a wide selection of indicators commonly used in practice to measure social impact. Which indicators are most applied in practice? Are outcome indicators adequately included in practice? Do organizations select from existing open-source indicators or are indicators developed internally? Are stakeholders engaged in the indicator selection process? To address the gap related to indicators and support those seeking standardization, future research can be carried out to inventory the indicators used in practice.
6. While this study identified many different measurement models across the literature, empirical evidence on the level of social impact achieved through different projects

and programs was lacking. Given that SROI is the most common model used to measure social impact, is there evidence that it effectively measures the level of progress and achievement of the intervention that is designed to lead to social impact? How have deliberate interventions created social impact? Does social impact at the individual, organization, or community level lead to systemic change (A. Clarke & Crane, 2018)? Roy et al. (Roy et al., 2014) raised similar points when calling for an increase in empirical research to examine the causal relationship between social enterprise activities and improved health and well-being.

7. Although theory was not thematically analyzed as part of this study, the descriptive analysis provided some insights into the theoretical framings used across the literature reviewed. Organizational theories were most common, often used to examine the adoption of SIM practices by organization types. Theories that appeared with less frequency warrant further investigation. Specifically, the general theory of social impact accounting that was proposed by Nicholls (2018) and cited in Kim Man Lee et al. (2021), as it incorporates important themes to SIM such as stakeholders, types of data, and materiality. Which theories can be used to better understand SIM? How does SIM differ from financial measurement and organization-centric non-financial measurement?
8. The harmonization of sustainability reporting standards is a contemporary topic that can be informed by a maturing SIM field. While this study established the importance of engaging stakeholders throughout the measurement process, the development of future sustainability reporting standards appears to be focused more narrowly on

investors needs (Adams & Abhayawansa, 2022). The emergence of ESG disclosures is an example of investor focused reporting that may not take a double materiality approach to capture both the risk of sustainability issues on the organization and the organization's impact on the economy, society, and environment (Adams & Abhayawansa, 2022; Cho et al., 2020). How can the strategies to improve measurement practices identified in this study contribute to the academic discourse on sustainability reporting standards? Are sustainability reporting standards capturing the risk and impact of projects and programs that are material to the organization and stakeholders? How can theory of change and logic model, concepts inherent to SIM, contribute to the integration of double materiality in sustainability reporting standards (Ng et al., 2022)?

9. The terms “evaluation”, “assessment”, and “measurement” are used interchangeably in social impact literature; however, they do not hold equal meaning (Vermeulen & Maas, 2020). Naturally, the scoping of this SLR may have led to the omission of articles on complementary topics from multiple disciplines. How does semantics impact our understanding of a field of research? How can the use of certain terminology hinder a multidisciplinary approach to research? How can studies on carbon accounting (Marlowe & Clarke, 2022) and accounting for sustainable development (Bebbington & Unerman, 2018) help advance the quality of SIM in practice?
10. Given the sheer volume of measurement models that exist and the debate on the possibility of an ideal way to measure social impact (Caló et al., 2021; Kah &

Akenroye, 2020), research gaps remain in the SIM field. While there may not be a ‘one-size-fits-all’ approach to SIM, standardization of measurement models and indicators could provide the ability to calculate collective impact towards transformational goals like SDGs. Is it possible to develop a deeper understanding of which measurement model is most suitable for an industry, organization, or program by examining the characteristics of organizations that use a specific measurement model? Answering this question will require empirical studies across sectors and organization types, indicating an important approach for future SIM research.

2.4.3 Contributions and concluding thoughts

This study contributes to the growing field of SIM. Specifically, it complements the work by Corvo et al. (2021) and Grieco et al. (2015), who analyzed and categorized existing measurement models. While similarities exist in these studies, our research provides additional insights on post-intervention measurement, which aims to support practitioners in better understanding the impact that programs and projects have on society and the environment. Additionally, our descriptive analysis shows that the literature in this field is growing and comes from a wide range of disciplines. Lastly, our descriptive analysis identified a variety of theories applied across the studies, with organizational theories being the most common.

Our thematic analysis attempts to demonstrate the nuances of SIM and identify a pathway forward for practitioners as they work to measure the social impact of projects and programs. Through this approach, we placed emphasis on the practitioner by identifying the

challenges they face, namely the complexity of measuring social impact; the absence of standardized measurement models and tools; the lack of data or data systems; and insufficient financial, human, and time resources. Then, we identified strategies to improve SIM in practice, specifically: (i) engage stakeholders throughout the process, (ii) mobilize existing operational data, (iii) increase measurement capacity, and (iv) use both qualitative and quantitative data. In addition to presenting implications for practitioners, we provide direction on future research in this field. As we approach the 2030 goal post for SDGs, an accurate understanding of our progress depends on the availability of data and the quality of measurement practices.

- End of Paper 1 -

Chapter 3 – Paper 2

Title: The impact of population size on climate performance measurement practices

Abstract: Canadian municipalities influence approximately 50% of the nation's greenhouse gas emissions and play a critical role in decarbonization. Performance measurement serves as an essential process for a municipality to analyze progress towards achieving strategic objectives, including net-zero. This paper examines the performance measurement practices of 31 Canadian municipalities using a contingency theory lens. Data were collected through interviews and supplementary documents. Data were analyzed using manual deductive and inductive coding in NVivo 14, followed by a comparative analysis to explore the influence of population size on the performance measurement process. Results show that municipalities with large population sizes have a greater number of themes prioritized for measurement, a larger number of indicator selection criteria, and report more frequently. Municipal population size does not appear to influence the involvement of stakeholders in indicator selection and data analysis strategies.

Keywords: sustainable development, climate mitigation, monitoring and evaluation, contingency theory, local government, Canada

3.1 Introduction

As cities around the world become key players in the fight against climate change, the urgency for effective local climate action has never been greater (Bertoldi et al., 2018; Roggero et al., 2023). In Canada, municipalities are central to achieving the country's greenhouse gas (GHG) emissions reduction targets under the Paris Agreement, influencing approximately 50% of national emissions and driving local decarbonization efforts (Guyadeen et al., 2019; Linton et al., 2021; Torrie, 2015). An overarching climate mitigation goal for municipalities is GHG emission reduction, and performance measurement is essential to the monitoring and evaluation of climate-related strategy implementation (Klostermann et al., 2018; Pearce-Higgins et al., 2022). With approximately five years left to reach the 2030 global climate commitments of the Paris Agreement, Canada has a responsibility to act swiftly and effectively to reduce its GHG emissions (Environment and Climate Change Canada, 2019, 2022).

Since performance measurement now includes dimensions beyond financial aspects, processes have evolved in practice as organizations increasingly address sustainability issues (Alhaddi, 2023; Mura et al., 2018). This is demonstrated by the rise of concepts such as contemporary performance measurement, which involves using both financial and non-financial indicators linked to strategy (Franco-Santos et al., 2012), sustainability performance measurement, a system of indicators for managing economic, environmental, and social activities (Searcy, 2012), and sustainability performance evaluation, which measures the impact of policies and actions on economic, social, and environmental outcomes (Büyükoçkan & Karabulut, 2018). Despite growth and continuous momentum in this field of

research (Alhaddi, 2023), many questions remain unanswered (Pazienza et al., 2023), including questions related to sustainability performance measurement design and how it is used differently across sectors. Also, the scope of the non-market performance being measured (i.e., inclusion of climate-related issues) is less known (Park & Krause, 2021).

Progress made in establishing sustainability performance measurement standards and frameworks are often centred around the private sector (Adams & Abhayawansa, 2022; Giacomini et al., 2018). Consequently, there is less coverage in academic studies of measuring sustainability performance in the public sector, including municipal governments (Guthrie & Farneti, 2008; Kaur & Lodhia, 2019; Navarro-Galera et al., 2014). Municipal governments are increasingly developing both corporate and community-wide climate mitigation that include monitoring and evaluation responsibilities (Federation of Canadian Municipalities, 2021; Guyadeen et al., 2019; Robinson & Gore, 2015). Although municipalities are engaged in climate action, the full extent is unknown since a mandatory standardized performance measurement process does not exist (Brown et al., 2018; Moreno Pires et al., 2014; Robinson & Gore, 2015). Despite this deficiency, there are voluntary platforms available to Canadian municipalities taking climate action, such as the Partners for Climate Protection (PCP) tool, which has grown over the past 25 years to serve more than 500 member municipalities, representing approximately 70% of Canada's population (FCM & ICLEI Canada, 2023; Neveroff, 2023).

Research studies on municipal climate action and governance have increased over time (Robinson & Gore, 2015) covering topics such as the quality of climate plans

(Guyadeen et al., 2019), technical pathways (Linton et al., 2022), progress on implementation (Messori, Brocchieri, Morello, Ozgen, & Caserini, 2020), and reporting (Feor, Murray, et al., 2023). Even with these contributions to municipal climate change research, gaps remain in this emerging field.

While local governments are not required to adopt a standardized measurement process for reporting on sustainability and climate-related performance, research highlights the need for such information to be clear and accessible to stakeholders (Gherardi et al., 2021; Montesinos & Brusca, 2019). Further, stakeholder engagement should go beyond simply informing to actually involving internal and external stakeholders through two-way communication (Herremans et al., 2016). Municipalities report sustainability and climate-related information in diverse ways (Guerrero-Gómez et al., 2021; B. Williams et al., 2011), suggesting that a uniform approach may not be feasible (Otley, 1980; Waterhouse & Tiessen, 1978). A situational approach, considering contextual factors, is therefore appropriate for organizational structures, systems, and strategies (Ordóñez-Ponce & Clarke, 2020; Parker, 1997). Contingency theory posits that factors such as organizational size influence decision-making and adaptability (Giacomini et al., 2018; Marcuccio & Steccolini, 2009; Otley, 1980; Thomas, 1986; Battilana & Casciaro, 2012), reinforcing the idea that there is no ‘one-size-fits-all’ solution for adopting non-financial accounting practices (Otley, 1980; Waterhouse & Tiessen, 1978).

Drawing on contingency theory, the aim of this work is to understand how population size of a municipality influences sustainability and climate-related performance measurement

practices (Furlan Matos Alves et al., 2017). This theoretical perspective, rooted in strategic management and accounting literature, asserts that there is no universal approach to organizational structure, strategy, or performance management (Hofer, 1975; Otley, 1999). Instead, contingent factors, such as organization size, external environmental pressures, uncertainties, and organizational structures, determine the most effective strategies and systems for different entities (Galbraith, 1973; Otley, 1980). By applying contingency theory, this research highlights the importance of a situational approach versus the idea of a ‘one-size-fits-all’ solution for performance measurement in public sector organizations (Parker, 1997).

It is argued that the size of the organization impacts the performance measurement process design and implementation (A. Taylor & Taylor, 2014). For instance, Marcuccio and Steccolini (2009) explored how organization size affects the voluntary disclosure of non-financial information in Italian local authorities, revealing that larger organizations did not exhibit higher disclosure rates, which opposes the contingency theory assumption that the greater the size, the greater the disclosure level (Adams, 2002). These results contrast with those of Giacomini et al. (2018), who used population as a measure of size, and found that sustainability reporting was more prevalent in larger municipalities in Italy. These divergent findings underscore the need for a deeper understanding of how size influences the entire performance measurement process.

The aim of this study is to enhance our understanding of sustainability and climate-related performance measurement within different sized municipalities. Specifically, it explores the performance measurement processes of a select sample of municipalities across

Canada that are voluntary members of the PCP program (FCM & ICLEI Canada, 2024).

Using a contingency approach, we examine how the population size of these municipalities may influence the performance measurement process (Giacomini et al., 2018). This qualitative research employs a descriptive method, incorporating semi-structured interviews and document analysis (Dul & Hak, 2012; Yin, 2018), to investigate performance measurement practices within the 31 Canadian municipalities. The study addresses the following research question: How do the sustainability and climate-related performance measurement practices of small, medium, and large Canadian municipalities compare? To answer this question, the findings are organized according to the five steps of the public sector performance measurement process (Van Dooren et al., 2010) outlined in Section 3.2.1.

This paper begins with a literature review in Section 3.2 and a theoretical perspective in Section 3.3. Methods are outlined in Section 3.4. Results are presented in Section 3.5 followed by a discussion in Section 3.6 and a conclusion in Section 3.7.

3.2 Literature review on performance measurement

The field of performance measurement has been evolving for decades. In the 1980s, there was a shift from budgetary control to integrated performance measurement, which broadened the scope to include environmental and social themes (Ali et al., 2024; Bititci et al., 2012). It was also around this time that the topic of performance measurement in the public sector developed (Bititci et al., 2012). This coincides with the emergence of New Public Management, a reform that brought private sector efficiencies and managerial approaches to the public sector (Cooper & Pearce, 2011; R. Gibson & Dale, 2023). As such,

performance measurement is not a new concept for local governments. Municipalities have been obtaining and interpreting data to inform decision-making for many years (Poister & Streib, 1999).

Given the maturity of financial accounting, there are well-established national and international rules that organizations must follow when producing financial statements (F. Phillips et al., 2018). Over the years, financial reporting has evolved to corporate reporting which includes financial and non-financial information (Uyar, 2016). When it comes to sustainability (i.e., ecological, social, economic issues), measurement and reporting systems and rules are not as mature, nor is there international consensus, partly due to the varying needs of stakeholder groups and the complexity of calculations and disclosures (Adams & Abhayawansa, 2022; Darnall et al., 2022; Laine et al., 2021; Weber, 2014).

Measurement is an important step in facilitating the monitoring and evaluation of progress towards targets and goals (Caldas et al., 2020; Shaker & Sirodoev, 2016). Measuring performance assists both local policy-makers (i.e. city councillors) and other levels of government that regulate the municipal sector (Caldas et al., 2020). Whether a municipality is operationalizing a sustainability or climate action plan, oversight and reporting are essential, which are dependent on the performance measurement process (Guyadeen et al., 2019; Linton et al., 2021; Robinson & Gore, 2015). To effectively measure performance against strategic objectives, such as net-zero GHG emissions by 2050, an organization must establish a performance measurement process that supports climate action accountability and improvement (S. Jones, 2019; Van Dooren et al., 2010).

3.2.1 The performance measurement process

Performance measurement in the public sector can be understood as a series of steps that include the prioritization of measurement areas, selecting indicators, obtaining and interpreting data, and reporting information to internal and external stakeholders, which should all be governed by quality control (Van Dooren et al., 2010). Together, these steps contribute to a continuous process that we used to frame this study on sustainability and climate-related performance measurement. Table 3-1 summarizes the five steps of the performance measurement process.

Table 3-1. Summary of findings from academic literature based on the performance measurement process defined by Van Dooren et al. (2010)

Performance measurement step	Literature review finding	Source
Prioritizing	Prioritization of sustainable development themes varies in practice globally. Themes related to the environment and climate action are insufficiently covered by commonly used indicators.	(Macdonald et al., 2018; Merino-Saum et al., 2020; Park & Krause, 2021; Tanguay et al., 2010)
Selecting indicators	Good indicator selection criteria include the ability to capture change, relevance to decision makers, and alignment with internal systems and available data sources.	(Maclaren, 1996b; Niemeijer & de Groot, 2008; Tanguay et al., 2010)
Obtaining data	Access to adequate data are a persistent challenge. Internal operational data are the most cost-effective source, but it has limitations. The performance measurement process relies on external data from other levels of government. AI could improve ease of access to data.	(Alexopoulos et al., 2019; Klopp & Petretta, 2017; Ruff & Olsen, 2018; Wei et al., 2022)
Interpreting data	There are different strategies for data analysis. Matching strategic objectives to performance is important. GHG emissions data are useful for multiple forms of data analysis. Causal analysis depends on multiple data sources.	(Feor, Clarke, et al., 2023; S. Jones, 2019; Klostermann et al., 2018; Linton et al., 2022)

Performance measurement step	Literature review finding	Source
Reporting	Reporting serves as an accountability tool that can be used by multiple users. Monitoring and evaluation are often prescribed, but reporting remains scarce. A ‘one-size-fits-all’ approach to reporting may not be possible for local governments.	(Feor, Murray, et al., 2023; Guyadeen et al., 2019; S. Jones, 2019; Linton et al., 2021)

3.2.1.1 Prioritizing

To ensure the integration of sustainable development principles into performance measurement, indicators used to evaluate progress need broader coverage to include environmental, social, and economic themes (Pham et al., 2020). However, the representation of themes and sub-themes used in practice varies globally, ranging from waste, climate change, and land use to employment, housing, to food security (Macdonald et al., 2018). When considering the indicators commonly used to measure the sustainability of cities, the environmental theme has a lower representation compared to the social and economic themes (Tanguay et al., 2010). While the vast majority of U.S. local governments measure at least one activity or program related to sustainable development, including community well-being, environmental protection, smart growth, and local employment, energy conservation is the least frequently measured (Park & Krause, 2021).

To achieve the 1.5°C target limit by 2100, thereby limiting global temperature increase, scientists are calling for a deep reduction in GHG emissions in the short- and medium-term (IPCC, 2021; Xu & Ramanathan, 2017). Accordingly, there is a need for

greater prioritization of themes related to climate action to increase its representation (Merino-Saum et al., 2020).

3.2.1.2 Selecting indicators

Indicators are an integral part of performance measurement and widely discussed in the literature (Merino-Saum et al., 2020). Given the interconnectedness of sustainability and climate change, and the value of integrating context-specific priorities when developing measurement tools (Merino-Saum et al., 2020), indicator selection must be informed by existing processes and practices, requiring direct engagement with municipal staff and major stakeholders (Bekier & Parisi, 2023; Bouckaert & Halligan, 2008).

Good indicators have many features including the ability to capture change, unambiguity in how an indicator is defined, and clarity to users (Maclaren, 1996b; Niemeijer & de Groot, 2008; Van Dooren et al., 2010). Indicators should also reflect the context of that which is being measured and facilitate timely action by decision-makers (Maclaren, 1996b; Niemeijer & de Groot, 2008). Additionally, the data collection process should be feasible and aligned with existing internal systems (Niemeijer & de Groot, 2008; Tanguay et al., 2010; Van Dooren et al., 2010). Given the importance and urgency of measuring progress on climate action, indicators should rely on available data, be widely adopted, and useful for decision-makers (Goonesekera & Olazabal, 2022; Maclaren, 1996b; Tanguay et al., 2010).

3.2.1.3 Obtaining data

As Dahl (2012, p. 16) so aptly puts it, “[i]ndicators are only as good as the data behind them.” Information management practices support the integration of performance measurement into organizational processes (Garengo & Bititci, 2007). The successful functionality of performance measurement in practice is dependent on accurate, reliable, and timely data inputs, which is why availability of data is often identified as an indicator selection criterion (Merino-Saum et al., 2020; Tanguay et al., 2010).

Internal operational data, which is collected through the normal course of operations, can offer a more cost-effective option when compared to externally-sourced data (Ruff & Olsen, 2018; Van Dooren et al., 2010). Access to adequate data are a persistent problem that will affect the measurement of sustainable development at the local level (Klopp & Petretta, 2017). Solely relying on internal operational data has its limits and can hinder the robustness of measurement (Diaz-Sarachaga et al., 2018; Van Dooren et al., 2010). In order for local governments to measure progress on sustainable development and climate action, they must also have access to disaggregated data from other levels of government (Wei et al., 2022). The adoption of artificial intelligence (AI) could help improve data collection efficiency, thereby offering municipalities a cost-effective alternative when sourcing external data (Alexopoulos et al., 2019).

3.2.1.4 Interpreting data

Analysis transforms data into information that is useful for decision making (Van Dooren et al., 2010). Diverse stakeholder perspectives across government systems can pose challenges when establishing a process to measure the sustainability and climate-related

performance of municipalities (Caldas et al., 2020). In part, this is due to a broad range of stakeholders seeking information about how environmental, social, and economic issues impact the organization and are impacted by the organization (Laine et al., 2021).

According to Van Dooren et al. (2010, p. 73), there are three strategies for interpreting data: “norm and target setting,” “breakouts,” and “causal analysis.” When data are interpreted based on norms and targets, the analysis can examine how performance is changing over time and how it compares to other organizations, scientific thresholds, and political ideals (Van Dooren et al., 2010). Therefore, it is important to match performance measures to strategic goals (S. Jones, 2019).

GHG emissions data are not only useful for benchmarking, but they also serve for breakout and aggregation analysis, the second strategy for data interpretation (S. Jones, 2019; Van Dooren et al., 2010). Local governments measure GHG emissions by creating an inventory of their emissions by sector. Canadian municipalities inventory their GHG emissions at the corporate- and/or community-scale (MacDonald et al., 2024). The corporate GHG emissions inventory (GEI) includes emissions generated by the municipalities operations such as building and facilities, fleet vehicles, and solid waste. Whereas the community GEI captures emissions occurring within the municipality’s geographic boundaries, including corporate GHG emissions (A. Clarke & Ordonez-Ponce, 2017). These emissions are from a wider range of sources including residential, commercial and industrial consumption, transportation, and agriculture (FCM & ICLEI Canada, 2021). Given that multiple pathways exist for a municipality to reduce its GHG emissions, inventory data can

support analysis in both breakout (i.e., by activity sector) and aggregate forms (Linton et al., 2022).

The third strategy for data interpretation is causal analysis (Van Dooren et al., 2010). This strategy requires a cause-and-effect approach to analysis which depends on multiple indicators in order to measure one outcome, creating the need for additional data that is typically sourced outside of the organization (Pádua & Jabbour, 2015; Tanguay et al., 2010). The logic model is a framework used to evaluate the different stages of a project or program by defining and measuring the inputs, activities, outputs, and outcomes that lead to impact (Feor, Clarke, et al., 2023). Within each stage of the pathway to impact, performance of a project or program can be measured against its objectives using indicators (Goonesekera & Olazabal, 2022; Klostermann et al., 2018). As such, the logic model framework can serve as a useful tool that captures causal relationships when measuring sustainability and climate-related performance at the local level. Ultimately, the analysis strategy adopted by a municipality will depend on the needs of the organization and the resources available to measure performance.

3.2.1.5 Reporting

Sustainability and climate-related reporting functions as an accountability tool that stakeholders can use when assessing a municipality. Reporting that incorporates environmental, social, and economic considerations complements financial reporting by offering broader insights, and has potential to be an effective tool in society's transition toward sustainability (Cho et al., 2015; Feor, Murray, et al., 2023). Municipalities'

performance is monitored and evaluated by multiple stakeholder groups with varying expectations and differing demands (Callaghan & Colton, 2008; Othman et al., 2017). Municipalities are responsible for providing services to constituents that align with sustainable development themes (León-Silva et al., 2020; Navarro-Galera et al., 2018). Reporting, which is meant to provide transparent performance information and enhance accountability, is one of the weakest aspects of the measurement process (S. Jones, 2019).

While non-financial reporting practices have matured over the years, the most recent sustainability and climate-related disclosure standards by the International Financial Reporting Standards (IFRS) are not designed for local governments (Demers et al., 2024; IFRS Foundation, 2024). The International Public Sector Accounting Standards Board (IPSASB) has made progress on developing climate-related disclosure standards for the public sector (IPSASB, 2024). While climate-related disclosures can be done through the Carbon Disclosure Project (CDP) Cities initiative, adoption is voluntary (Chen et al., 2021).

Although a specific framework has not been mandated for local governments to report on sustainability and climate-related performance, academic literature suggests a need for sustainable development information to be made available to stakeholders in a clear and comprehensible manner (Montesinos & Brusca, 2019). Municipal reports disseminate climate-related information in various ways and at different levels (Linton et al., 2021). For example, reporting to internal stakeholders will differ from reporting to external stakeholders, resulting in different formats and frequencies of publication of information (Van Dooren et al., 2010). Despite monitoring and evaluation often being prescribed in

municipal climate action plans, there are still unknowns since plans are scarcely reported on (Feor, Murray, et al., 2023; Guyadeen et al., 2019).

3.3 Methods

3.3.1 Study area

In Canada, approximately 5,000 municipalities exist, ranging from large cities to small rural communities (Statistics Canada, 2017b). Municipalities are responsible for providing good governance, necessary and desirable services, and for maintaining safe communities (Z. Taylor & Dobson, 2020). These municipalities provide services such as public safety, transportation, waste management, libraries, parks, local police, water systems, and roadways (Library of Parliament, 2021). Although municipalities, which are local governments, derive their authority from provincial legislation, they do have jurisdiction over some policies (Vidoni, 2021).

The study area of this research focuses on Canadian municipalities, which operate under provincial and territorial authority within Canada's federal system. At the federal level, Canada aims for net-zero GHG emissions by 2050 (Government of Canada, 2024). Climate action priorities and regulations vary at provincial and municipal levels (Environment and Climate Change Canada, 2021, 2022; Guyadeen et al., 2019). The PCP program, led by ICLEI and the Federation of Canadian Municipalities, supports municipalities by providing resources such as the Milestone Framework to help reduce GHG emissions (FCM & ICLEI Canada, 2023). Municipalities can inventory emissions at the corporate level (focused on municipal operations) or the community level (including residential, commercial, and

industrial sources) (A. Clarke & Ordonez-Ponce, 2017; FCM & ICLEI Canada, 2023; MacDonald et al., 2024). This free resource aims to help municipalities reduce GHG emissions despite possible fiscal challenges.

3.3.2 Research design

This study examined the sustainability and climate-related performance measurement practices of 31 diverse Canadian municipalities (Yin, 2018). The case studies were divided into three groups based on the population size of the municipality (small <10,000; medium 10,000 – 150,000; large >150,000) to allow for a comparative analysis of the impact that size could have on the performance measurement process.

Case study municipalities were selected using a purposeful sampling strategy (Patton, 1990), which is a non-probabilistic technique that uses a clear rationale to determine the inclusion of cases in the sample. This approach aims to capture the heterogeneity of the population (Maxwell, 2012; Yin, 2018). As such, the case study sample was selected from 297 existing PCP program members that have achieved the first milestone. In other words, they have created a GEI at the corporate or community level (FCM & ICLEI Canada, 2023). This results in a sampling bias in the selection of municipalities that are already measuring climate-related performance in the form of a GEI.

The following stage of the sample selection process organized the list of 297 municipalities by size (139 small, 128 medium, and 30 large). After organizing municipalities into their respective size groups, the main website for each municipality was scanned to identify the municipalities with publicly available climate-related and

sustainability indicators. This reduced the sample population to 128 municipalities to recruit from (27 small, 79 medium, and 22 large).

Municipalities were recruited across all three population size groupings with the aim of recruiting 12 municipalities per size group and reaching a diversity criteria that considered the following:

- English-speaking and French-speaking municipalities.
- Representation from Canadian provinces and territories in proportion to population size.
- Representation from urban and rural municipalities.
- Representation from different types of municipalities (cities, towns, regions, etc.)

Table 3-2 shows the list of municipalities recruited for this study.

Table 3-2. List of participating municipalities by size group

Small Municipality (< 10,000)	Medium Municipality (10,000 - 150,000)	Large Municipality (>150,000)
Municipalité de Contrecoeur, Quebec	City of Fredericton, New Brunswick	Capital Regional District, British Columbia
Tay Valley Township, Ontario	City of Nanaimo, British Columbia	City of Kitchener, Ontario
Town of Bridgewater, Nova Scotia	City of Peterborough, Ontario	City of London, Ontario
Town of Devon, Alberta	City of St. John's, Newfoundland	City of Ottawa, Ontario
Town of Northeastern Manitoulin and the Islands, Ontario	City of Thunder Bay, Ontario	City of Saskatoon, Saskatchewan
Town of Wolfville, Nova Scotia	MRC de la Côte-de-Gaspé, Quebec	City of Surrey, British Columbia
Township of Huron-Kinloss, Ontario	Town of Canmore, Alberta	City of Winnipeg, Manitoba
Township of Qualicum Beach, British Columbia	Town of Okotoks, Alberta	Regional Municipality of Halton, Ontario
Township of the Blue Mountains, Ontario	Town of Stratford, Prince Edward Island	Ville de Gatineau, Quebec
	Township of Selwyn, Ontario	Ville de Québec, Quebec
	Victoriaville, Quebec	Ville de Sherbrooke, Quebec

3.3.3 Data collection

Primary data were collected through interviews and supplementary documents that were found on the municipalities' websites and/or provided by the participating. The interview questions were developed with input from municipal experts, academics, and literature (Searcy, 2012; Tanguay et al., 2010; Van Dooren et al., 2010). The interviews were conducted virtually over Zoom between November 2023 – March 2024 with the municipal staff member(s) responsible for the measurement of sustainability and climate-related performance. Some interviews were held with more than one person from within the organization at the request of the participants. In total, 37 people were interviewed across 31 Canadian municipalities. The interviews were conducted using semi-structured questions and were recorded for transcription to allow for manual deductive and inductive coding. Interviews were transcribed by Transcript Heroes, a secure transcription service.

3.4.4 Data analysis

The transcribed interviews and supplementary data were manually coded deductively and inductively in NVivo 14. Codes were either pre-defined based on the literature for deductive coding (Maclaren, 1996b; Van Dooren et al., 2010) or identified through an inductive coding process using the Gioia method which employs ordered coding analysis (Gioia et al., 2013). Transcripts were initially reviewed to establish first-order codes, followed by an analysis to determine second-order codes (Gioia et al., 2013). Once second-order codes were established, the transcripts and supplementary documents were reviewed again to ensure accuracy. The inductive coding process involved data reduction techniques where similar codes are merged and re-named (when necessary) (Naeem et al., 2023). After

the coding was complete, a comparative analysis was conducted to examine the performance measurement practices of the three different size groups of sample Canadian municipalities (Baxter & Jack, 2010).

3.4 Results

To formulate a response to our research question, the results are divided into the five steps of the performance measurement process described in Section 3.2.1 (Van Dooren et al., 2010).

3.4.1 Prioritizing

Measurement areas prioritized by the municipalities were determined through an inductive coding process that identified which performance areas were focused on and which indicator themes were covered. Figure 3-1 shows the distribution of frequency counts for two different categories that help serve as proxies to determine measurement priorities: the number of focus areas and the number of indicator themes. Focus areas were broader categories confirmed by the interviewee. While these themes are not mutually exclusive, they are not identical. Therefore, each category was coded for equally, even if some areas are sub-categories of others. One example is that of sustainable development which captures the broader three dimensions of sustainability. Environmental sustainability focuses more narrowly on areas such as waste and water management. The indicator themes were identified by synthesizing the sub-categories listed in the supplementary documents. Analyzing the indicator themes provides a more detailed understanding of areas prioritized for measurement by the municipalities.

The number of focus areas appears to be influenced by the population size of the municipality, with larger municipalities having a greater number. Whereas the number of indicator themes are not as straightforward. The small municipalities have on average slightly more themes than the medium municipalities. There is also a larger variation in the number of themes for small municipalities when compared to the medium and large municipalities. The large municipalities have the highest average number of indicator themes with over 10.

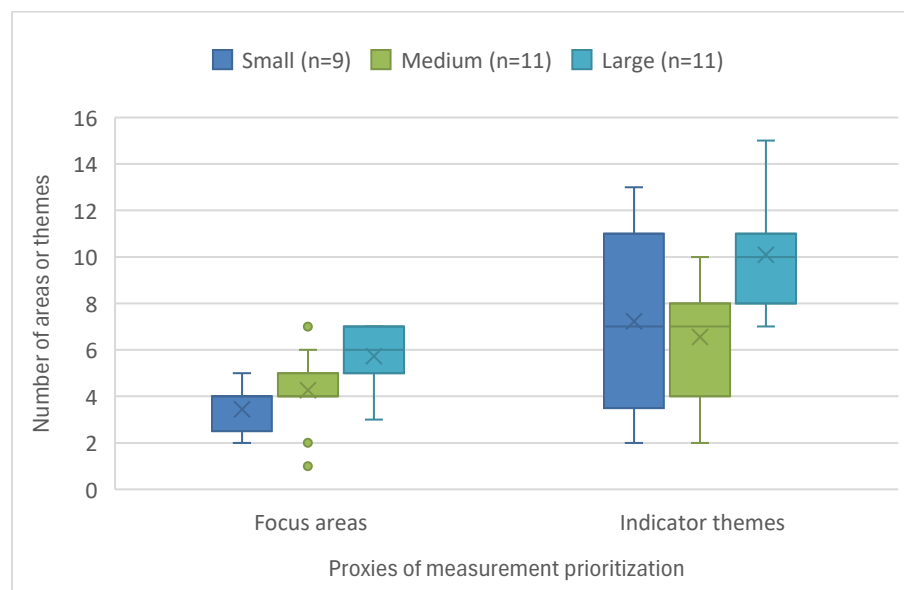


Figure 3-1. Distribution of the number of focus areas and indicator themes by size group

Based on the responses, the group of large municipalities consistently has the greatest percentage of municipalities measuring a specific measurement focus area (i.e., climate mitigation and GHG emissions). Greater than 50% of the large municipalities measure performance in a specific area across all seven categories charted in Figure 3-2. This is not the case for the small and medium groups. The medium group almost always has a greater

percentage of municipalities measuring a specific area as compared to the small group, with exception to the areas of sustainable development and transportation. Buildings are the least represented measurement focus area among small- and large-sized municipalities, whereas sustainable development is the least common among medium-sized municipalities.

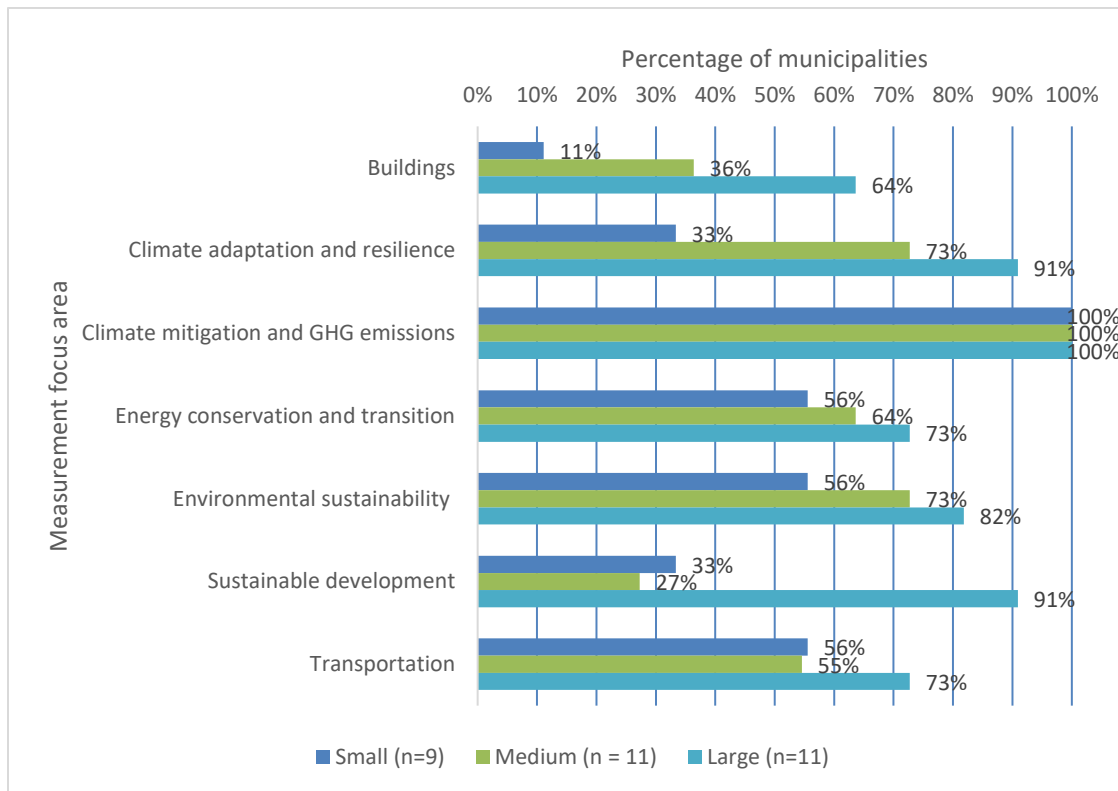


Figure 3-2. Percentage of municipalities by measurement focus area and size groups

Prioritized measurement areas were also determined by analyzing the indicator themes found in the supplementary materials made available by the participants and through the municipalities' websites. The indicator themes that were extracted from plans were not necessarily reported on. This would suggest that not all indicators included in planning documents are currently in use. The indicator theme categories were coded inductively, and data were reduced to provide additional depth on the measurement focus areas prioritized by

municipalities. Based on the analysis, Figure 3-3 shows a substantial breadth of coverage across the different dimensions of sustainability. Climate mitigation and GHG emissions, energy and transition, and transportation and mobility are the three highest ranking indicator themes across all three size groups. For the most part, large municipalities have the highest frequency count across all themes, with exception to economic development and green economy, equity, diversity, and inclusion (EDI), and housing.

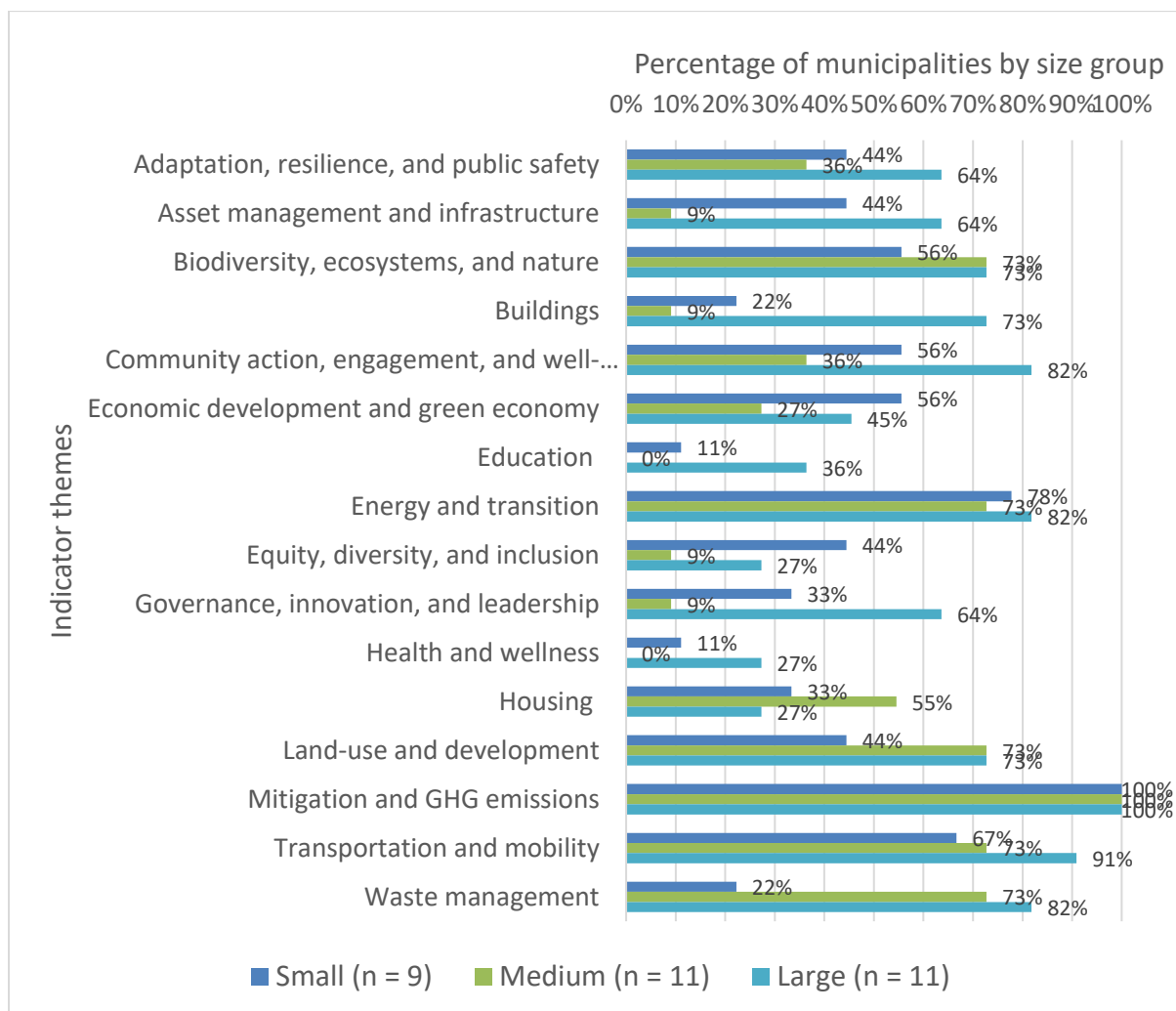


Figure 3-3. Indicator theme frequency by type and size group

3.4.2 Selecting indicators

Interviewees were asked about the existence of indicator selection criteria. Through these discussions, many participants acknowledged the use of informal selection criteria and offered some examples of the criteria used when selecting indicators. Interview transcripts were coded inductively based on the presence or absence of indicator selection criteria across three main categories: yes – informal, yes – formal, and no. Most municipalities across all three size groups indicated that while they do not have formalized selection criteria, they do factor in certain criterion when selecting indicators. Therefore, a total of 28 municipalities across all three size groups were coded as having informal selection criteria. There are three municipalities out of the entire sample that do not currently have any selection criteria. Two of these three municipalities are medium, and one is large. The two medium municipalities rely on external consultants to select their indicators.

While some municipalities stated that they do not have selection criteria, they may have mentioned criteria during their interview. Also of note is that not all participants mentioned specific indicator selection criteria. The criteria were coded deductively using the indicator selection criteria defined by Maclaren (1996b) because it offered an exhaustive list that was represented across the literature reviewed for this study. A frequency count was conducted and is presented in Figure 3-4.

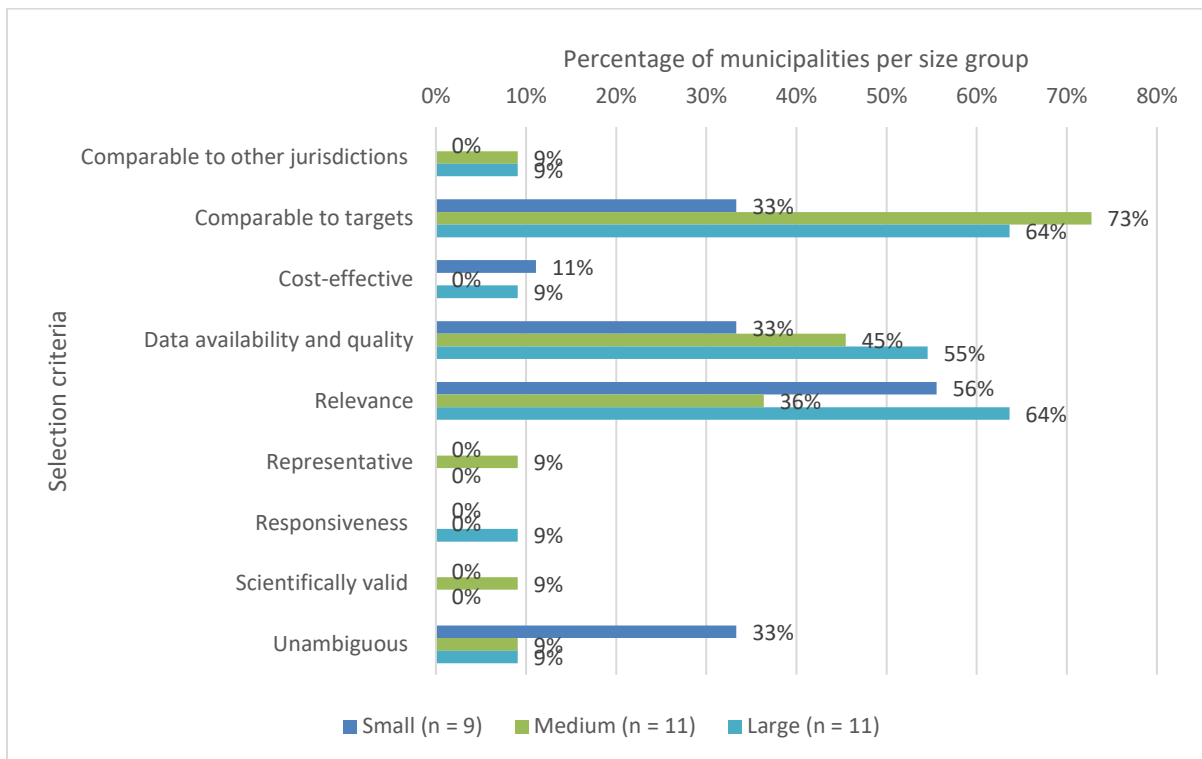


Figure 3-4. Selection criteria frequency by size group as defined by Maclaren (1996b)

Comparable to targets, data availability and quality, and relevance are the most common categories across all three size groups, although the percentage of municipalities that mentioned these selection criteria vary between size groups. Comparable to targets is the most common criterion when considering the three size groups collectively. The selection criterion most used by small municipalities relates to relevance of the indicator to municipal context, whereas comparability to targets is the most common criterion for medium municipalities. Relevance and comparability to targets are the indicator selection criteria that were most identified by large municipalities. The unambiguous criterion is among the most popular for small municipalities with 33% of the group’s participants mentioning it in their interviews.

For the participating municipalities that confirmed the informal use of selection criteria, Figure 3-5 shows that the number of indicator selection criteria mentioned by participants range between one and five per municipality, with the medium group having this range, with small and large municipalities ranging from one to three and one to four, respectively. The average number of indicator selection criteria per municipality is nearly equal for medium and large municipalities, small municipalities have less.

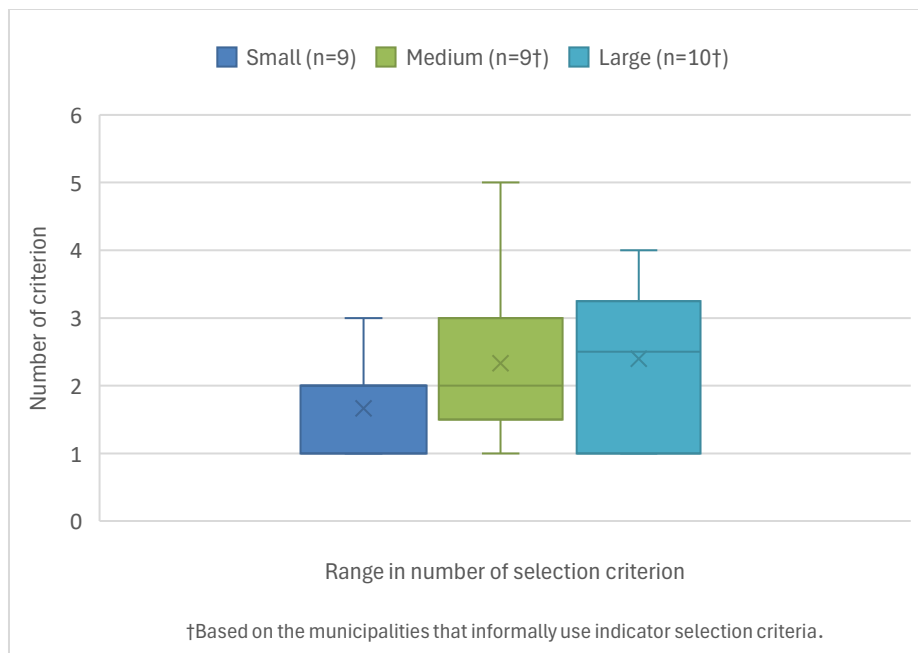


Figure 3-5. Range and averages in number of indicator selection criteria by size group

Internal and external stakeholder involvement in the indicator selection process was discussed during the interviews. To document this part of the process, the use of consultants was not considered external involvement. Interestingly, there is minimal variation in responses across the three size groups, as seen in Figure 3-6. Approximately 80% of the municipalities involve either internal stakeholders or internal and external stakeholders in the

indicator selection process. A little over half of the municipalities across all three size groups involve both internal and external stakeholders.

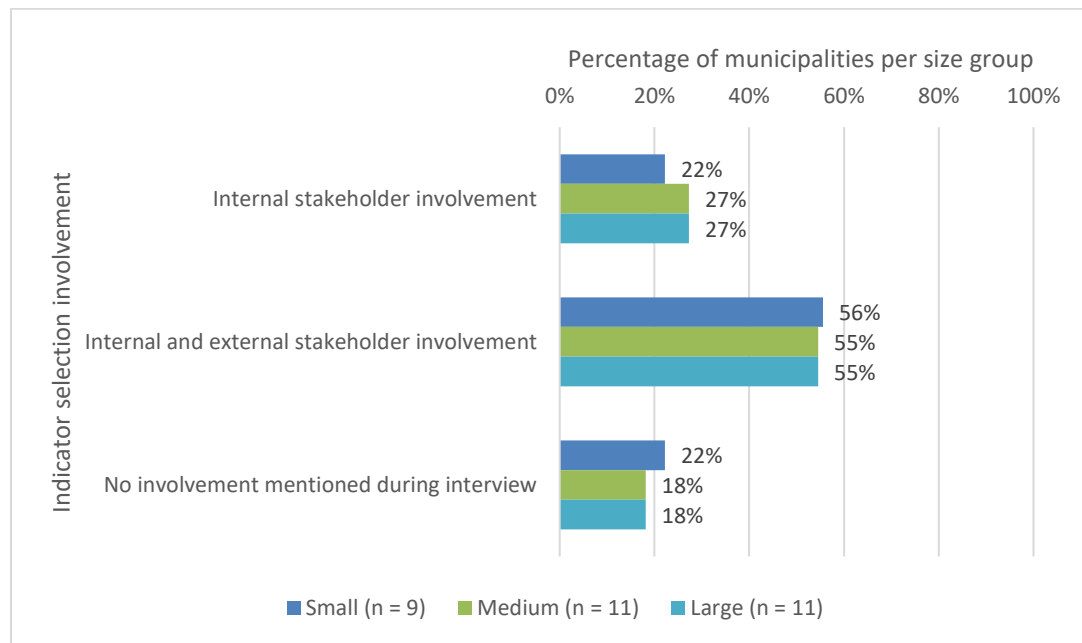


Figure 3-6. Level of stakeholder involvement in the indicator selection process

3.4.3 Obtaining data

To better understand the data collection step of the performance measurement process and how it compares by population size group, interviewees were asked about data sources. Data sources were coded inductively to capture the frequency counts. If a municipality used multiple sources (i.e., departments) within the federal government, that was only counted once under the “nationally sourced” code. Figure 3-7 demonstrates the range in quantity of data sources by size group. The average number of data sources across all municipalities is 3.5, which is roughly the average number of data sources for the medium municipalities. Small municipalities had on average 3 data sources, whereas large municipalities had on average over 4 data sources.

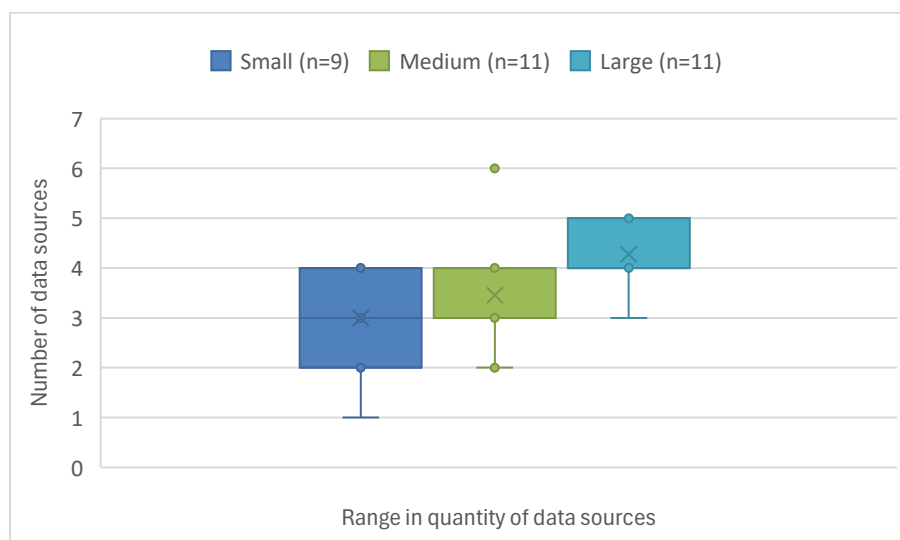


Figure 3-7. Distribution in number of data sources used by size group

Internal operational data were the most common source with 100% usage across all three size groups, as seen in Figure 3-8. Provincially and nationally sourced data are commonly used across all three size groups to varying degrees. Large municipalities use third-party data to a much greater extent than the small and medium municipalities. AI-generated data are not commonly used and there is only one source (Google Environmental Insights Explorer⁵) currently used by a small percentage of medium and large municipalities.

⁵ <https://insights.sustainability.google/>

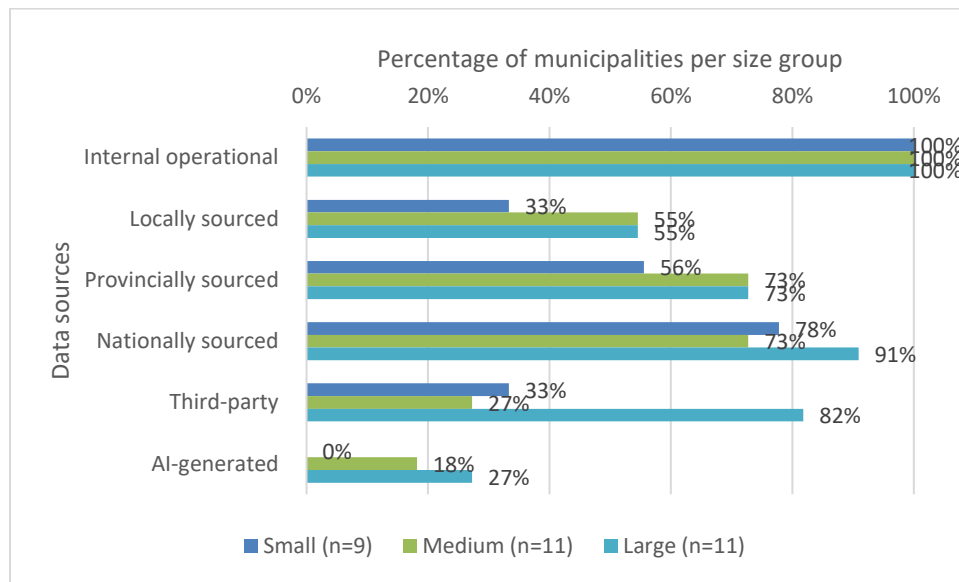


Figure 3-8. Percentage of municipalities use of data source types across size groups

3.4.4 Interpreting data

According to Van Dooren et al., (2010, p. 73), performance measurement analysis can be broken down into three interpretive strategies: “norms and targets”, “breakouts”, and “causal analysis”. These strategies were used to deductively code the municipalities’ approach to analysis. While all large-, medium-, and small-sized municipalities discussed their use of the norms and targets and the breakouts strategies, only one medium municipality and one small municipality mentioned using causal analysis to measure performance. None of the large municipalities mentioned causal analysis in their interview. Figure 3-9 shows the frequency counts of the different interpretive strategies used to analyze data for performance measurement.

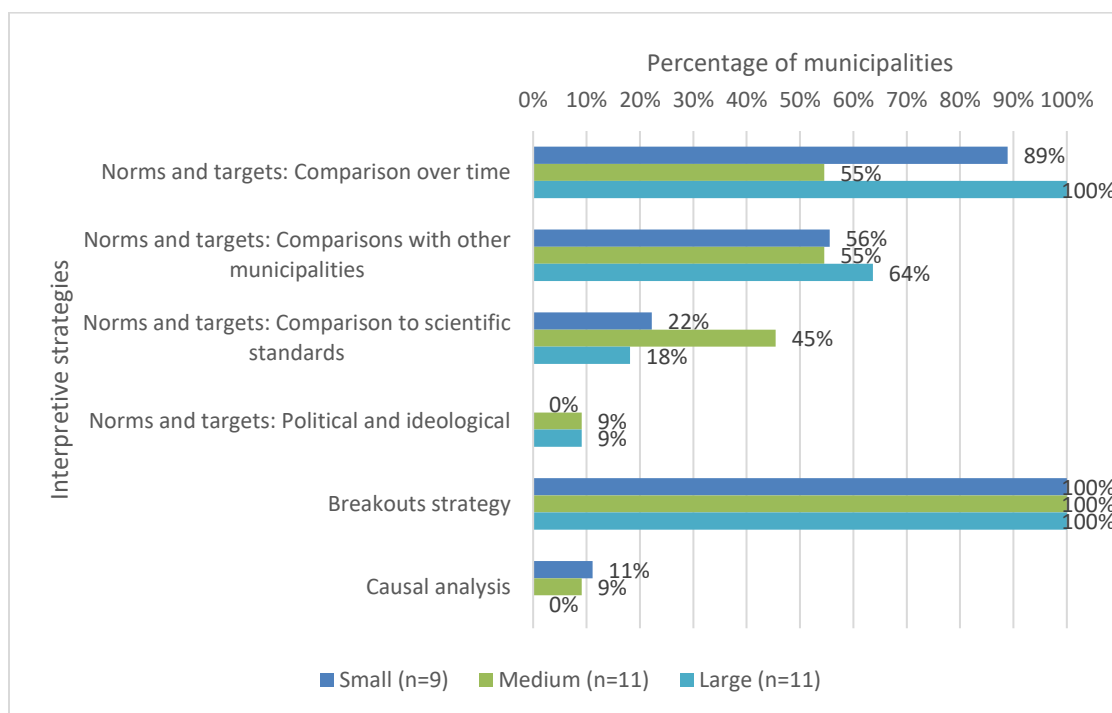


Figure 3-9. Percentage of municipalities using interpretive strategies across size groups

All municipalities mentioned the use of multiple indicators (breakouts strategy) to measure a common object (e.g., climate mitigation). However, the only type of aggregate index mentioned was a GEI, which measures emissions across multiple activity sectors at the corporate and community levels (FCM & ICLEI Canada, 2021).

3.4.5 Reporting

To better understand how information is communicated, transcripts were coded inductively to determine the frequency, format, and target audience. Figure 3-10 shows that large municipalities report with the greatest frequency, with 90% of them reporting annually or more than once per year. More than half of the small- and medium-sized municipalities are reporting on an annual basis, with approximately 10% of municipalities from each size-group reporting more than once per year. One third of the small municipalities are reporting on an

as-needed basis and roughly 20% of medium municipalities are reporting less than once per year.

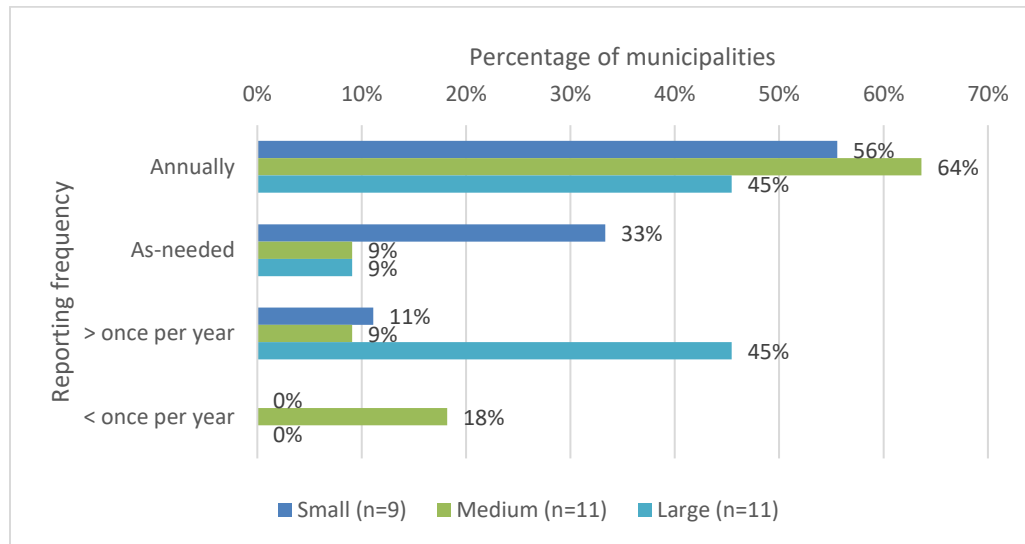


Figure 3-10. Percentage of municipalities reporting based on frequency across size groups

As seen in Figure 3-11, most municipalities across all three size groups report to multiple stakeholder groups including the public and to municipal councils and committees. Over half of the small municipalities are reporting to other levels of government. This is not the case for the medium and large municipalities, with 18% and 36%, respectively, reporting to other levels of government. Approximately a quarter or less of municipalities in each of the size groups mentioned internal departments and staff as intended audiences for their reporting.

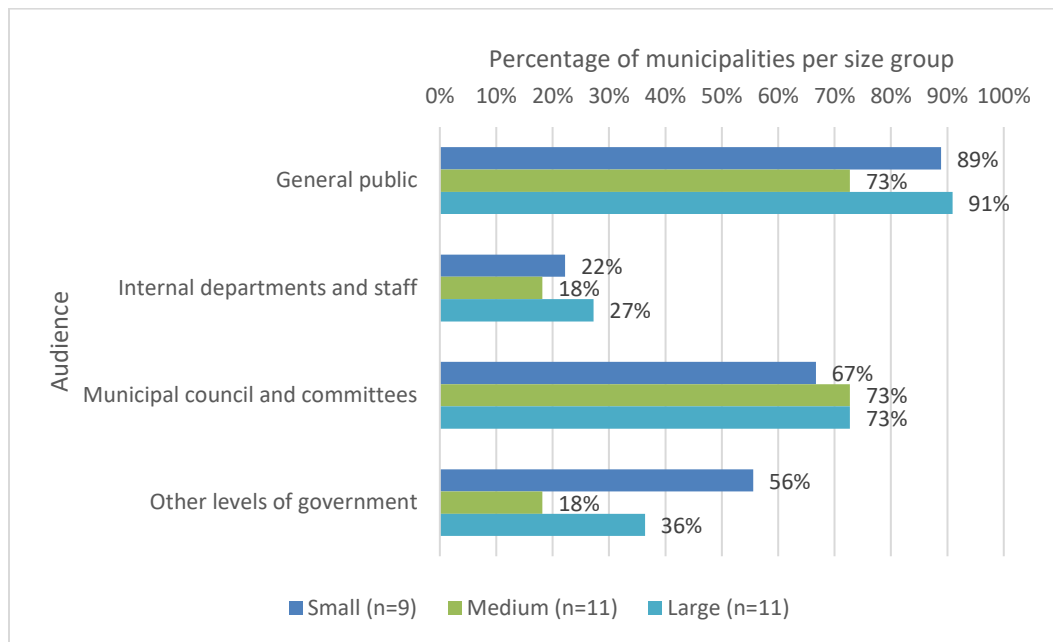


Figure 3-11. Percentage of municipalities reporting by audience type across size groups

Municipalities across all three size groups disseminate sustainability and climate-related information through report form (i.e., PDF document), as seen in Figure 3-12. Over half of the municipalities in the small and large-sized groups use a provincial reporting framework, with about one third of medium municipalities using this format. Many of the municipalities report through CDP Cities, with over 50% of the large-sized municipalities using this format. Slightly less than 50% of the medium-sized municipalities report through CDP Cities, whereas only 11% of the small-sized municipalities report this way. Nearly one third of large municipalities use a reporting dashboard, whereas only one medium municipality uses one. None of the small municipalities use a reporting dashboard. One municipality from each size group reports using a report card format.

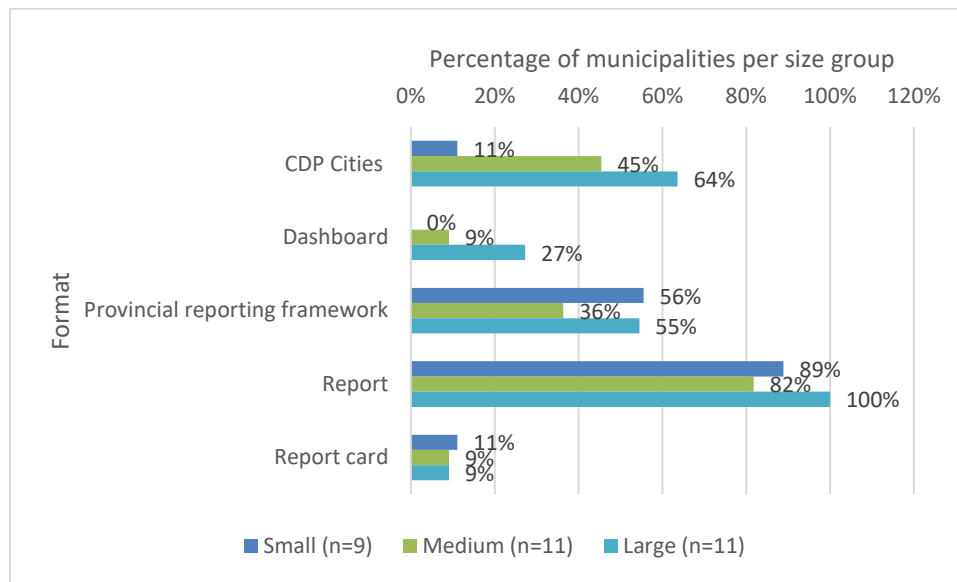


Figure 3-12. Percentage of municipalities reporting by format type across size groups

3.5 Discussion

This study examined the performance measurement practices of 31 Canadian municipalities using a contingency theory framing to answer our research question: How do the sustainability and climate-related performance measurement practices small, medium, and large Canadian municipalities compare? The results of this study indicate that the contingent factor of population size influences at least one aspect of each step of the performance measurement process. While population size should be taken into consideration if a standardized framework is developed for local governments, enough similarities were found across each size group that could lead to a streamlined process that can be adopted by all Canadian municipalities, regardless of size. In other words, all 31 municipalities were following a performance measurement process, even though the extensiveness of this process varied by size-group.

Past research has highlighted the importance of environmental and social indicator themes (Pham et al., 2020), and some authors have identified a lack of coverage for climate action and energy conservation (Merino-Saum et al., 2020; Park & Krause, 2021). According to our results, population size appears to influence the number of measurement focus areas, and to a lesser extent, the number of indicator themes covered by the sample municipalities. Overall, there appears to be less emphasis on areas related to social themes such as education, EDI, and health when compared to environmental themes. This could indicate that the social dimension of sustainability may not be sufficiently emphasized within the climate-related context, with the small- and medium-sized municipalities having lower representation than large municipalities. Given the sample selection method for this study, participating municipalities were chosen because they exhibit a commitment to climate mitigation and a level of engagement with performance measurement practices related to sustainable development and climate action. Therefore, it is not surprising that they have prioritized different sustainability themes and that there is a high level of prioritization when it comes to climate change.

Selecting indicators is fundamental for measuring performance. Literature on the topic has offered a variety of criteria that can be considered when selecting indicators (Maclaren, 1996b; Tanguay et al., 2010). While most municipalities in our study have informal selection criteria that they follow, the breadth of criteria mentioned by participants is quite narrow. Specifically, the focus is on selecting indicators that are comparable to

targets, reliant on quality data that is readily available, and relevant within the local context. These criteria connect with the literature, highlighting the importance of context, alignment with existing systems, and data availability (Merino-Saum et al., 2020; Van Dooren et al., 2010). The medium and large municipalities have on average a higher level of selection criteria when compared to the small municipalities, which could signal that population size may influence the comprehensiveness of the indicator selection process.

When considering the level of involvement of internal and external stakeholders in the indicator selection process, the results showed a surprising consistency in responses across all three size groups. In other words, there did not appear to be any variation based on population size. It is important to note that the interview questions and responses did not address the number of stakeholders consulted nor the specifics of the engagement process. While the results did show that greater than 50% of the sample municipalities involve internal and external stakeholders in the process, there is significant room for improvement given the importance of stakeholder engagement mentioned in the literature (Bekier & Parisi, 2023; Bouckaert & Halligan, 2008; Merino-Saum et al., 2020).

Although research on the types of data used by local governments to measure sustainability and climate-related performance is scarce, there is a common understanding that reliable and readily available data are core to performance measurement (Merino-Saum et al., 2020; Tanguay et al., 2010). As noted in the literature, while there are benefits to internal operational data (Ruff & Olsen, 2018), other sources of data are necessary to measure progress on sustainable development and climate action (Klopp & Petretta, 2017;

Wei et al., 2022). Our results show that the municipalities included in our study rely on multiple sources of data, with internal operational data being the most common. Large municipalities use third-party data to a much greater extent than the small and medium municipalities. From a contingency perspective, the type of data obtained appears to be influenced by size, with large municipalities making use of various data types.. AI-generated data are the least common source for municipalities of all sizes, with the smaller ones not yet using it. Although AI is still in its infancy when it comes to wide-spread adoption, local government could benefit from its use to help address the data deficiency that makes measurement more challenging (Alexopoulos et al., 2019; Diaz-Sarachaga et al., 2018). However, the implementation of AI as a tool to support the performance measurement process through improved data collection raises questions that require ethical considerations and stakeholder engagement (Sousa et al., 2019).

Data are transformed into information used for decision-making through the interpretation process that Van Dooren et al. (2010, p.73) categorize according to three strategies: “norm and target setting,” “breakouts,” and “causal analysis.” Municipalities in our study are widely using the first two strategies, but they are rarely using causal analysis. The “norm and target setting” strategy is largely applied by the sample municipalities to examine how performance is changing over time and how it compares to other jurisdictions. Interestingly, while nearly all the small and large municipalities analyze using a time dimension, only about half of the medium municipalities do. Whereas the medium-sized group is leading in percentage of municipalities that mentioned the use of scientific standards

for their analysis. All three size groups have about the same percentage of municipalities that compare their performance with other jurisdictions, and all municipalities in this study use a breakout strategy, namely through GEIs. While this finding aligns with the study by Tanguay et al. (2010) that identify GHG emissions in tonnes of CO₂e per year as a common indicator, it could be the result of our sampling bias. Taking all this into consideration, there does not appear to be any size influence connected to the data interpretation techniques used by the municipalities included in this study. Therefore, an opportunity exists to develop a standardized approach to interpreting data, regardless of the population size of the municipality. Given the responsibility that municipalities have to provide services related to sustainable development, and the importance of accountability, sustainability and climate-related reporting is essential to inform stakeholders and decision-makers (León-Silva et al., 2020). Municipalities of all sizes are reporting; however, the frequency, audience, and format does vary across the sample, with some evidence of the influence of population size. In relation to the intended audiences for reporting, results show very little size influence since the percentage of municipalities per size group for each of the audience types is roughly the same. The only outlier is when considering other levels of government as the audience. The small size group has the highest percentage of municipalities reporting to other levels of government, followed by large, then medium municipalities. This may be a matter of the province that the municipalities belong to rather than a matter of size as a contingent factor. Indeed, population size is just one of many factors that can be used to analyze the sustainability and climate-related reporting of municipalities (Giacomini et al., 2018; Marcuccio & Steccolini, 2009).

One area of reporting where size appears to have some influence is when it comes to frequency. Nearly all municipalities report regularly, with larger municipalities reporting more frequently and to a broader audience. More than half of municipalities report annually. Smaller municipalities tend to report less frequently. These findings reinforce the assumption that greater the size, greater the disclosure level (Adams, 2002). This aligns with a study by Giacomini et al. (2018) that found that sustainability reporting appears to be more common for large municipalities. The practice of reporting through the CDP Cities initiative is also more common amongst the medium- and large-sized groups according to our results. Our research aligns and extends existing literature in this field, as presented in Table 3-3.

Table 3-3. Comparison of literature review and empirical findings based on the performance measurement process defined by Van Dooren et al. (2010)

Performance measurement step	Literature review findings	Empirical evidence	Contribution
Prioritizing	Municipalities can prioritize a wide range of sustainable development themes. Measurement areas can be narrow in scope or include a broad coverage of themes and sub-themes.	Themes related to climate action have a high-level of coverage. There is less emphasis on social and governance themes. Population size appears to impact the number of themes prioritized for measurement.	Extend
Selecting indicators	Indicators can be selected by municipalities using selection criteria to ensure that measurement captures change in performance, is relevant to decision makers, and aligns with internal systems and available data sources. Stakeholders should inform the indicator selection process.	The breadth of indicator selection criteria informally applied is low. Larger municipalities have a higher number of indicator selection criteria in comparison to small municipalities. There is no apparent impact based on population size when considering the involvement of stakeholders in the indicator selection process.	Align/extend

Obtaining data	Municipalities can collect data from different sources with internal operational data being the most cost-effective source. The performance measurement process can also utilize external data from other levels of government. AI could improve access to data.	Municipalities rely on multiple sources of data; population size appears to have minimal impact on the number of sources. Internal operational data are the most common source. AI is scarcely used for data collection.	Align/extend
Interpreting data	Municipalities should match strategic objectives to performance measurement. GHG emissions data are useful for data analysis. Causal analysis depends on multiple data sources and is useful to capture causal relationships.	Municipalities commonly use strategies that measure performance over time and against targets. GHG emissions data are widely used for analysis. Causal analysis is seldom used. Overall, there is no apparent relationship with size when considering the type of analysis strategy applied.	Align/extend
Reporting	Reporting is an accountability tool that municipalities can use to share information with stakeholder groups. A 'one-size-fits-all' approach to reporting may not be possible for local governments.	Nearly all municipalities studied are reporting, with more than half of them doing so annually. There is limited relationship with size when considering the format and audience, whereas the frequency of reporting shows that larger municipalities report more frequently.	Align/extend

3.6 Conclusion

This study set out to better understand the performance measurement practices of select Canadian municipalities and to determine if population size influences the process. The five steps outlined by Van Dooren et al. (2010) of the ideal performance measurement process served as a useful framework to analyze the data we collected through interviews and supplementary documents (e.g., sustainability and climate-related plans and reports) from participating municipalities. This framing offers both academic and practical contributions.

From an academic perspective, this study provides a deeper understanding of sustainability and climate-related performance measurement practices of Canadian municipalities. By including sub-categories for each step of the performance measurement

process defined by Van Dooren et al. (2010), we and provide replicable research methods for scholars seeking to investigate this topic within a different local context. Additionally, this study contributes to literature on contingency theory using population to analyze the influence of size on the performance measurement process.

Municipalities interested in assessing their own performance measurement process can draw from the methods and results of this study. Furthermore, they can use the details from our findings to address gaps in their practices through the inclusion of new indicator selection criteria or data sources. For example, the use of AI for performance measurement is an emerging trend that can benefit public organizations, but research suggests that it needs to be explored with input from municipal stakeholders in relation to the type of data that should be collected.

This study is not without its limitations. This research cannot extrapolate beyond the region of the study, nor can the findings be generalized across all Canadian municipalities. For example, the scope of this research is focused on the Canadian context by examining a select sample of municipalities. This leaves room for future research to explore the performance measurement process of local governments across a wider range of Canadian municipalities and in different countries and regions.

While the standardization of a performance measurement is a worthwhile goal, it should not be approached without considering the broadly recognized view that organizational systems cannot be evenly applied across contexts (Giacomini et al., 2018; Marcuccio & Steccolini, 2009; Otley, 1999). The scope of this paper is limited to examining

population size as a contingent factor, highlighting the need for further research that adopts a contingency theory lens. Further, the qualitative nature of this study limits the ability to hypothesize and test contingent factors. Future research can work to address these gaps by examining a larger sample size and additional contingent factors. Contributions to contingency theory can also be made by looking at specific stages of the performance measurement process in isolation (i.e., selecting indicators, reporting).

Canadian municipalities are responsible for making a meaningful contribution to progress towards Canada achieving the Paris Agreement. Given Canada's commitment to the ambitious net-zero emissions by 2050 target, there is much work to be done. Improved performance measurement practices can help support the achievement of climate commitments through more informed decision-making and enhanced accountability.

- End of Paper 2 -

Chapter 4 – Paper 3

Title: Selecting climate mitigation indicators to measure municipal progress towards net-zero

Abstract: Over half of the global population lives in urban areas, a number expected to reach nearly 70% by 2050. Urbanized areas are responsible for 70% of global greenhouse gas (GHG) emissions and 75% of energy consumption. In response, local governments are setting GHG emissions reduction targets and developing climate action plans. The extent of implementation and effectiveness of these plans remains uncertain, as standardized measurement frameworks are scarce. This study examines the indicator sets used by Canadian municipalities to explore which climate mitigation indicators are currently employed and which are most suitable for measuring local performance. We conducted a document analysis to identify climate-related indicators used by Canadian municipalities. The study analyzed the indicators using the logic model framework and predefined local GHG emissions activity sectors. An indicator evaluation matrix was then used to propose a parsimonious list of climate mitigation indicators, with the Delphi technique employed to reach consensus. Results from this study show that while there is representation across most of the logic model, the distribution is uneven, with only one impact indicator identified. By categorizing indicators by activity sector, our results also show the emergence of nature-based solutions as a newer area of climate mitigation in municipalities. Our analysis of climate-related indicators used by Canadian municipalities led to a set of 19 new indicators across various GHG emissions activity sectors, including buildings, energy, transportation, and waste. These indicators aim to help municipalities move beyond GHG emissions inventories and effectively track progress toward climate targets.

Keywords: Indicator selection, logic model, GHG emissions, local government, Canada, nature-based solutions

4.1 Introduction

Over half of the planet's population currently live in urbanized areas, with estimates that the number will increase to nearly 70% by 2050 (UN DESA, 2019). Currently, urban areas are responsible for approximately 70% of global greenhouse gas (GHG) emissions and 75% of global energy consumption (International Energy Agency, 2021). Local governments of all sizes around the globe are increasingly taking action to address climate change, aligning with the Paris Agreement by setting emissions reduction targets and developing climate action plans (Bertoldi et al., 2018; Roggero et al., 2023). The full extent of implementation and performance on these plans remains unclear, as few standardized measurement and monitoring systems are in place, and public reporting is often lacking (Feor, Murray, et al., 2023; S. Jones, 2019; Linton et al., 2021; Rivas et al., 2022). The scarcity of standardization leads to cities applying different methodologies when calculating their GHG emissions inventory (GEI) (Mia et al., 2019), which is a core data source for measuring climate-related performance (Mondal et al., 2024). Indeed, a number of city-level GEI frameworks exist, with the vast majority derived from the Intergovernmental Panel on Climate Change (IPCC) GHG inventory guidelines (Arioli et al., 2020; IPCC, 2006). Even with the availability of commonly used methodologies, such as the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) (C40 Cities Climate Leadership Group et al., 2014), data limitations remain an issue when measuring local GHG emissions (Li et al., 2017). As does the time lag between when the emissions occur and when they are calculated and disclosed on (Mia et al., 2019). Thus, measuring climate mitigation

efforts (e.g., reduction of GHG emissions), remains a challenge for local governments globally.

Canada's municipal landscape is extensive with about 5,000 municipalities ranging from remote rural communities to large urban centers, which now represent approximately 75% of the country's population (Statistics Canada, 2017a, 2025). In Canada, municipalities play a crucial role in addressing climate change and achieving the nation's Paris Agreement commitments (Environment and Climate Change Canada, 2021; Torrie, 2015).

Municipalities influence approximately 50% of Canada's GHG emissions by improving energy efficiency, increasing urban densification, and promoting a shift in transportation modes (Torrie, 2015). They have direct control over GHG emitted by the local government itself (e.g., municipal buildings, public transportation, etc.) and indirect control community-wide emissions that occur within the municipal boundaries (A. Clarke & Ordonez-Ponce, 2017). Meeting the necessary global 1.5°C temperature limit increase by 2100 requires significant GHG emissions reductions in the short and medium term (IPCC, 2018, 2021).

Local governments are increasingly developing corporate and community climate mitigation plans with monitoring and evaluation measures (Feor, Murray, et al., 2023; MacDonald et al., 2024). However, like at the international level, standardized systems are lacking for municipalities in Canada (Guyadeen et al., 2019).

According to a recent survey of 256 Canadian municipalities by MacDonald et al., (2024), roughly 25% of them have committed to achieving net-zero emissions by 2050 or sooner. These commitments are largely based on a production-based method of accounting

for GHG emissions. In other words, direct emissions (Scope 1) and indirect energy production emissions (Scope 2) are the main sources of GHG emissions quantified in inventories (Neveroff, 2023). While net-zero emissions can be achieved at the local level, it requires municipalities to significantly reduce emissions from their internal operations and across activity sectors within their municipal boundaries (IPCC, 2022). This process involves the reduction of emissions from key activity sectors (e.g., buildings, transportation, waste, etc.), a transition to renewable energy sources, and the preservation of carbon sinks like forests and wetlands (IPCC, 2022; MacDonald et al., 2024; Verma et al., 2023).

The Partners for Climate Protection (PCP) program offers Canadian municipalities support to help them reduce GHG emissions (FCM & ICLEI Canada, 2024). This initiative led by ICLEI—Local Governments for Sustainability Canada (ICLEI Canada) and the Federation of Canadian Municipalities (FCM) freely provides access to resources including the five-step milestone framework that guides municipalities through creating a GEI, setting reduction targets, climate action planning, monitoring progress, and reporting results (FCM & ICLEI Canada, 2024). The PCP program aligns with the Cities for Climate Protection Protocol, a global initiative established in the 1990's by a network of local governments that collectively emit 10% of global GHG emissions (Betsill & Bulkeley, 2004; FCM & ICLEI Canada, 2021). In 2024, there were over 500 PCP member municipalities, representing approximately 70% of Canada's population (FCM & ICLEI Canada, 2024).

In its current state, the PCP tool is limited to quantifying the level of emissions across different activity sectors at a point in time (FCM & ICLEI Canada, 2021; Mi et al., 2019).

Municipalities can inventory their GHG emissions at the corporate- or community-scale (FCM & ICLEI Canada, 2024). The corporate GEI includes emissions generated by the municipalities operations such as building and facilities, fleet vehicles, and solid waste (A. Clarke & Ordonez-Ponce, 2017). Whereas the community GEI captures emissions occurring within the municipality's geographic boundaries, including corporate GHG emissions (A. Clarke & Ordonez-Ponce, 2017). These emissions are from a wider range of sources including residential, commercial and industrial consumption, transportation, and agriculture (FCM & ICLEI Canada, 2021).

Although PCP provides municipalities with a useful tool to develop and monitor a municipal climate plan, standardized measurement and reporting guidelines are limited to the quantification of emissions from corporate and community activity sectors only (FCM & ICLEI Canada, 2024). Further, in its current form, there is no mechanism to report on sequestration related to carbon sinks (e.g., conservation of forests and wetlands), which are part of the agriculture, forestry, and other land-use (AFOLU) sector (FCM & ICLEI Canada, 2021). Alongside these challenges remain issues related to the availability of data for calculating GHG emissions at the local level and the timeliness of disclosures (Li et al., 2017; Mia et al., 2019).

Indicators are essential for evaluating climate action and supporting decision-making at the local level (Goonesekera & Olazabal, 2022; Maclaren, 1996b). Further, by classifying them through a logic model framework, indicators can effectively measure progress across the various stages of the net-zero GHG emissions transition, capturing the entire causal chain from inputs to impacts (Barnett et al., 2020; Hale et al., 2021; Millar et al., 2001).

The use of indicators to measure progress in the public sector has grown since the turn of the century (Kitchin et al., 2015), and the logic model has long been used to evaluate the impact of programs (Ebrahim, 2019). Additionally, there is an increasing amount of literature on indicator selection and frameworks to measure progress towards sustainability within local governments (Caldas et al., 2020; Merino-Saum et al., 2020; Moreno Pires & Fidélis, 2015; Tanguay et al., 2010). While research on indicator selection to measure climate mitigation performance at the local level is starting to emerge (Mondal et al., 2024; Purcel & Croitoru, 2025), it is still scarce. Many local climate mitigation studies to date have focused more broadly on governance, the quality of plans, and the extent to which plans are reported on (Feor, Murray, et al., 2023; Guyadeen et al., 2019; Linton et al., 2022; Robinson & Gore, 2015).

This study fills this gap by conducting an empirical study on the indicator sets currently in use by a sample of municipalities that are members of the PCP program. The following question is used to guide our research: What types of indicators are currently in use by Canadian municipalities, and which indicators are most suitable to measure local climate mitigation performance?

Through our research, we develop a parsimonious list of climate mitigation indicators for Canadian municipalities that can complement the PCP tool. The indicator selection process was guided the Maclaren (1996a) framework used to develop a Canadian urban sustainability indicator set. This paper begins in Section 4.2 with an overview of climate mitigation performance and indicators. Section 4.3 outlines the methodological approach

used in the study. The results are presented in Section 4.4, followed by a discussion in Section 4.5 and a conclusion in Section 4.6.

4.2 Background

4.2.1 The role and importance of indicators

Despite growing academic interest, challenges remain in developing measurement tools that integrates the multi-dimensional nature of sustainability while recognizing thresholds-of-effect, discouraging trade-offs, and including public participation to ensure representation of local context (Bond et al., 2012; R. B. Gibson, 2006; Shaker & Mackay, 2021). Indicators are key tools for evaluating and guiding sustainability and climate-related efforts at different scales (Goonesekera & Olazabal, 2022; Klostermann et al., 2018; Purcel & Croitoru, 2025; Wilson et al., 2013). They help to provide a simplified representation of complex issues, which is crucial for decision-making at both local and regional levels (Maclaren, 1996b). Indicators are also valuable for analyzing, communicating, and quantifying complex information (Kitchin et al., 2015; Singh et al., 2012).

Indicators are distinct from data, and there are different types of indicators depending on the measurement objectives of the organization (Tanguay et al., 2010). One way to frame indicators is to classify them according to the logic model which captures the causal chain from input to impact, providing a more comprehensive evaluation (Ebrahim, 2019; Purcel & Croitoru, 2025). See Table 4-1 for a synthesis of definitions for each indicator type included in the logic model.

Table 4-1. Descriptions and examples of indicator types (D. Clarke, 2021; Ebrahim, 2019; Goonesekera & Olazabal, 2022; Huovila et al., 2019); author synthesis.

Indicator type (time horizon)	Description	Examples
Input (short-term)	Input indicators measure the resources used to carry out the activities required to achieve climate action targets and goals.	• Funds • Staff hours • Stakeholder contributions • Materials and supplies
Activity (short-term)	Activity indicators, also referred to as process indicators, measure whether a planned action occurred.	• Climate plan development • Completion of the GHG emissions inventory
Output (short-term)	Output indicators measure the short-term achievement of planned activities at a point in time.	• Annual GHG emissions measurement • Acres of land restored • Number of trees planted
Outcome (medium-term)	Outcome indicators measure the effect of a planned activity on an environmental, economic, or social system. .	• Reduction in GHG emissions • Increase in tree canopy coverage • Increase in percentage of greenspace
Impact (long-term)	Impact indicators capture changes that occur because of interventions. They measure the environmental, social, and economic state in relation to set targets and goals.	• Sustained reduction in GHG emissions • Percentage of achievement to net-zero GHG emissions

The logic model concept has been used as a tool for over half a century to evaluate and measure the impact of programs (Ebrahim, 2019). Logic models are frameworks that outline causal chains, explaining how specific inputs and activities lead to desired outcomes and impacts by influencing people or problems through a series of controlled actions (Millar et al., 2001). For decision-makers seeking to evaluate the key stages of the transition to net-

zero GHG emissions, indicators should measure the entire causal chain (Hale et al., 2021). Therefore, the logic model concept offers a useful framing for classifying indicators (Ebrahim & Rangan, 2010; Feor, Clarke, et al., 2023). Empirical evidence shows a level of consensus by identifying output indicators as the most common typology (Goonesekera & Olazabal, 2022; Hale et al., 2021; Huovila et al., 2019). While Seyisi et al. (2023) also found that output indicators outnumbered the other types; the indicators were more evenly distributed across the causal chain. Thus, indicators used to measure the transition towards net-zero GHG emissions should capture the entire causal chain, or at the very least the output, outcome, and impact.

4.2.2 Indicator selection criteria

Selecting indicators is recognized as a crucial step of the performance measurement process in the public sector (Van Dooren et al., 2010). Considering the interconnection of sustainability and climate change, along with the necessity for context-specific priorities, selecting indicators requires engagement with municipal staff and key stakeholders (Bekier & Parisi, 2023; Bouckaert & Halligan, 2008). Effective indicators should capture change and be easily understood by potential users (Maclaren, 1996b). They must also reflect the local context, enable timely decision-making, and align with existing data collection systems (Niemeijer & de Groot, 2008; Tanguay et al., 2010; Van Dooren et al., 2010). To make progress on measuring climate action across Canadian municipalities, indicators should rely on accessible data, be widely adopted, and support decision-making (Goonesekera & Olazabal, 2022; Tanguay et al., 2010). Additionally, indicators should be theoretically sound

and scientifically valid in relation to the targets and goals they seek to measure progress on (Maclaren, 1996a).

4.2.3 Climate mitigation performance measurement

Measuring climate mitigation performance at the local level is essential for municipalities to contribute to national and global progress toward net-zero GHG emissions, in line with the targets of the Paris Agreement (Mondal et al., 2024). Scientists stress the need for substantial reductions in greenhouse GHG emissions to keep global temperature rise below the 1.5°C limit by 2100 (IPCC, 2021; Xu & Ramanathan, 2017). Achieving the Paris Agreement's targets will require action and accountability from multiple actors across various scales, including local governments (Chan et al., 2019). Local governments play a significant role in implementing mitigation efforts, particularly through decarbonization, which includes increasing energy efficiency and reducing reliance on fossil fuels (Broto, 2017; Burch, 2018; Linton et al., 2022). As such, selecting appropriate indicators to measure local climate mitigation performance is a priority, ensuring that municipalities can effectively track their progress and contribute meaningfully to broader climate goals.

Indicators are used to simplify the measurement of complex phenomena (Maclaren, 1996b). Building on this understanding, we define a climate mitigation indicator as a measure used to capture the change in status of performance connected either directly or indirectly to GHG emission sources and sinks (Filonchyk et al., 2024; Linton et al., 2022; MacDonald et al., 2024). For this study, climate mitigation indicators align with the main activity sectors defined by MacDonald et al., (2024), including buildings, energy,

transportation, agriculture, land-use, industrial processes, waste, and natural infrastructure.

See Figure 4-1.

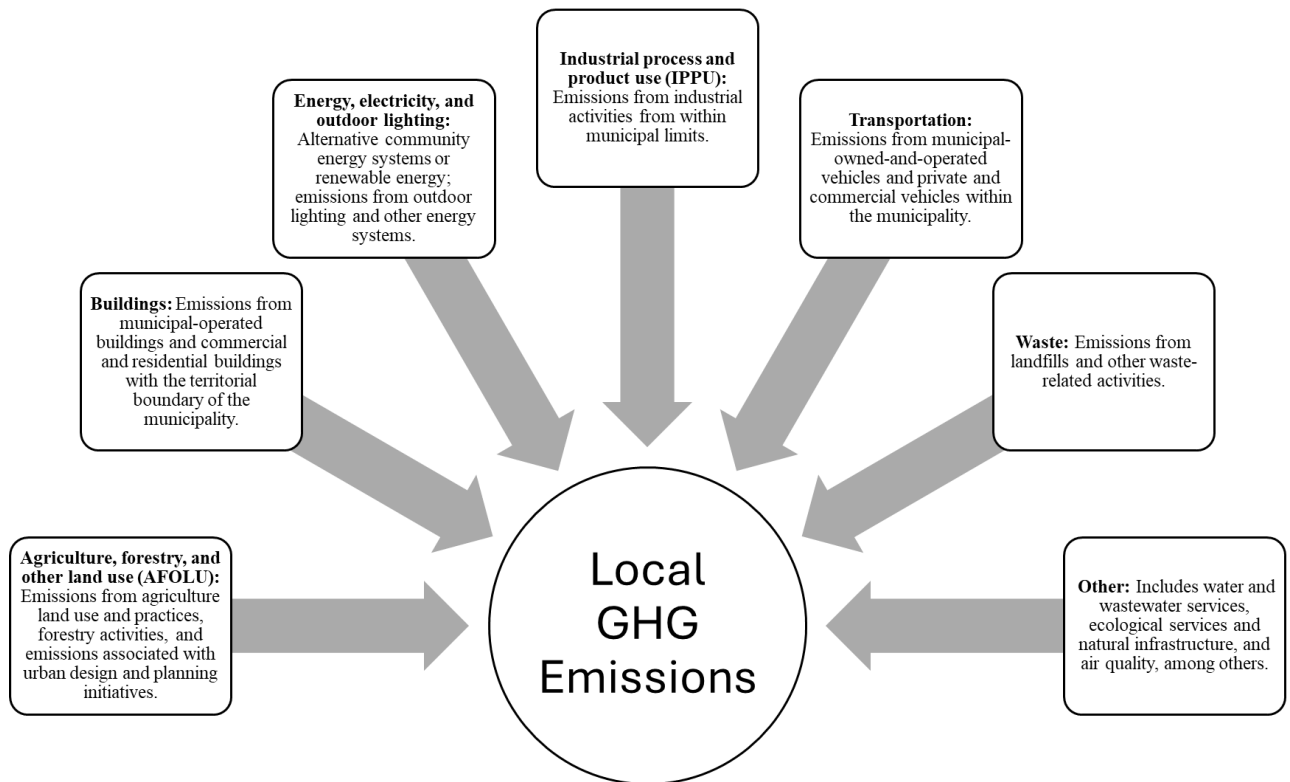


Figure 4-1. Activity sectors in Canadian municipalities that contribute to local GHG emissions. Text quoted from MacDonald et al, 2024, p. 24; figure is original

Developing high-quality indicators improves the accuracy and effectiveness of climate tracking, helping cities adjust strategies and maintain progress (Jones, 2019). Naturally, GHG emissions in tonnes of CO₂e per year would appear as a common output indicator for cities, which relies on accurate GHG inventories (Tanguay et al., 2010). Despite this common occurrence, local governments go beyond GHG emissions indicators, particularly when using a bottom-up approach to measuring local climate action (Mondal et al., 2024). This is in part due to the complexity of global climate change and the time lag

between strategy implementation and measurable outcomes (Mondal et al., 2024; Underdal, 2010).

According to a survey conducted by the Municipal Net-Zero Action Research Partnership (N-ZAP) that examined the state of climate action in Canadian municipalities, buildings, energy, transportation, and waste are the most prioritized activity sectors where local interventions occur (MacDonald et al., 2024). While agriculture, forestry, and other land use, along with industrial processes, have less representation. This is likely due to the level of influence that local governments have over these specific sectors (A. Clarke & Ordonez-Ponce, 2017). GHG emission sources from buildings, energy, transportation, and waste are all represented in the GEI reporting requirements for PCP member municipalities (FCM & ICLEI Canada, 2021). While agriculture and industrial processes are also present, only emissions related to stationary fuel combustion and purchased electricity and energy are required. There are no reporting requirements for emissions from the agriculture sector, instead, methane emissions from enteric fermentation and manure management are listed as optional. There are no reporting requirements for forestry and land-use emissions and sinks (FCM & ICLEI Canada, 2021).

Against this theoretical and practical backdrop, this study aims to deepen our understanding of the climate mitigation indicators currently in use within a Canadian context. Additionally, it seeks to propose a refined shortlist of new indicators that Canadian municipalities can use to supplement the PCP tool. The next section details the methodological approach employed in this paper.

4.3 Methodological approach

This study used document analysis to identify climate-related performance indicators currently employed by sample municipalities at the local level (Goonesekera & Olazabal, 2022; Merino-Saum et al., 2020). We followed a series of steps adapted from Goonesekera and Olazabal (2022) and Huovila et al. (2019) to identify climate mitigation indicators that are currently in use by select Canadian municipalities and to provide a parsimonious list of proposed indicators that are most suitable to measure local climate mitigation performance. Our methodological approach is presented in Figure 4-2, with further detail provided in the text following.

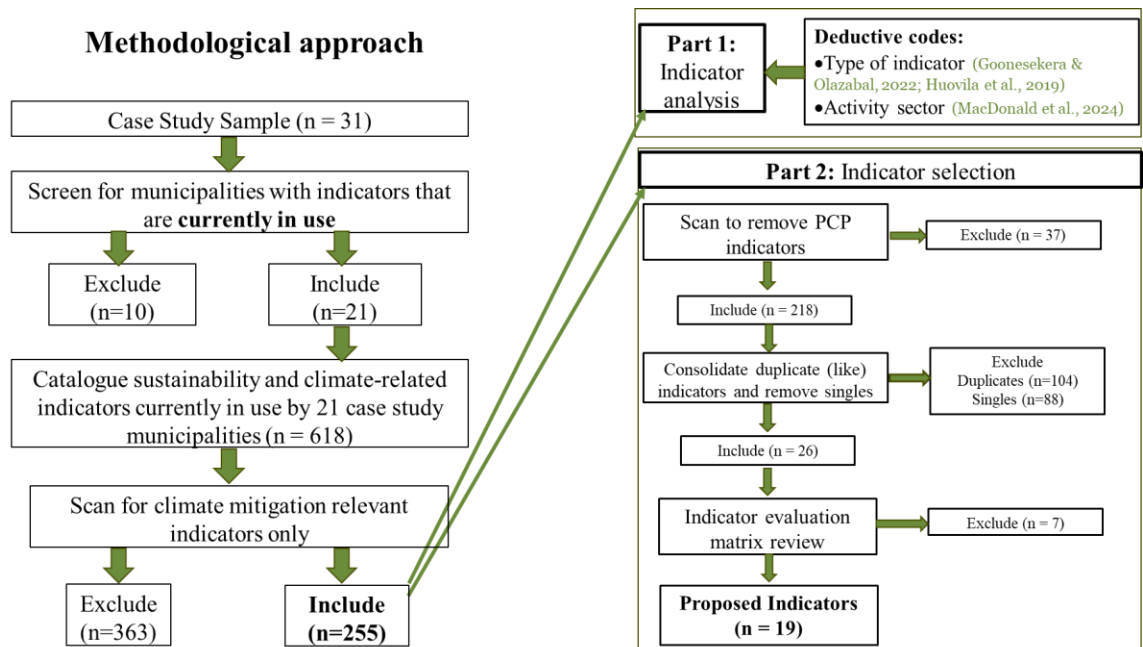


Figure 4-2. Outline of the methodological approach

We employed the Delphi technique, a process used to gather expert opinions on a specific matter, to build consensus at different stages of the methodological process including

during the initial screening and the indicators selection process (Frare et al., 2020; Yousuf, 2007). We engaged members of working group 2 (WG 2) from N-ZAP as the experts⁶. We met four times per year between December 2022 – February 2025. Input was gathered via in-person and online meetings, by email communications, and through an online questionnaire.

4.3.1 Study area and sample selection

The municipalities in this study were selected as part of a larger research project aimed at ensuring diverse representation across Canadian municipalities that are members of the PCP program and have achieved at least the first milestone (FCM & ICLEI Canada, 2024). A purposeful sampling strategy (Patton, 1990) was employed to capture the heterogeneity of the population (Maxwell, 2012; Yin, 2018). The sample was drawn from the 297 PCP program members who had completed a GHG emissions inventory at the corporate or community level as of June 2023.

The municipalities were then organized by size (139 small, 128 medium, and 30 large) and analyzed based on the availability of publicly accessible climate-related and/or sustainability indicators. This process narrowed the sample to 128 municipalities (27 small, 79 medium, and 22 large). The recruitment aimed for 12 municipalities per size group, ensuring diversity in terms of language (English and French), provincial and territorial representation, urban and rural locations, and municipal types (cities, towns, regions, etc.). A total of 54 municipalities were contacted, and 31 agreed to participate, yielding a response rate of 57%. Of the 43% of municipalities that did not participate in the study, some did not

⁶ <https://uwaterloo.ca/implementing-sustainable-community-plans/working-group-2>

respond to email requests, others lacked capacity, and a few felt they had no relevant information based on the interview questions. The final sample includes municipalities from all provinces, though municipalities from the territories were not successfully recruited.

4.3.2 Data collection

Primary data were collected through interviews and supplementary documents from participants and municipal websites. Interview questions were developed with input from experts, academics, and literature (Searcy, 2012; Tanguay et al., 2010; Van Dooren et al., 2010). Virtual interviews were conducted via Zoom between November 2023 and March 2024 with municipal staff responsible for measuring sustainability and climate-related performance. The indicator sets were obtained directly from supplementary documents that were provided by the study participants following their interview. During each interview, participants were asked the following question: “Would you be open to sharing your sustainability and climate change indicators with me after this interview?”. Emails were sent to thank all participants following each interview with an additional request for them to share any indicators that are currently in use by their municipality. The supplementary documents gathered through these requests were analyzed to screen for indicators that are currently in use by the participating municipalities. Indicator sets labelled as “suggested”, “recommended”, or “potential” were removed from the sample, thus leaving 21 municipalities with indicators sets in use. A total of 618 individual indicators were catalogued from documents and links provided by the 21 sample municipalities.

In addition to documenting the name of the indicator, this study also catalogued the goal/target/thematic area the indicator is connected to, any description of the indicator that is provided, and the source of the data used to compute the indicator. Indicator sets were subsequently analyzed and screened to include indicators relevant to climate mitigation only. To enhance the reliability of the analysis, we sought input from N-ZAP WG2 members and applied a multiple reviewer screening approach (Goonesekera & Olazabal, 2022). The screening process included five steps that involved independent scans and consensus meetings by three reviewers. The key areas where consensus was not originally achieved include waste, water, transportation, and land-use. After screening out non-climate mitigation indicators, a total of 255 individual indicators remained, as shown in Figure 4-3.

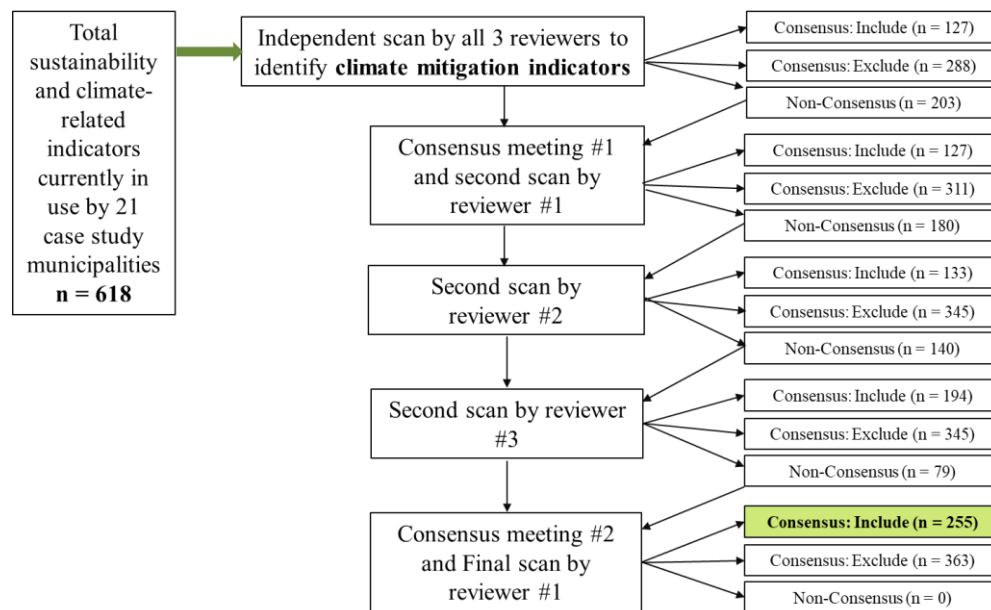


Figure 4-3. The multi-reviewer screening process to identify climate mitigation indicators for analysis.

4.3.3 Data analysis

4.3.3.1 Indicator analysis

Part 1 of the data analysis included manual deductive coding to determine the type of indicator according to the logic model framework (Goonesekera & Olazabal, 2022; Huovila et al., 2019) and to categorize the indicators by climate mitigation theme, namely the activity sectors described by MacDonald et al., (2024). A taxonomy was developed to classify the indicators included in the analysis, as seen in Figure 4-4. The coding results were analyzed to identify the most common indicators and present descriptive statistics about the indicators that are currently in use.

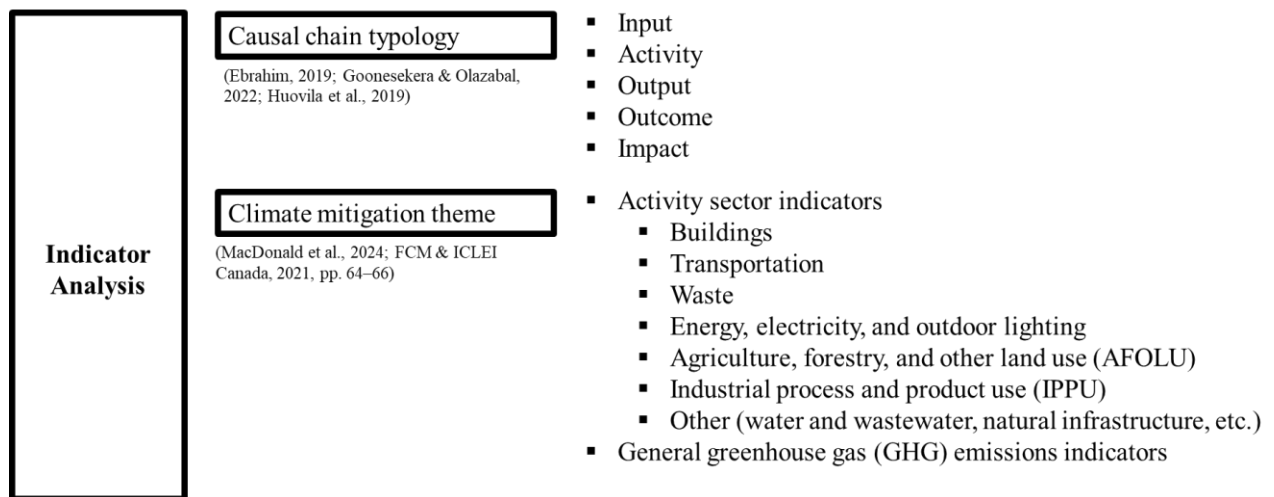


Figure 4-4. Taxonomy for indicator analysis

4.3.3.2 Indicator selection

With the aim of developing a parsimonious list of climate mitigation indicators that can be used by Canadian municipalities, the second part of the analysis included a series of steps that involved removing indicators that are already part of the Partners for Climate Protection (PCP) tool (FCM & ICLEI Canada, 2021, pp. 64–66) and by manually

consolidating indicators inductively using the Gioia method of order analysis (Gioia et al., 2013). The final step of the selection process used an indicator evaluation matrix adapted from Maclaren (1996a). The selection criteria included in the indicator evaluation method were based on literature (Maclaren, 1996a, 1996b; Tanguay et al., 2010) and Delphi technique (Yousuf, 2007) input from WG 2. Table 4-2 defines the selection criteria used in this study. The criteria related to theoretical soundness was applied during the early stages of the indicator screening process, which identified the 255 climate mitigation indicators.

Table 4-2. Definitions of general criteria used to select indicators. Sources: (Maclaren, 1996a, 1996b; Tanguay et al., 2010) and input from WG 2

General Criteria (GC)	Definition
Responsive	• Facilitates timely action by decision-makers • Useful for tracking progress and matching it with costs (cost/benefit analysis) • Responsive to local needs (local context)
Relevant to the needs of potential users	• Alignment with the broader community to facilitate “buy-in” • Alignment with data needs of stakeholders (for measuring their own goals) • Accessible to various stakeholder groups and educational backgrounds • Not all indicators will be useful to all stakeholders (focus on key users)
Relevant to stated goals	• Useful for tracking progress towards broader goals and vision (e.g., climate and net-zero goals) • Useful for comparing performance to others with shared goals • Promotes accountability (evidence of doing what was promised) • Aligns with work being done/planned by the municipality
Availability of quality data	• Data to measure the indicator currently exists • Dependent on data from other levels of government • Proxy data are likely still required since data availability is an ongoing challenge that requires improvement
Comparable to thresholds or targets	• Facilitates the tracking of progress • Useful for adjusting actions • Reflects local context

General Criteria (GC)	Definition
Comparable with other jurisdictions	• Used by more than one municipality • Allows senior managers and elected officials to compare performance against other municipalities • Common indicators allow for enhanced comparability • Allows for benchmark comparisons
Unambiguous	• Derived from unambiguous data and methods • Indicators that are ambiguous to certain users could be improved through communication strategies (not all indicators will be understood by all stakeholders)

4.4 Results

The results of this study are presented in two parts, each addressing one part of the research question posed. The first part provides an analysis of the 255 climate mitigation indicators used by Canadian municipalities, focusing on the local GHG emissions activity sectors and the types of indicators defined by the logic model framework. The second part of the results presents the indicator selection process and proposes a parsimonious list of indicators, highlighting those most suitable to measure local progress towards net-zero GHG emissions among the climate mitigation indicators currently used by select municipalities.

4.4.1 Indicator analysis

When analyzing all 255 climate mitigation indicators, the most common activity sectors represented include transportation and “other”, with 85 and 54 indicators per sector, respectively. Transportation indicators cover themes such as active transportation and public transportation that occur within the municipal boundaries. The “other” category captures a broader range of themes including air quality, natural infrastructure, and water conservation. Some of the climate mitigation indicators did not correspond to a specific activity sector but

were instead identified as general GHG. These accounted for 34 of the 255 indicators and included themes like GHG per capita, which uses GEI and census data. AFOLU and industrial processes and product use (IPPU) indicators are largely absent from the 255 climate mitigation indicators identified in this study. Table 4-3 presents examples of themes covered within each activity sector and the number of corresponding indicators.

Table 4-3. Examples of indicator themes covered by activity sector and number of corresponding climate mitigation indicators.

Activity sector	Examples of themes (3rd order coding)	Number of indicators (n=255)
AFOLU	Agricultural land, built environment	7
Buildings	Building efficiency, retrofits, natural gas	19
Energy and electricity	Electrification, energy consumption, renewable energy	22
IPPU	Emissions from industrial, commercial, and institutional sources	2
Transportation	Active transportation, electrification, public transportation, vehicle use	85
Waste	Waste diversion, waste to landfill	32
Other	Air quality, built environment, canopy coverage, natural infrastructure, water conservation	54
General GHG	Implementation of projects and programs, GHG emissions per capita	34

The climate mitigation indicators were also analyzed to examine the indicator type according to the logic model framing of input, activity, output, outcome, and impact, as described in Section 4.2 of this study. Output and outcome indicators are by far the most common type of indicators with some activity sectors consisting of only these types. For example, of the 19 indicators in the building category, 95% are considered output indicators

and 5% are considered outcome indicators. For the most part, output indicators are the dominant type across all activity sectors with the exception of AFOLU and other, where outcome indicators are the most common. Input and activity indicators do not represent a majority in any of the activity sectors. Only two indicators are categorized as impact indicators, both falling within the general GHG category. See Figure 4-5 for full details on climate mitigation indicators by type across each activity sector.

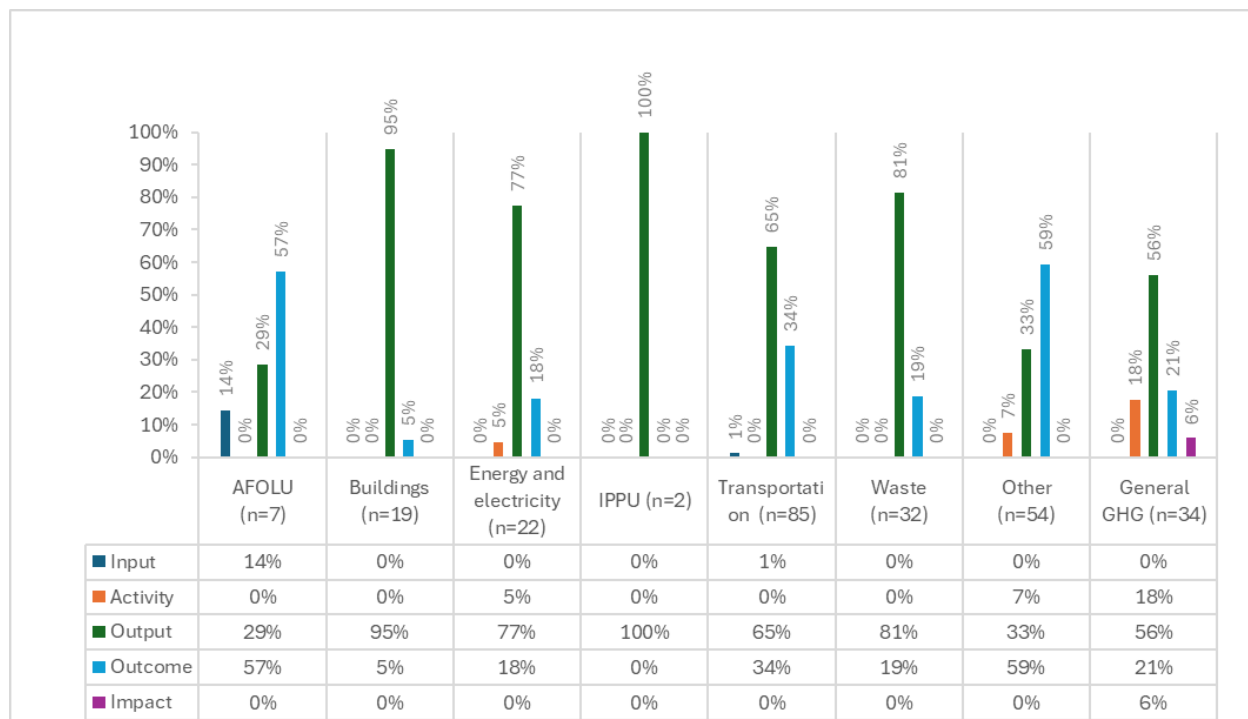


Figure 4-5. Climate mitigation indicators by type and activity sector (n=255)

4.4.2 Indicator selection

Following the analysis of the 255 climate mitigation indicators, a series of steps were followed to omit the PCP indicators already included in the tool and to identify a shortlist of indicators that are used by at least two Canadian municipalities.

4.4.2.1 Shortlist indicator analysis

Like the activity distribution found across the entire sample of 255 climate mitigation indicators, transportation and “other” are the most common sectors, with 11 and 7 indicators, respectively. Contrarily, no general GHG indicators made the shortlist. AFOLU and IPPU indicators are completely absent from the shortlist, likely due to their minimal presence in the larger sample of 255 climate mitigation indicators. Table 4-4 presents a list of the activity sectors represented in the shortlist along with corresponding indicators organized by output indicator (measuring the achievement of planned activities) and outcome indicator (measuring the effect of a planned activity on an environmental, economic, or social system).

Table 4-4. Shortlisted indicators by activity sector and type (output and outcome only)

Activity sector	Output indicator [number of municipalities using indicator]	Outcome indicator [number of municipalities using indicator]
Buildings	• Natural gas consumption per capita (m³/year/person) [2]	• N/A
Energy, electricity, and outdoor lighting	• Average yearly electricity consumption per capita (kWh/year/person) [2] • Annual renewable electricity generated per capita (kWh/year/person) [4] • Total installed renewable electricity generation capacity per capita (MW/year/person) [3]	• Savings achieved through the implementation of energy (efficiency) initiatives per capita (dollars/year/person) [2]
Transportation	• Total distance (km) of sidewalk, bike lanes and multi-use trails network per capita [5] • Number of electric vehicles (community scale) per capita [5] • Percentage of fleet vehicles and municipal equipment that are electric [2] • Use of EV chargers (hours charging, kWh consumed) per capita [2] • Number of EV charging stations per thousand people for public use [4]	• Percentage of residents commuting by active transportation and public transit [5] • Percentage of road network with a sidewalk [3] • Savings (\$ and/or GHG) achieved through electrification of the municipal fleet [2] • Percentage of households within 400 metres of a regular service public transit stop [2]

Activity sector	Output indicator [number of municipalities using indicator]	Outcome indicator [number of municipalities using indicator]
	• Vehicle kilometres travelled per capita (VKT km/year) [2] • Number of transit rides per capita [7]	
Waste	• Percentage of municipal residential waste diverted from landfill annually [12] • Quantity of residual material from the residential sector destined for landfill annually per capita (kg/year/person) [7]	
Other	• Number of trees planted per year on public property per capita [6] • Annual water consumption per capita (L/year/person) [3]	• Local Air Quality Health Index (AQHI) [5] • Percentage of impervious area within the municipal boundaries [2] • Percentage of tree canopy coverage within the municipal boundaries [11] • Percentage of greenspace and natural areas within the municipal boundaries [5] • Percentage of protected greenspace and natural areas within the municipal boundaries [3]

In addition to the shortlisted indicators representing a smaller number of activity sectors, they are also concentrated in two types of indicators according to the logic model framing: output and outcome. While the transportation indicators are more evenly distributed between output and outcome indicators, the building, energy and electricity, and waste categories are predominantly output indicators. The other activity sector, which includes themes related to air quality and natural infrastructure, for example, is the only category that contains more outcome rather than output indicators. Figure 4-6 shows the distribution of indicator types across the different activity sectors included in the shortlist.

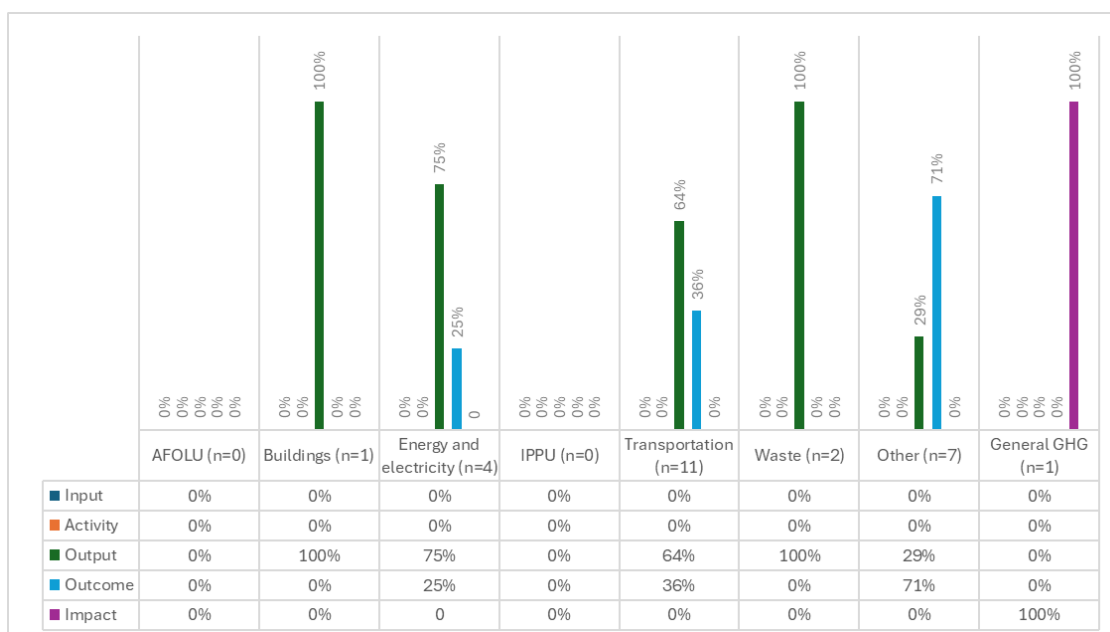


Figure 4-6. Shortlisted indicators by type and activity sector (n=26)

4.4.2.2 Indicator evaluation matrix

Following the analysis of the shortlisted indicators, we employed the Delphi technique (Yousuf, 2007) to engage our group of experts to complete the indicator evaluation matrix defined by Maclaren (1996a). Six of nine experts from WG 2 completed a questionnaire that included the 26 shortlisted indicators and the option to select any combination of the general criteria outlined in Table 4-2. Since there are seven criteria to choose from and six experts completing the questionnaire, the highest score that can be achieved is 42 points by allocating 1 point per criterion per person. It was established that an indicator must score 30 points or greater to be included in the final list of indicators. Based on the results of the survey, 19 out of 26 indicators will be proposed for use by Canadian municipalities seeking to complement the PCP when measuring climate mitigation performance. See Table 4-5 for a list of the final list of indicators and corresponding scores.

Table 4-5. List of proposed indicators with activity sector and evaluation matrix score

Proposed indicators	Activity sector	Score
Average yearly energy consumption per capita (kWh/year/person)	Energy, electricity, and outdoor lighting	41
Natural gas consumption per capita (m3/year/person)	Buildings	38
Progress towards GHG emissions reduction targets (percentage of target achieved)	GHG General	38
Total installed renewable electricity generation capacity (MW) per capita	Energy, electricity, and outdoor lighting	36
Number of trees planted per year on public property per capita	Other	36
Percentage of fleet vehicles and municipal equipment that are electric	Transportation	36
Number of EV charging stations per thousand people for public use	Transportation	36
Percentage of municipal residential waste diverted from landfill annually	Waste	36
Annual renewable energy generated per capita (kWh/year/person)	Energy, electricity, and outdoor lighting	35
Percentage of greenspace and natural areas within the municipal boundaries	Other	35
Quantity of residual material from the residential sector destined for landfill annually per capita (kg/year/person)	Waste	34
Percentage of tree canopy coverage within the municipal boundaries	Other	33
Percentage of protected greenspace and natural areas within the municipal boundaries	Other	33
Percentage of residents commuting by active transportation and public transit	Transportation	33
Total distance (km) of sidewalk, bike lanes and multi-use trails network per capita	Transportation	33
Number of electric vehicles (community scale) per capita	Transportation	32
Annual water consumption per capita (L/year/person)	Other	31
Number of transit rides per capita	Transportation	31
Percentage of households within 400 metres of a regular service public transit stop	Transportation	30

4.5 Discussion

Indicators are a practical performance measurement tool that can be used to analyze, communicate, and quantify complex information (Kitchin et al., 2015; Singh et al., 2012). A good indicator should be relevant and capture meaningful change (Bekier & Parisi, 2023; Bouckaert & Halligan, 2008). Indicators should be theoretically sound and easily understood by the user (Maclaren, 1996b; Niemeijer & de Groot, 2008). Further, indicators should support timely decision-making and rely on accessible data to facilitate broad adoption and effective climate-related performance measurement (Bekier & Parisi, 2023; Goonesekera & Olazabal, 2022; Tanguay et al., 2010).

Based on this understanding, this research was conducted within a Canadian municipal context to further understand performance measurement in practice and to propose a parsimonious list of climate mitigation indicators that can be widely adopted by municipalities, complementing the existing GEI tool (FCM & ICLEI Canada, 2021). This study examined indicators currently used by participating municipalities to identify their type according to the logic model framework (Ebrahim, 2019; Purcel & Croitoru, 2025). Additionally, indicators were analyzed to determine which local GHG emissions activity sectors they relate to. Our research offers several findings within a Canadian municipal climate mitigation context that could be applied by other nations. It also contributes to indicator selection literature, especially within the context of the logic model as a performance measurement framework.

4.5.1 Measuring performance across the causal chain

To evaluate the key stages of the transition to net-zero GHG emissions, indicators should assess the entire causal chain for decision-makers aiming (Hale et al., 2021). Since the logic model captures the entire causal chain from input to impact (Ebrahim, 2019), it serves as a useful framework and should be considered as a criteria during the indicator selection process. The analysis of 255 climate mitigation indicators included in our study shows that while there is representation across the majority of the causal chain, the distribution is uneven. For example, we only identified one impact indicator, which is currently in use by two of the sample Canadian municipalities included in our study. Upon reducing the original list of 255 climate mitigation indicators to establish a shortlist to be assessed using the Maclaren (1996a), input and activity indicators were absent altogether.

For this study, the findings that relate to input and activity indicators do not limit the usefulness of our proposed list of indicators since these types of indicators do not necessarily need to be standardized. Instead, input and activity indicators can be developed locally to reflect context-specific factors like the level of resources available to the specific municipality (Hale et al., 2021). Impact indicators, which are used to measure long-term changes related to targets and goals, should be present within a common set of indicators. Indeed, the declared commitment of net-zero emissions by 2050 should be accompanied by a common indicator to measure how well municipalities are performing on achieving this national goal (Environment and Climate Change Canada, 2021). See Table 4-6 for a list of climate mitigation indicators organized using the logic model framework.

Table 4-6. Description of logic model indicator types (Ebrahim, 2019; Goonesekera & Olazabal, 2022; Huovila et al., 2019) and examples from Canadian municipalities.

Logic model framework	Examples of climate mitigation indicators from master list (n=255)	Examples of climate mitigation indicators from final list (n=19)
Input indicators measure the resources used to carry out the activities required to achieve climate action targets and goals.	i. Per capita investment in active mobility networks (\$/inhabitant) ii. Land available for farming	No indicator included
Activity indicators, also referred to as process indicators, measure whether a planned action occurred.	i. Number of actions implemented from climate action plan ii. Number of trees measured iii. Percent of forest canopy coverage measured	No indicator included
Output indicators measure the short-term achievement of planned activities at a point in time.	i. Acres removed from mowing ii. Walking trips per capita iii. Tonnes of renewable natural gas captured	i. Average yearly energy consumption per capita (kWh/year/person) ii. Number of trees planted per year on public property iii. Percentage of municipal residential waste diverted from landfill annually
Outcome indicators measure the effect of a planned activity on an environmental, economic, or social system.	i. Percentage of zero emission buses in City's transit fleet ii. Diversity of tree inventory iii. Landfill gas efficiency	i. Percentage of tree canopy coverage within the municipal boundaries ii. Percentage of protected greenspace and natural areas within the municipal boundaries iii. Percentage of residents commuting by active transportation and public transit
Impact indicators capture changes that occur because of interventions. They measure the environmental, social, and economic state in relation to set targets and goals.	i. Progress toward GHG reduction targets	i. Progress toward GHG reduction targets

4.5.2 Local GHG emissions activity sector indicators

When considering the distribution across the activity sectors where local GHG emissions occur, indicators related to buildings, energy and electricity, transportation, and waste should be the most common since that is where climate mitigation actions are prioritized (MacDonald et al., 2024). While transportation indicators are common in both the larger sample of 255 climate mitigation indicators and the shortlisted ones, this is not necessarily the case when considering some of the other prioritized activity sectors. For example, when examining the entire list of indicators, buildings and energy and electricity indicators are less common than waste indicators by over 30%.

This perceived overrepresentation of waste indicators could be the result of PCP member municipalities intentionally supplementing their GEI since reporting requirements related to GHG emissions from waste are scarce (FCM & ICLEI Canada, 2021). Further, it could also relate to the frequency count of indicators in use. Indeed, one of the two waste indicators that ultimately made the shortlist is used by over 50% of the sample municipalities, whereas the other is adopted by over 30%. Regardless of the reason for the waste indicator representation, they are useful measures since resource efficiency is not captured by municipalities only using a GEI tool (Mondal et al., 2024).

When reviewing the shortlist indicators, the building activity sector is hardly represented with only one indicator related to natural gas consumption, which is used by two separate municipalities. To complement PCP tool, which currently only captures emissions from stationary fuel combustion, purchased electricity, and purchased steam or district

energy (FCM & ICLEI Canada, 2021), new indicators would be useful. For example, given the importance of building retrofits to decarbonization (Linton et al., 2022), an indicator that measures the efficiency of building retrofits should be adopted.

In addition to the previously discussed activity sectors, local GHG emissions and carbon sinks are included in a sector categorized as “other”, which captures areas such as water, ecological services, and natural infrastructure. Our findings show that “other” as an activity sector has a large representation of indicators in the full sample of 255 climate mitigation indicators, in the shortlist of 26 new indicators, and in the proposed list of 19 new indicators. This shows the emergence of nature-based solutions (Mosca et al., 2023) as a newer area of climate mitigation in municipalities. See Table 4-7 for a list of climate mitigation indicators organized by local GHG emissions activity sector.

Table 4-7. Examples of climate mitigation indicators from Canadian municipalities by local GHG emissions activity sector

Local GHG emissions activity sector	Examples of climate mitigation indicators from master list (n=255)	Examples of climate mitigation indicators from final list (n=19)
Agriculture, forestry, and other land use (AFOLU)	i. % of new units built within the built area boundary ii. Dwelling Density	No indicator included
Buildings	i. Total GHG emissions per year from municipal buildings* ii. Number of LEED-Certified buildings	i. Natural gas consumption per capita (m3/year/person)
Energy, electricity, and outdoor lighting	i. Total corporate energy-related GHG emissions per year (tonnes CO2e)* ii. Number of non-electric systems replaced	i. Average yearly energy consumption per capita (kWh/year/person) ii. Annual renewable energy generated per capita (kWh/year/person)

Local GHG emissions activity sector	Examples of climate mitigation indicators from master list (n=255)	Examples of climate mitigation indicators from final list (n=19)
Industrial process and product use (IPPU)	i. Total GHG emissions per year from Industrial, Commercial & Institutional (IC&I) sources (tonnes CO ₂ e)* ii. Per capita GHG emissions per year from IC&I (tonnes CO ₂ e)	No indicator included
Transportation	i. Total GHG emissions per year from transportation (tonnes CO ₂ e)* ii. Density on Transit Corridors	i. Number of EV charging stations per thousand people for public use ii. Total distance (km) of sidewalk, bike lanes and multi-use trails network per capita
Waste	i. Total GHG emissions from in-boundary landfill* ii. Reduction in commercial waste	i. Percentage of municipal residential waste diverted from landfill annually ii. Quantity of residual material from the residential sector destined for landfill annually per capita (kg/year/person)
Other	i. Local Air Quality Health Index (AQHI) ii. Percentage of impervious area within the municipal boundaries	i. Percentage of tree canopy coverage within the municipal boundaries ii. Annual water consumption per capita (L/year/person)

*PCP tool indicator (FCM & ICLEI Canada, 2021); screened out during the indicator selection process

Given the alignment of the AFOLU and "other" activity sectors with the natural environment, unlike sectors such as buildings and transportation, which are linked to the built environment, questions arise about the ideal distribution of indicators across local GHG emissions activity sectors. Certainly, indicators related to biodiversity, public health and environment, and resource efficiency, which are not currently captured in inventory tools, are all necessary when local climate mitigation performance (FCM & ICLEI Canada, 2021; Mondal et al., 2024). Thus, when municipalities adopt climate mitigation indicators, they

should consider which sectors are most relevant to the local context, allowing for comprehensive measurement of progress toward net-zero GHG emissions targets and goals.

4.5.3 A common set of climate mitigation indicators

Effective climate mitigation performance measurement at the local level is essential to ensure that municipalities can track progress and align with broader climate objectives (Goonesekera & Olazabal, 2022; Maclaren, 1996b). Our analysis of climate mitigation indicators used by select Canadian municipalities resulted in a refined set of 19 new indicators, applicable across a range of GHG emissions activity sectors, including buildings, energy, transportation, waste, and others. These indicators, selected through expert evaluation using the Delphi technique (Yousuf, 2007) and Maclaren's (1996a) indicator selection framework, are intended to complement the PCP tool (FCM & ICLEI Canada, 2024). Ultimately, these new indicators are meant to help municipalities go beyond GEI tools to make meaningful contributions to measuring progress towards GHG emissions targets, including net-zero (MacDonald et al., 2024).

The selection of high-quality indicators enhances the accuracy and effectiveness of tracking climate mitigation efforts, enabling municipalities to refine strategies and maintain progress over time (S. Jones, 2019). While GHG emissions in tonnes of CO₂e remains a core measure of absolute emissions, municipalities are increasingly adopting a broader set of indicators that reflect the complexity of local climate action and the challenges of achieving long-term goals (Mondal et al., 2024). Using the logic model framework during the indicator selection process acknowledges the time lag between strategy implementation and

measurable impact (Ebrahim, 2019; Underdal, 2010). Accordingly, the proposed new indicators provide municipalities with common measures that can be used to monitor their progress in a timely manner, compare their performance across jurisdictions, and meaningfully contribute to the national and global efforts to mitigate climate change.

4.6 Conclusions and future research directions

Despite the existence of literature on indicators and indicator selection, the scope and scale of these studies vary. Currently, few studies exist that focus on the selection of local climate mitigation indicators. This research contributes to this growing field. In addition to providing empirical evidence using a sample of Canadian municipalities, this study also presents a replicable methodological approach that can be used in research and in practice to establish a list of indicators that are relevant within different local contexts. By examining other regions, additional indicator themes that were not present in this study could emerge, including those related to social inclusion and the green economy (Linton et al., 2021; Mondal et al., 2024).

This research is not without its limitations. For example, the exploration of indicator types across the GHG emission activity sectors offered an initial glimpse into how climate mitigation is currently being measured at the local level. Future research can explore this topic further by examining whether local climate mitigation indicator sets established by municipalities can be designed to capture all stages of the logic model. From an accountability perspective, it is worth exploring whether a comprehensive indicator set that

captures the entire causal chain can help citizens and municipal decision-makers to better understand the outcomes and impacts achieved.

While this study relied on a scientific understanding of climate mitigation for the initial scan that included 255 indicators (Filonchyk et al., 2024), it did not conduct further screening to identify the indicators that have the highest level of impact on climate change. Accordingly, there exists the opportunity for additional analysis on the new climate mitigation indicators proposed in this study to investigate the indicators as they relate to deep decarbonization pathways (Linton et al., 2022).

Lastly, future research can examine climate mitigation indicators currently in use by municipalities from other countries to establish a larger selection of indicators to fill some of the gaps across the causal chain and the GHG emissions activity sectors. There is certainly more work to be done to better inform local climate mitigation decision-making and thus local climate action.

- End of Paper 3 -

Chapter 5 – Conclusion

This thesis includes three stand-alone research papers that explored different aspects of performance measurement with a goal of furthering the field of study within a local climate mitigation context. For this thesis, relevant findings from the first paper were used to inform the second and third papers. The three papers are connected through the exploration of models, processes, and indicators that are used in practice to measure sustainability and climate-related performance.

Paper 2 of this thesis is grounded in contingency theory which proposes that there is no ‘one-size-fits-all’ approach to organizational systems and structures (Giacomini et al., 2018; Marcuccio & Steccolini, 2009; Otley, 1980; Thomas, 1986; Waterhouse & Tiessen, 1978). Further, this thesis is framed by the following concepts: (1) the evaluation and control step of the strategic management process (Hunger & Wheelen, 2011), (2) the performance measurement process (Van Dooren et al., 2010), and (3) the indicator framework and selection process (Maclaren, 1996a, 1996b). Within this framing, three research questions (RQ) were answered, as shown in Figure 5-1.

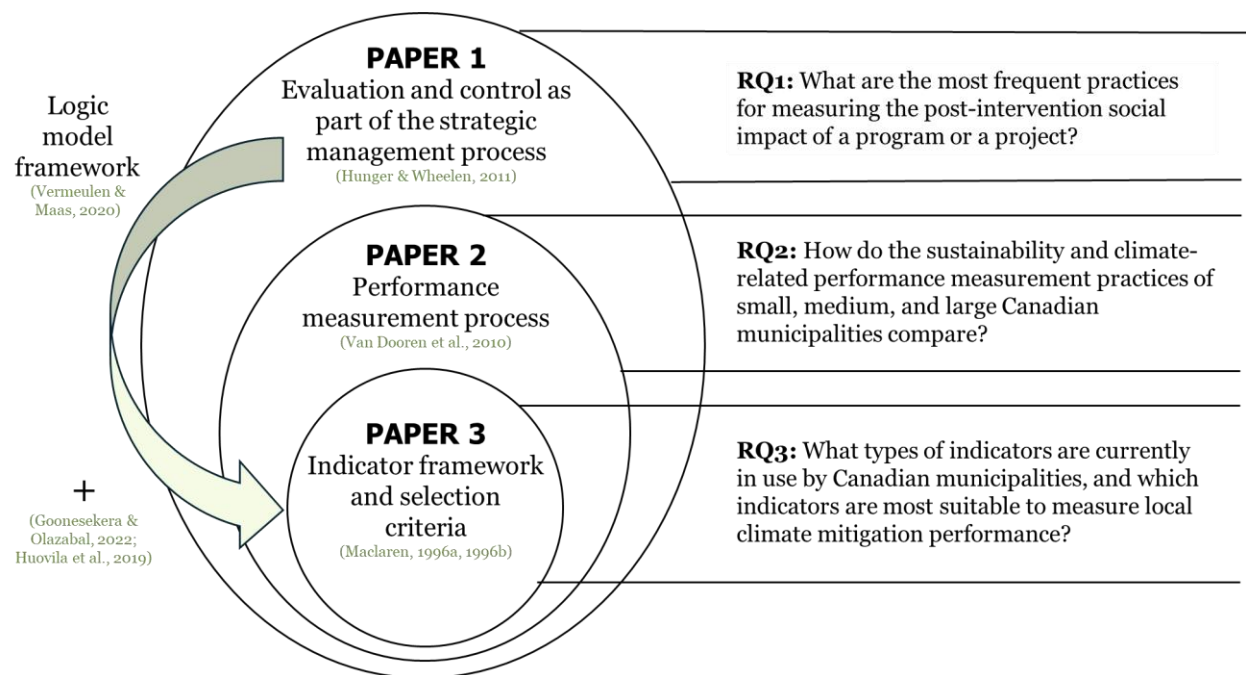


Figure 5-1. Conceptual framework and corresponding research questions

5.1 Contributions to scholarship

This research is set against the background of global challenges, including climate change, one of nine planetary boundaries (Steffen et al., 2015). As cities increasingly take climate action and contribute to the achievement of the Paris Agreement targets and Sustainable Development Goals (SDG) (UN DESA, 2019; Bertoldi et al., 2018), this research contributes empirical knowledge on climate-related performance measurement.

The first paper examines post-intervention social impact measurement (SIM) models and offers strategies to improve measurement in practice. This study also identifies the relevant types of indicators, namely performance and causal (represented by the logic model), that are used to measure social impact (Calvo-Mora et al., 2018; Lazzarini, 2018; Lombardo et al., 2019; Mulloth & Rumi, 2021; Tse & Warner, 2020). Lastly, it highlights

research gaps, prompting questions like "*are stakeholders engaged in the indicator selection process?*" and "*which indicators are most applied in practice?*" (Feor, Clarke, et al., 2023, p. 830). These shaped subsequent papers in this thesis.

Building on the first paper, paper 2 focuses on sustainability and climate-related performance measurement in Canadian municipalities. The study uses a contingency theory lens to explore the influence of population size on the performance measurement process defined by Van Dooren et al., (2010). Larger municipalities rely on a greater number of indicator selection criteria, use various data sources, and report more frequently. Whereas size does not appear to influence the level of stakeholder involvement in the indicator selection process, nor the strategies used to interpret data. While population size influences the comprehensiveness of each step of the performance measurement process, enough similarities were found across each size group to suggest the possibility of a standardized approach.

The third paper integrates several methods and frameworks, including the logic model, Delphi technique, and Gioia method, to examine and analyze climate mitigation indicators used by Canadian municipalities (Gioia et al., 2013; Goonesekera & Olazabal, 2022; Huovila et al., 2019; Maclaren, 1996a; Yousuf, 2007). A noteworthy contribution of this paper is the creation of a parsimonious list of new indicators that local governments can use to improve climate mitigation performance measurement. This list aims to address the challenges municipalities face in reporting their progress towards climate goals and to include newer thinking such as performance measurement related to nature-based solutions.

This study contributes to climate-related indicator literature by offering a Canadian municipal perspective (D. Clarke, 2021; Mondal et al., 2024). Figure 5-2 provides a summary of the contributions from each paper of this thesis.

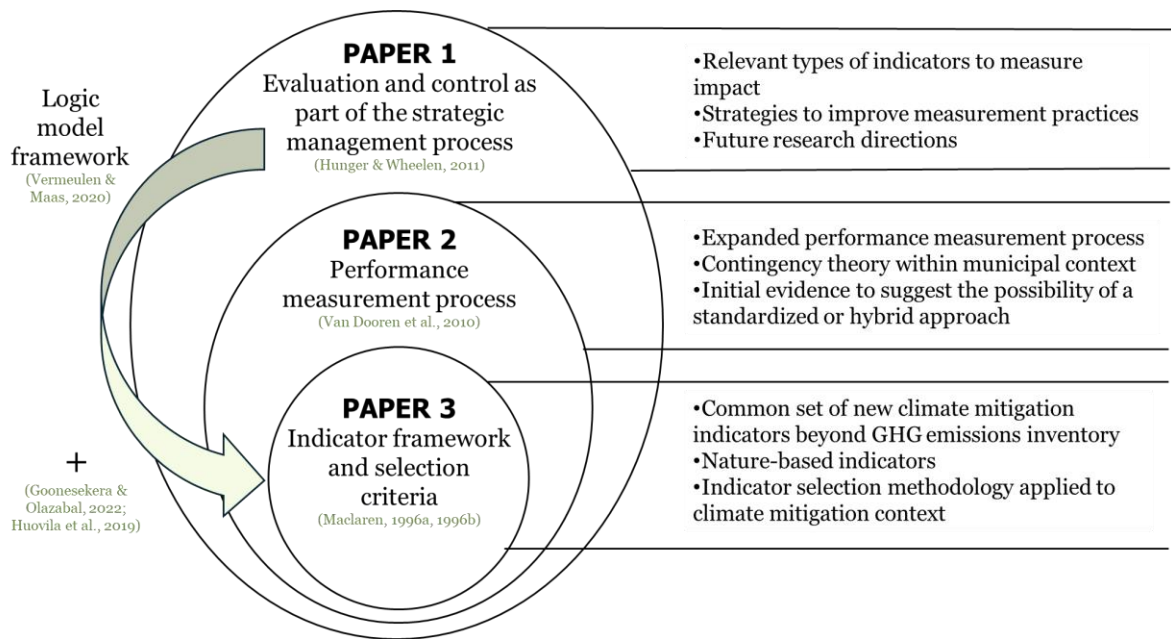


Figure 5-2. Theoretical contributions by thesis paper

5.1.1 Performance measurement of non-financial topics

The field of non-financial performance measurement has grown over the last several decades in all sectors, including the public sector (Bititci et al., 2012; Mura et al., 2018; Searcy, 2012). External stakeholders expect organizations to demonstrate their contributions to social impact and broader sustainability goals (Alomoto et al., 2021; Barnett et al., 2020; Nguyen et al., 2015). Beyond external expectations, organizations use non-financial performance measurement as a tool for strategic decision-making and continuous improvement (Cerioni & Marasca, 2021; Elauria et al., 2017). In the context of local climate

governance, where municipalities are instrumental in driving decarbonization, non-financial performance measurement plays a critical role (Cooper & Pearce, 2011; Linton et al., 2021),

Social impact can be measured in a myriad of ways. This research identified 68 different measurement models in as many articles analyzed. The voluminous number of measurement models adds complexity to non-financial performance measurement in practice. Findings included in this study show that social return on investment (SROI) is the most frequently discussed model across the literature. These findings are based on a study of post-intervention measurement models at the project and program levels. Accordingly, adoption of a complex measurement model like SROI may face different challenges when scaled to the organization level.

The first paper of this thesis demonstrates that the logic model framework, an integral component of SROI methodology, can be used to measure impact. Causal analysis and long-term impact measurement are underdeveloped despite their theoretical importance. While the logic model is well-established in the literature (Ebrahim & Rangan, 2014; Frantzen et al., 2018; Vermeulen & Maas, 2020), municipalities examined in this study rarely incorporate causal analysis in sustainability and climate-related performance measurement. This disconnect between theory and practice reinforces observations by Ferraro and Hanauer (2014) and Lazzarini (2018) regarding the challenges organizations face in capturing causality. From a contingency perspective, findings from the second paper of this thesis show that population size does not influence the data interpretation strategies used by

municipalities. This may reflect gaps in technical capacity (Marcuccio & Steccolini, 2009) or signify influence from other contingent factors (Adams, 2002).

5.1.2 Standardization versus contextualization

The debate between a standardized versus a contextualized approach to performance measurement is ongoing (R. B. Gibson, 2006; Ruff & Olsen, 2018). Contingency theory, which is central to the second paper of this thesis, suggests that internal (e.g., organization size, competencies of the preparer) and external factors (e.g., broader environmental concerns, provincial/territorial regulations) can influence management decisions, measurement systems, and performance (Amhalhal et al., 2022; Baumann et al., 2015; Bouma & van der Veen, 2002; Qian et al., 2011; Rejc, 2004). Findings from Chapter 3 establish that while population size influences the extensiveness of performance measurement (Van Dooren et al., 2010), all municipalities, regardless of size, follow broadly similar processes. Accordingly, this study provides empirical evidence that supports a standardized approach to performance measurement, with nuanced adjustments for contingent factors. Such an approach speaks to the concept of “bounded flexibility” proposed by Ruff and Olsen (2018, p. 404) in relation to indicator selection where there is commonality in the construct and flexibility within a bound set of options (Ruff & Olsen, 2018).

Through the integration of the logic model framework and activity sectors for local GHG emissions, this study developed a parsimonious list of climate mitigation indicators that are both contextually relevant and broadly applicable across Canadian municipalities

(Goonesekera & Olazabal, 2022; MacDonald et al., 2024; Maclaren, 1996a). These indicators were designed to complement existing tools, such as GHG emissions inventories (GEI), and aim to address the dual need for localized information and standardization to allow comparisons across jurisdictions and the consolidation of data for other levels of government (Maclaren, 1996b; Mia et al., 2019; Tanguay et al., 2010). In doing so, this paper offers empirical evidence that can support a standardized or hybrid approach to measuring progress towards national climate mitigation targets, including Canada’s commitment to net-zero GHG emissions by 2050 (Government of Canada, 2024).

5.1.3 Measuring what matters to climate mitigation performance

Building on the idea that GEIs can be complemented with a suite of indicators, this research proposes a set of 19 new climate mitigation indicators that span the key activity sectors that contribute to local GHG emissions (MacDonald et al., 2024). Canadian municipalities influence roughly 50% of the nation’s GHG emissions, with direct control over corporate emissions from municipal buildings and fleets, public transportation, and municipally owned parks and green spaces (A. Clarke & Ordonez-Ponce, 2017; Torrie, 2015; Zhou et al., 2022). While these first two areas of direct control are well-represented in GEIs, measurement related to green spaces are largely absent (C40 Cities Climate Leadership Group et al., 2014; FCM & ICLEI Canada, 2021). This research offers two commonly used indicators to fill this gap: (1) number of trees planted per year on public property per capita, and (2) percentage of tree canopy coverage within the municipal boundaries. The findings

from this research contributes to an emerging field of study that examines climate mitigation indicators (D. Clarke, 2021; Mondal et al., 2024).

Municipalities indirectly control community-wide GHG emissions from several activity sectors including from residential and commercial buildings, non-public transportation, agricultural and industrial processes, and land-use (A. Clarke & Ordonez-Ponce, 2017; Zhou et al., 2022). Many of these activity sectors are represented in GEIs; however, measurement is limited to emissions related to stationary fuel combustion and purchased electricity and energy (C40 Cities Climate Leadership Group et al., 2014; FCM & ICLEI Canada, 2021). This study proposed 19 new climate mitigation indicators across community-wide activity sectors that go beyond GEI calculations to also measure the outputs and outcomes required to achieve net-zero GHG emissions. Applying a concept like “bounded flexibility” (2018, p. 404) can initiate the adoption of common indicators that enable comparisons across jurisdictions and the consolidation of data, while also being responsive to local needs (Maclaren, 1996b; Mia et al., 2019; Tanguay et al., 2010).

5.2 Implications for scholars and future research directions

This thesis offers a nuanced understanding of SIM, a process used to demonstrate impacts of deliberate interventions aimed to create social benefit (McLoughlin et al., 2009; Nguyen et al., 2015). While the second and third papers of this thesis align with the future research directions suggested in the first paper, opportunities for investigations persist. One area for future research relates to the usefulness of causal indicator sets (with representation from input to impact) when measuring performance related to grand challenges such as

climate change at the local level. Another area that remains to be explored in municipal practice are the measurement drivers and pressures. The research on SIM found that there are internal drivers, such as continuous improvement, and external pressures, like demands from stakeholders. While this thesis examined the “how” of performance measurement, it did not explore the “why”. This offers opportunities for additional empirical studies within Canadian and global contexts using different theoretical lenses such as stakeholder theory, legitimacy theory, and institutional theory, all of which are common in this field of study (Mura et al., 2018).

The pursuit of standardization for measuring local climate mitigation performance should not ignore the widely accepted notion that there is ‘one-size-fits-all’ approach to organizational systems and structures (Giacomini et al., 2018; Marcuccio & Steccolini, 2009; Otley, 1980; Park & Krause, 2021; Rejc, 2004; Thomas, 1986). Findings from Chapter 3 are limited to population size only, leaving room for additional research using a contingency theory perspective. For example, population size does not appear to influence whether stakeholders are engaged in the indicator selection process. Since nearly half of the municipalities in this study do not engage external stakeholders when selecting indicators, other contingent factors, such as location or province, might be of influence and are worth examining in future research. Indeed, size is not the only contingent factor that can influence performance measurement practices (Adams, 2002).

The selection of high-quality indicators improves the usefulness of climate mitigation performance measurement, supporting municipalities in refining strategies and maintaining

progress over time (S. Jones, 2019). Identifying suitable indicators to measure local climate mitigation performance is a priority so that local governments can effectively track their progress and contribute meaningfully to national and global climate goals. This process is not without its challenges. Indeed, the multiple reviewer screening method applied in Chapter 4 required several steps to achieve consensus amongst three experts. This indicates a normative approach to screening and selecting indicators, emphasizing the importance of establishing a systematic approach with pre-set definitions and ongoing discussions to achieve consensus.

While GHG emissions in tonnes of CO₂e remains a central indicator, municipalities are increasingly adopting a broader set of indicators that reflect the complexity of local climate action (D. Clarke, 2021; Mondal et al., 2024; Purcel & Croitoru, 2025). Further, there is evidence that while standardized indicator sets exist, local governments are taking a bottom-up approach by identifying customized indicators that capture local context and a broader range of sustainable development themes aligned with climate action (Mondal et al., 2024). This reinforces the idea of a hybrid approach to local climate mitigation performance measurement.

To fully capture the scope of local climate mitigation, it is essential to integrate indicators that go beyond emissions alone, like those addressing biodiversity, environmental health, and resource efficiency (FCM & ICLEI Canada, 2021; Mondal et al., 2024). Therefore, measuring progress toward net-zero targets should prioritize activity sectors that are within local government's influence, locally relevant, and most related to deep GHG emissions reduction. As noted in this thesis, engaging stakeholders is an important aspect of

the performance measurement process, with their involvement in the indicator selection process emphasized. While stakeholder engagement is important when identifying the activity sectors that are most material to the local area, indicators must be theoretically sound and scientifically valid (Maclaren, 1996a). This tension is worthy of additional research using a stakeholder theory lens to study the influences and expectations of different stakeholders (Mia et al., 2019).

Municipalities have direct influence of GHG emissions stemming from sources such as municipal buildings and fleets, public transit systems, landfills, and municipally owned green spaces (Zhou et al., 2022). Sectors like buildings and transportation are closely tied to the built environment, others, such as agriculture, forestry, and other land use (AFOLU), are inherently linked to natural ecosystems (Verma et al., 2023). This contrast raises important considerations regarding how climate mitigation indicators should be distributed across different local GHG emissions activity sectors.

Future explorations of climate mitigation performance measurement practices at the local government level can occur more broadly geographically, capturing different nations globally. This thesis offers a breadth of empirical evidence from the Canadian municipal perspective. By expanding the geographic scope, these same methodologies can be used to validate and develop a large suite of indicators that can better capture the local transition to net-zero GHG emissions. This expansion can fill the activity sector gaps noted in Chapter 4, specifically as they relate to industry, including agriculture and forestry. Future research should also examine the alignment between indicators from commonly represented climate

mitigation activity sectors (e.g., buildings and transportation) and the effectiveness of municipal actions taken to reduce GHG emissions within these sources.

While input and activity indicators can be developed locally, impact indicators that are used to measure long-term changes related to shared targets and goals should be available within a standardized set of indicators (Hale et al., 2021). Indeed, the widely declared commitment of net-zero GHG emissions by 2050 should be accompanied by a common indicator to measure how well municipalities are performing on achieving this goal (Environment and Climate Change Canada, 2021; MacDonald et al., 2024). Accordingly, future research could explore SROI as a standardized model for municipalities to demonstrate the cost-benefit analysis of the local transition towards net-zero. Further, it could examine the feasibility of adopting a complex measurement model like SROI at the organizational level.

Beyond government, implementation of climate-related strategies and accountability by non-state actors are crucial to meeting the targets of the Paris Agreement (Chan et al., 2019; Stafford-Smith et al., 2017). While the empirical focus of this research was on municipalities, which are part of the public sector, the findings from the second and third papers of this thesis can be extended by exploring practices of organizations in other sectors that are measuring the impact of taking climate action.

Finally, by following Maclaren's (1996a, 1996b) indicator framework and evaluation matrix, this thesis offers practical contributions to support the development of a climate mitigation themed framework that Canadian municipalities can use when measuring progress towards net-zero GHG emissions targets at the local level. The framework seeks to

complement the PCP milestone tool already in use by more than 500 municipalities across Canada, representing nearly 70% of the nation's population (FCM & ICLEI Canada, 2024; Neveroff, 2023). Use of the proposed indicators in practice will create the opportunity for data collection across participating municipalities. If this data are collected in sufficient quantities, a factor analysis can be conducted to identify redundancy amongst the proposed indicator set (Rajaonson & Tanguay, 2017), and a local climate mitigation index could be developed (Caldas et al., 2020; Mori & Christodoulou, 2012; Shaker, 2018). This index should capture the activity sectors where municipalities have the greatest influence to reduce GHG emissions. Future research can use this index to examine which municipalities use the indicators included in the index, and to what extent. Further, the index would be made available to PCP members, offering municipalities an additional measurement tool. As municipalities adopt the index, data can be gathered to study climate mitigation performance levels across Canada.

5.3 Contributions to practice and implications for practitioners

My practical contribution focuses on performance measurement practices that support informed, multi-stakeholder decision-making and enhance accountability for climate action at the municipal level. These practices also enable the measurement of climate mitigation performance to assess local progress toward global targets and goals. The key contributions of my thesis include strategies for improving SIM in practice, a useful resource for municipalities to conduct self-assessments of their current performance measurement

systems, and guidance on a climate mitigation indicator framework for local governments, including a proposed set of new indicators for practice.

The benefits of performance measurement depend on how the information is used, providing value through enhanced decision-making, public accountability, and organizational learning, while the associated costs are more immediate and tangible, creating an asymmetry in the cost-benefit balance (Bouckaert & Halligan, 2008). Policymaker investment in building organizational capacity is crucial to the successful implementation and maintenance of performance measurement practices (Feor, Clarke, et al., 2023). The results presented in this thesis are useful for those seeking to improve their performance measurement process, including the selection of indicators. Accordingly, our suggestions to practitioners are as follows:

1. Policymakers and international bodies can improve comparability across jurisdictions by developing a common performance measurement framework. The five steps outlined by Van Dooren et al. (2010) of the ideal performance measurement process, with expanded sub-sections, serve as useful framing. This would increase cohesion across different levels of government and enable more effective tracking of national priorities, such as progress toward net-zero targets.
2. The indicator selection process presented by Maclaren (1996a) provides a systematic approach for the development of a theme-based indicator framework that is suitable for municipalities measuring climate mitigation performance. While many municipalities use informal criteria for selecting indicators, the process should be

- expanded to include a broader set of considerations such as responsiveness to the local context, scientific validity, and alignment with existing measurement systems.
3. Despite a general consistency in stakeholder involvement across all municipality size groups examined in this study, there remains substantial room for improvement. Engaging both internal and external stakeholders during the indicator selection process increases representativeness and relevance to the needs of potential users.
 4. While internal operational data are commonly used, municipalities should expand their data sources. This requires cooperation with local organizations, provincial and federal governments, and third-party organizations.
 5. Municipalities commonly use strategies that measure performance over time and against targets while causal analysis remains largely underutilized. Promoting the use of causal analysis can deepen understanding of the underlying factors driving performance outcomes and impact, ultimately supporting more targeted and effective policy interventions.
 6. By applying a logic model approach to indicator selection, municipalities can better account for time lags associated with climate-related strategies (Ebrahim, 2019; Underdal, 2010), enabling more accurate tracking of progress over time.

5.4 Concluding remarks

This thesis provides meaningful contributions to both the theoretical and practical aspects of sustainability and climate-related performance measurement. This research not only enhances understanding of measurement practices in the social impact field but also

offers actionable insights for municipalities to streamline their climate-related performance measurement. These contributions are timely as cities play a central role in addressing global climate challenges, and participation from municipalities in Canada is vital to meeting the Paris Agreement targets and the SDGs. This thesis advances academic knowledge and offers practical solutions to support municipalities as they seek to better track and report their climate mitigation efforts and ensure accountability for their citizens.

- End of Thesis -

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Appendices

Appendix A. Screenshot of Editor's Choice Articles for *World* (Paper 1)

Journals / World / Editor's Choice



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Review for World

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Editor's Choice Articles

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Social Impact Measurement: A Systematic Literature Review and Future Research Directions

by Leah Feor, Amelia Clarke and Ilona Dougherty
World 2023, 4(4), 816–837; <https://doi.org/10.3390/world4040051> - 1 Dec 2023
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Abstract This paper explores the current state of the social impact measurement (SIM) field to better understand common practices in measuring the post-intervention social impact of a program or project and to identify strategies to improve measurement in practice. This study employed a systematic [...] [Read more.](#)

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Appendix B: List of PCP members (n=297) organized province and size (Papers 2 and 3)

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
Municipal District of Big Lakes County	11/21/2017	4,986	Alberta	3
Town of Devon	4/10/2017	6,545	Alberta	3
Town of Drayton Valley	8/26/2015	7,291	Alberta	3
Town of Banff	2/22/1999	8,305	Alberta	3
Town of Hinton	6/26/2019	9,817	Alberta	1
Town of Canmore	2/27/1997	15,990	Alberta	3
Town of Okotoks	6/12/2000	30,405	Alberta	2
City of Leduc	6/13/2016	34,094	Alberta	4
City of Grande Prairie	1/28/2002	64,141	Alberta	3
City of St. Albert	1/18/2010	68,232	Alberta	5
City of Lethbridge	2/5/2007	98,406	Alberta	1
City of Edmonton	7/1/1995	1,010,899	Alberta	5
District of New Hazelton	1/8/2018	602	British Columbia	3
Village of Midway	3/1/2008	651	British Columbia	4
Village of Kaslo	3/12/2019	1,049	British Columbia	4
Village of Burns Lake	7/23/2018	1,659	British Columbia	3
Village of Lumby	7/11/2017	2,063	British Columbia	5
District of Ucluelet	1/23/2018	2,066	British Columbia	4
District of Clearwater	10/3/2018	2,388	British Columbia	4

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
District of Elkford	7/23/2018	2,749	British Columbia	4
City of Rossland	3/30/2009	4,140	British Columbia	5
Bowen Island Municipality	2/1/2001	4,256	British Columbia	2
City of Duncan	3/14/2007	5,047	British Columbia	4
Town of Smithers	1/1/2008	5,378	British Columbia	4
Town of Creston	4/9/2019	5,583	British Columbia	4
District of Peachland	9/23/2019	5,789	British Columbia	1
City of Revelstoke	6/1/2006	8,275	British Columbia	3
City of Castlegar	11/22/2017	8,338	British Columbia	3
Town of Qualicum Beach	5/7/2007	9,303	British Columbia	4
City of Quesnel	10/1/2003	9,889	British Columbia	4
City of Williams Lake	6/2/2010	10,947	British Columbia	2
City of Nelson	8/13/2007	11,106	British Columbia	5
City of Terrace	10/29/2008	12,017	British Columbia	4
District of Summerland	12/11/2017	12,042	British Columbia	3
City of Powell River	5/17/2012	13,943	British Columbia	4
Resort Municipality of Whistler	11/17/1997	13,982	British Columbia	5
District of Sooke	9/10/2019	15,086	British Columbia	2
District of Central Saanich	7/31/2018	17,385	British Columbia	4
Township of Esquimalt	2/4/2019	17,533	British Columbia	2

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
Metro Vancouver (Electoral area)	11/1/1996	18,612	British Columbia	5
City of Salmon Arm	9/9/2019	19,432	British Columbia	2
City of Cranbrook	1/9/2017	20,499	British Columbia	1
District of Squamish	3/27/2007	23,819	British Columbia	4
City of Langley	8/1/2002	28,963	British Columbia	3
District of North Cowichan	6/9/2013	31,990	British Columbia	3
Regional District of Sunshine Coast	12/1/2007	32,170	British Columbia	4
Regional District of Kootenay Boundary	10/27/2017	33,152	British Columbia	4
City of Port Moody	6/17/1996	33,535	British Columbia	3
City of Penticton	5/5/2008	36,885	British Columbia	4
District of West Vancouver	10/1/2000	44,122	British Columbia	3
City of North Vancouver	7/1/1997	58,120	British Columbia	5
City of Port Coquitlam	5/13/2002	61,498	British Columbia	4
Regional District of Central Kootenay	1/25/1997	62,509	British Columbia	4
Regional District of East Kootenay	5/1/2008	65,896	British Columbia	4
Comox Valley Regional District	3/27/2006	72,445	British Columbia	5
City of Prince George	7/1/2002	76,708	British Columbia	5
City of New Westminster	10/21/1996	78,916	British Columbia	5
District of North Vancouver	5/1/2001	88,168	British Columbia	5
Cowichan Valley Regional District	3/1/2008	89,013	British Columbia	4

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
City of Maple Ridge	9/15/2000	90,990	British Columbia	4
City of Victoria	11/1/1994	91,867	British Columbia	4
City of Kamloops	7/1/1996	97,902	British Columbia	4
City of Nanaimo	10/21/2002	99,863	British Columbia	4
City of Delta	8/1/1996	108,455	British Columbia	5
District of Saanich	7/19/1996	117,735	British Columbia	5
Township of Langley	1/29/2001	132,603	British Columbia	5
City of Kelowna	1/1/2001	144,576	British Columbia	4
City of Coquitlam	3/3/1997	148,625	British Columbia	5
City of Abbotsford	6/1/2002	153,524	British Columbia	4
Regional District of Nanaimo	11/26/2002	170,367	British Columbia	4
Capital Regional District	10/10/2018	415,451	British Columbia	4
City of Vancouver	2/1/1995	662,248	British Columbia	5
Rural Municipality of Wallace-Woodworth	5/9/2017	322	Manitoba	3
Rural Municipality of Ellice-Archie	3/8/2016	831	Manitoba	4
Village of Dunnottar	5/21/2014	989	Manitoba	3
Rural Municipality of Minto-Odanah	4/7/2016	1,121	Manitoba	3
Rural Municipality of Victoria (MB)	7/13/2016	1,188	Manitoba	1
Town of Powerview-Pine Falls	8/15/2012	1,239	Manitoba	4
Rural Municipality of Elton	3/15/2016	1,276	Manitoba	3

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
Rural Municipality of Saint-François Xavier	4/21/2015	1,449	Manitoba	3
Rural Municipality of St. Laurent	6/18/2008	1,542	Manitoba	3
Rural Municipality of Stuartburn	5/17/2016	1,731	Manitoba	4
Municipality of Norfolk Treherne	8/8/2017	1,770	Manitoba	3
Town of Carberry	5/2/2016	1,818	Manitoba	3
Town of Morris	7/26/2012	1,975	Manitoba	3
Municipality of West Interlake	9/21/2017	2,228	Manitoba	3
Municipality of Emerson-Franklin	3/13/2012	2,437	Manitoba	4
Municipality of Russell-Binscarth	12/12/2017	2,596	Manitoba	3
Town of Minnedosa	3/22/2016	2,741	Manitoba	3
Municipality of Lorne	5/12/2017	2,904	Manitoba	3
Municipality of North Cypress-Langford	5/2/2016	3,011	Manitoba	3
Rural Municipality of Morris	5/14/2014	3,049	Manitoba	3
Town of Virden	1/20/2009	3,118	Manitoba	3
Rural Municipality of Cartier	12/19/2016	3,344	Manitoba	3
Rural Municipality of Alexander	10/14/2009	3,854	Manitoba	3
Rural Municipality of De Salaberry	6/12/2008	3,918	Manitoba	3
Town of Altona	5/6/2016	4,267	Manitoba	4
Town of Stonewall	11/4/2015	5,046	Manitoba	4
Rural Municipality of Ste. Anne	7/13/2016	5,584	Manitoba	3

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
Town of Neepawa	4/5/2016	5,685	Manitoba	3
Municipality of Rhineland	3/23/2016	5,819	Manitoba	3
Town of Niverville	8/1/2012	5,947	Manitoba	2
Rural Municipality of East St. Paul	6/27/2012	9,725	Manitoba	4
City of Selkirk	7/7/2014	10,504	Manitoba	3
Rural Municipality of St. Clements	6/26/2012	11,586	Manitoba	3
Rural Municipality of St. Andrews	6/12/2012	11,723	Manitoba	3
City of Portage La Prairie	9/11/2017	13,270	Manitoba	3
Rural Municipality of Springfield	5/23/2017	16,142	Manitoba	3
Rural Municipality of Hanover	7/29/2014	17,216	Manitoba	3
City of Brandon	2/1/2005	51,313	Manitoba	5
City of Winnipeg	11/25/1998	749,607	Manitoba	4
Rural Community of Strait Shores	12/10/2008	381	New Brunswick	5
Village de Maisonnnette	12/14/2017	535	New Brunswick	3
Village de Paquetville	12/18/2013	718	New Brunswick	5
Village de Grande-Anse	4/24/2017	731	New Brunswick	1
Village de Rivière-Verte	1/31/2018	744	New Brunswick	3
Village de Pointe-Verte	12/30/2013	865	New Brunswick	5
Village of Five Rivers	3/9/2016	874	New Brunswick	3
Village of Dorchester	2/1/2001	906	New Brunswick	5

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
Village of McAdam	1/15/2016	1,173	New Brunswick	3
Village de Nouvelle-Arcadie	2/10/2014	1,193	New Brunswick	5
Village of Three Rivers	12/23/2015	1,476	New Brunswick	3
Municipalité de Neguac	3/5/2018	1,692	New Brunswick	3
Village of Southern Victoria	2/15/2016	1,887	New Brunswick	3
Village de Petit-Rocher	11/12/2014	1,954	New Brunswick	5
Ville de Saint-Quentin	11/25/2014	2,141	New Brunswick	5
Ville de Vallée-des-Rivières	2/7/2018	2,213	New Brunswick	1
Communauté rurale de Kedgwick	2/19/2014	2,282	New Brunswick	5
District of Carleton North	5/9/2017	2,521	New Brunswick	1
Ville de Rivière-du-Nord	2/3/2014	3,034	New Brunswick	5
Village d'Atholville	5/1/2017	3,290	New Brunswick	3
Ville de Shippagan	12/2/2013	3,421	New Brunswick	5
Village de Bois-Joli	11/29/2013	3,447	New Brunswick	3
Hampton	2/1/2004	4,395	New Brunswick	3
Ville de Haut-Madawaska	8/8/2017	4,405	New Brunswick	3
Town of Heron Bay	1/18/2016	4,546	New Brunswick	3
Town of Grand Bay-Westfield	5/25/2016	4,967	New Brunswick	3
Town of Woodstock (NB)	2/9/2004	5,553	New Brunswick	3
Ville de Caraquet	10/31/2017	5,596	New Brunswick	3

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
Town of Sussex	4/19/2016	5,898	New Brunswick	3
Town of Tantramar	10/11/2003	7,005	New Brunswick	5
Ville de Belle-Baie	11/21/2017	8,110	New Brunswick	3
Town of Rothesay	4/11/2016	11,977	New Brunswick	3
City of Bathurst	4/1/2001	12,157	New Brunswick	5
Selwyn Township	7/9/2007	16,043	New Brunswick	5
City of Miramichi	4/1/2005	17,692	New Brunswick	2
Town of Quispamsis	4/11/2000	18,768	New Brunswick	3
Town of Riverview	5/11/2009	20,584	New Brunswick	2
Ville de Dieppe	3/11/2014	28,114	New Brunswick	5
City of Fredericton	6/11/2001	63,116	New Brunswick	5
City of Saint John	6/1/2006	69,895	New Brunswick	3
City of Moncton	11/1/2001	79,470	New Brunswick	3
Town of Bauline	5/24/2018	412	Newfoundland & Labrador	3
Town of Baie-Verte	10/1/2018	1,311	Newfoundland & Labrador	2
Town of Channel-Port aux Basques	8/6/2019	3,547	Newfoundland & Labrador	3
Town of Deer Lake	5/24/2019	4,864	Newfoundland & Labrador	2
Town of Stephenville	4/18/2018	6,540	Newfoundland & Labrador	3
Town of Torbay	5/11/2020	7,852	Newfoundland & Labrador	1
Town of Portugal Cove-St. Philip's	9/3/2019	8,415	Newfoundland & Labrador	3

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
City of Corner Brook	11/6/2006	19,333	Newfoundland & Labrador	3
City of Mount Pearl	12/1/2004	22,477	Newfoundland & Labrador	1
Town of Paradise	1/1/2006	22,957	Newfoundland & Labrador	3
Town of Conception Bay South	1/1/2003	27,168	Newfoundland & Labrador	4
City of St. John's	12/11/2000	110,525	Newfoundland & Labrador	3
City of Yellowknife	2/23/1998	20,340	Northwest Territories	5
Town of Annapolis Royal	9/1/2003	530	Nova Scotia	5
Town of Wolfville	1/1/2006	5,057	Nova Scotia	3
Town of Bridgewater	6/9/2014	8,790	Nova Scotia	4
Town of New Glasgow	3/8/1998	9,471	Nova Scotia	3
West Hants Regional Municipality	9/11/2018	19,509	Nova Scotia	2
Municipality of the District of Lunenburg	10/22/2019	25,545	Nova Scotia	1
Municipality of the County of Colchester	8/9/2016	51,476	Nova Scotia	1
Township of Billings	3/18/2019	753	Ontario	1
Township of The Archipelago	3/29/2019	979	Ontario	1
Township of McKellar	10/21/2019	1,419	Ontario	1
Township of Carling	6/20/2019	1,491	Ontario	1
Municipality of Central Manitoulin	6/13/2019	2,235	Ontario	1
Town of Northeastern Manitoulin and the Islands	7/4/2017	2,641	Ontario	1
Township of North Kawartha	3/17/2015	2,877	Ontario	4

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
Township of Melancthon	5/2/2019	3,132	Ontario	1
Township of Sables-Spanish Rivers	4/24/2019	3,237	Ontario	1
Township of Georgian Bay	5/14/2018	3,441	Ontario	3
Township of Mulmur	2/6/2020	3,571	Ontario	3
Township of Perth South	3/6/2001	3,776	Ontario	1
Township of Asphodel-Norwood	1/27/2015	4,658	Ontario	5
Township of Havelock-Belmont-Methuen	5/4/2015	5,083	Ontario	3
Township of Seguin	8/6/2019	5,280	Ontario	1
Town of Cochrane (ON)	7/29/2019	5,390	Ontario	1
Tay Valley Township	8/13/2019	5,925	Ontario	1
Municipality of Trent Lakes	1/6/2015	6,439	Ontario	5
Town of Parry Sound	6/18/2019	6,879	Ontario	1
Township of Otonabee-South Monaghan	3/20/2015	7,087	Ontario	5
Municipality of Bayham	1/22/2016	7,096	Ontario	3
Town of St. Marys	6/25/2019	7,386	Ontario	1
Township of Douro-Dummer	1/6/2015	7,632	Ontario	5
Township of Huron-Kinloss	11/9/2017	7,723	Ontario	3
Town of Goderich	1/8/2020	7,881	Ontario	1
Town of Smiths Falls	11/4/2019	9,254	Ontario	1
Town of Mono	11/28/2017	9,421	Ontario	1

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
Township of Cavan Monaghan	2/16/2015	10,016	Ontario	3
Municipality of South Huron	12/18/2017	10,063	Ontario	1
Town of Penetanguishene	1/24/2018	10,077	Ontario	3
Township of Hamilton	7/2/2020	11,059	Ontario	1
Township of Tay	3/28/2018	11,091	Ontario	3
Township of Brock	8/4/2009	12,567	Ontario	3
Township of Perth East	5/22/2019	12,595	Ontario	1
Township of Tiny	1/29/2018	12,966	Ontario	3
Township of Severn	4/18/2018	14,576	Ontario	3
Township of West Lincoln	7/4/2019	15,454	Ontario	1
Municipality of North Perth	5/15/2019	15,538	Ontario	1
Municipality of Port Hope	7/1/1997	17,294	Ontario	3
Town of Midland	9/24/2018	17,817	Ontario	3
Corporation of Loyalist Township	10/10/2017	17,943	Ontario	3
Township of Selwyn	1/13/2015	18,653	Ontario	5
Town of Cobourg	1/31/2011	20,519	Ontario	2
County of Haliburton	6/19/2019	20,571	Ontario	3
Town of Huntsville	1/25/2012	21,147	Ontario	1
Town of Collingwood	6/22/1998	24,811	Ontario	1
Township of King	5/13/2019	27,333	Ontario	2

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
Town of Orangeville	6/11/2018	30,167	Ontario	1
City of Stratford	3/8/2004	33,232	Ontario	1
City of Timmins	6/5/2018	41,145	Ontario	3
County of Huron	7/3/2019	61,366	Ontario	1
Town of Aurora	8/21/2018	62,057	Ontario	3
County of Dufferin	6/6/2018	66,257	Ontario	3
District Municipality of Muskoka	5/21/2019	66,674	Ontario	1
City of Sault Ste. Marie	9/9/2019	72,051	Ontario	3
Lanark County	1/28/2015	75,760	Ontario	2
Town of Caledon	9/1/2003	76,581	Ontario	5
City of Kawartha Lakes	6/30/2016	79,247	Ontario	3
City of Peterborough	9/11/2000	83,651	Ontario	4
Town of Newmarket	3/25/2008	87,942	Ontario	1
Municipality of Clarington	3/3/2020	101,427	Ontario	2
City of Brantford	7/2/1996	104,688	Ontario	3
City of Thunder Bay	3/24/1997	108,843	Ontario	5
City of Kingston	4/17/2001	132,485	Ontario	5
City of St. Catharines	11/12/2007	136,803	Ontario	1
City of Cambridge	3/26/2012	138,479	Ontario	5
City of Guelph	4/6/1998	143,740	Ontario	5

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
County of Peterborough	9/4/2013	147,681	Ontario	5
City of Barrie	3/1/2001	147,829	Ontario	3
City of Greater Sudbury	7/1/1997	166,004	Ontario	4
City of Oshawa	3/9/2009	175,383	Ontario	5
City of Burlington	6/1/2002	186,948	Ontario	5
City of Richmond Hill	9/1/2000	202,022	Ontario	5
Town of Oakville	5/26/2004	213,759	Ontario	5
City of Windsor	12/1/2002	229,660	Ontario	3
City of Kitchener	1/20/1997	256,885	Ontario	5
City of Vaughan	4/5/2011	323,103	Ontario	3
City of Markham	2/13/2007	338,503	Ontario	5
City of London	11/28/1994	422,324	Ontario	5
Regional Municipality of Niagara	8/1/2008	477,941	Ontario	3
County of Simcoe	4/24/2018	533,169	Ontario	1
Regional Municipality of Waterloo	4/14/2010	587,165	Ontario	5
Regional Municipality of Halton	2/24/2005	596,637	Ontario	1
City of Mississauga	12/2/1999	717,961	Ontario	5
City of Ottawa	2/12/1997	1,017,449	Ontario	5
Regional Municipality of York	9/20/2001	1,173,334	Ontario	3
Region of Peel	Region of Peel	1,451,022	Ontario	2

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
City of Toronto	2/1/1994	2,794,356	Ontario	5
Town of Stratford	4/1/2008	10,927	Prince Edward Island	3
City of Charlottetown	1/1/2002	38,809	Prince Edward Island	3
Municipalité de Calixa-Lavallée	7/7/2021	509	Québec	3
Municipalité de Saint-Luc-de-Vincennes	2/4/2020	519	Québec	1
Municipalité de Sainte-Flavie	8/20/2019	904	Québec	1
Municipalité d'Austin	11/2/2020	1,748	Québec	3
Municipalité de Verchères	6/7/2021	5,759	Québec	3
Ville de Plessisville	5/4/2015	6,414	Québec	5
Ville de Baie-Saint-Paul	6/26/2017	7,371	Québec	4
Municipalité de Chelsea	1/6/1997	8,000	Québec	1
Ville de Nicolet	6/18/2012	8,620	Québec	5
Municipalité de Contrecoeur	7/7/2021	9,480	Québec	3
Ville de Bromont	12/7/2015	11,357	Québec	1
Ville de Saint-Amable	10/1/2021	13,322	Québec	3
Municipalité de Val-des-Monts	1/15/2019	13,328	Québec	5
MRC de la Côte-de-Gaspé	4/16/2019	17,547	Québec	3
Ville de Rivière-du-Loup	2/8/2010	20,118	Québec	5
Ville de Varennes	8/16/2021	21,198	Québec	3
Ville de Candiac	9/24/2018	22,997	Québec	1

Municipality	Member Since	Census Population	Province	Highest Milestone Achieved
Arrondissement d'Outremont	3/2/2020	23,954	Québec	1
Ville de Beloeil	2/22/2021	24,104	Québec	1
Ville de Sainte-Julie	4/12/2018	30,045	Québec	3
MRC de Marguerite-d'Youville	2/13/2020	80,313	Québec	3
Arrondissement Saint-Laurent	12/3/2013	98,828	Québec	5
MRC de Vaudreuil-Soulanges	3/29/2017	162,600	Québec	3
Ville de Sherbrooke	6/6/2016	172,950	Québec	2
Ville de Laval	3/3/1997	438,366	Québec	3
Ville de Québec	1/15/1997	549,459	Québec	3
Village of Zenon Park	8/11/2016	176	Saskatchewan	3
Town of Carrot River	9/19/2016	946	Saskatchewan	3
Town of Eston	8/25/2017	972	Saskatchewan	3
Town of Gravelbourg	7/12/2018	986	Saskatchewan	3
Town of Tisdale	7/16/2018	2,962	Saskatchewan	3
City of Humboldt	2/27/2017	6,033	Saskatchewan	3
City of Warman	10/15/2019	12,419	Saskatchewan	1
City of Saskatoon	12/15/2003	266,141	Saskatchewan	3
City of Whitehorse	7/1/1995	28,201	Yukon	5

Appendix C: Ethics clearance certificate (Papers 2 and 3)

UNIVERSITY OF WATERLOO

Notification of Ethics Clearance to Conduct Research with Human Participants

Principal Investigator: Amelia Clarke

Student investigator: Leah Feor

Co-Investigator: Jeffrey Wilson

Administrative Support: Samantha Linton

Co-Investigator: Georges Tanguay (Université du Québec à Montréal)

File #: 45590

Title: Examining the non-financial performance measurement practices of Canadian municipalities

The Human Research Ethics Board is pleased to inform you this study has been reviewed and given ethics clearance.

Initial Approval Date: 09/08/23 (m/d/y)

University of Waterloo Research Ethics Boards are composed in accordance with, and carry out their functions and operate in a manner consistent with, the institution's guidelines for research with human participants, the Tri-Council Policy Statement for the Ethical Conduct for Research Involving Humans (TCPS2 2022), the Ontario Personal Health Information Protection Act (PHIPA), and all laws and regulations of the province of Ontario (as applicable). Additionally, CREB operates in a manner consistent with the International Conference for Harmonization of Technical Requirements for Pharmaceuticals for Human Use (ICH) Guidance E6(R2): Good Clinical Practice, the International Organization for Standardization of Good Clinical Practices (GCP) as set out by ISO 14155 - Clinical investigation of medical devices for human subjects, Part C, Division 5 of the Food and Drug Regulations, Part 4 of the Natural Health Products Regulations, Part 3 of the Medical Devices Regulations. Both Boards are registered with the U.S. Department of Health and Human Services under the Federal Wide Assurance, FWA00021410, and IRB registration number IRB00002419 (HREB) and IRB00007409 (CREB).

Expiry Date: 09/09/24 (m/d/y)

Multi-year research must be renewed at least once every 12 months unless a more frequent review has otherwise been specified. Studies will only be renewed if the renewal report is received and approved before the expiry date. Failure to submit renewal reports will result in the investigators being notified ethics clearance has been suspended and Research Finance being notified the ethics clearance is no longer valid.

Level of review: Delegated Review

Signed on behalf of the Human Research Ethics Board



Karen Pieters, Manager, Research Ethics, karen.pieters@uwaterloo.ca, 519-888-4567, ext. 41495

This above named study is to be conducted in accordance with the submitted application and the most recently approved versions of all supporting materials.

Documents reviewed and received ethics clearance for use in the study and/or received for information:

file: N-ZAP_WG2_Interview script_version 2_September 2023.pdf

file: WG2_recruitment-email_version 2_September 2023.pdf

file: WG2_Information letter_version 2_September 2023.pdf

file: WG2_follow-up-email_version 1_August 2023.pdf

file: WG2_follow-up phone call script_version 1_August 2023.pdf

file: WG2_Aculty confirmation email_version 2_September 2023.pdf

file: WG2_Information letter_version 2_September 2023.pdf

file: WG2_thank-you-email_version 1_August 2023.pdf

Approved Protocol Version 4 in Research Ethics System

This is an official document. Retain for your files.

You are responsible for obtaining any additional institutional approvals that might be required to complete this study.

Appendix D: Appendices D.1–D.6 – Interview and recruitment materials (Papers 2 and 3)

Appendix D.1: N-ZAP Working Group 2 Interview Guide – November 2023

Introduction

This study aims to gain a better understanding of current non-financial performance measurement practices of Canadian municipalities, including their use of sustainability/climate change indicators. Information related to measurement motivations, barriers, and suggestions for a standardized tool will be gathered and analyzed to identify commonalities and differences between sample municipalities. It is hypothesized that measurement practices will vary between case study participants and that indicators may not be applicable across all Canadian municipalities.

The objective of this research is to identify a meaningful selection of climate mitigation indicators to be considered for integration into the Partners for Climate Protection (PCP) tool. To recognize the value of comparability with other jurisdictions while considering the local context, it is proposed that there are core indicators (for use by all Canadian municipalities) and elective indicators (context-based, for use by certain municipalities).

Related research questions

1. What are the internal and external contingent factors that affect non-financial performance measurement practices?
2. Which of the climate-related indicators currently used by select Canadian municipalities are most suitable to measure climate mitigation performance at the municipal level?

Procedures

Before getting started, the interviewer will need to set up an **Acuity account** to schedule interviews and a **Zoom account** to conduct interviews.

Note: all correspondence between the interviewer and interviewees must be done with an official email address from their institution.

Recruitment

- The interviewer will use the **Recruitment and Interview Tracking Sheet** (to document all recruitment efforts).
- Using their institution email address, the interviewer will email pre-selected municipalities on behalf of the N-ZAP project. Contact names and email addresses can be found on the Recruitment Tracking Sheet.

- The (RA) will carbon copy Dr. Amelia Clarke (amelia.clarke@uwaterloo.ca), Megan Meaney (megan.meaney@iclei.org), Adlar Gross (adlar.gross@iclei.org), Leah Feor (lfeor@uwaterloo.ca), Georges Tanguay (tanguay.georges@uqam.ca).
- Within the **recruitment email**, target participants will be asked to schedule an interview through a link to the Acuity Scheduling app (ensure the hyperlink is working).
- Attach the interview **Information Letter** to the recruitment email.
- If the initial email does not yield any results, the interviewer will contact Leah Feor (lfeor@uwaterloo.ca) and Georges Tanguay (tanguay.georges@uqam.ca).
- Optional step if necessary: If the initial recruitment email does not result in an interview being scheduled, a **follow-up email** will be sent approximately 1 week after the initial recruitment email.
 - The follow-up email will be sent by the same research assistant.

Scheduling the interview

- The interviewer will use the **Recruitment and Interview Tracking Sheet** to document key details about the interview process (scheduling the interview, conducting the interview, and post-interview).
- The interviewer will receive a notification from Acuity once a recruited participant schedules an interview.
- Using the information provided through Acuity, the interviewer will send the participant(s) an invite using their Outlook calendar. The interviewer will include the Zoom invitation in the description field of the Outlook calendar invite.
- If the participant does not feel comfortable using Zoom, a Teams meeting or telephone interview will be planned.
- Once an interview is scheduled, the interviewer will ensure that all participants have received the **information letter** and **interview questions**.
- The interviewer should leave at least 30 minutes between each interview. This gives the interviewer additional time (with the consent of the interviewee), if needed. It also allows the interviewer to download and save the interview recording and transcript.

Conducting and recording the interview

- The interviewer will use the **Recruitment and Interview Tracking Sheet** to document key details about the interview process (scheduling the interview, conducting the interview, and post-interview).
- The interviewer will use the **Interview Script** to conduct semi-structured interviews.
- The interview will take place over Zoom and is scheduled for 60 minutes. If the interview requires additional time (i.e., 5 minutes), the interviewer will confirm with the participant that they are available beyond the hour.
- **The participant will provide consent at the beginning of the interview.**
- **The interviewer will start recording in Zoom prior confirming participants' consent (after reading a brief introduction).**

- The interviewer will ensure that the transcription function is activated in Zoom and will save the transcript at the end of the interview (not required for French interviews).
- During the interview, the participant will be asked a series of core questions related to their municipality's non-financial/climate-related performance measurement practices.
- Several questions (numbered) have sub-questions (lettered) that will be used at the discretion of the interviewer. The lettered sub-questions include prompts that the interviewer can ask the participant if they are not providing sufficient details when responding to the numbered question.
- The interviewer will take notes throughout the interview that may be deemed necessary to provide a more complete understanding of the interview. For example, the interviewer can make note of the participant's body language or tone.

Post-interview

- Use the **Recruitment and Interview Tracking Sheet** to document key details about the interview process (scheduling the interview, conducting the interview, and post-interview).
- Download the audio and transcript to a **confidential and secure folder** using the following name format:
 - Name of municipality_Date_Type of document
 - For example, VilledeGatineau_October252023_Audio
- Send **thank you e-mail** to participant and provide date for the supplementary documents to be shared by.
- Download the supplementary documents to a **confidential and secure folder** using the following name format:
 - Name of municipality_Date_Type of document
 - For example, VilledeGatineau_October252023_IndicatorSelectionMaterials

Appendix D.2: Recruitment email

Subject: Interview invitation: Measuring climate action in Canadian municipalities

Sender: N-ZAP Researcher (Leah Feor)

CC: Dr. Amelia Clarke (amelia.clarke@uwaterloo.ca), ICLEI staff (megan.meaney@iclei.org), Adlar Gross (adlar.gross@iclei.org).

Dear (Title Name),

I am writing to you on behalf of the [Municipal Net-Zero Action Research Partnership \(N-ZAP\)](#) to invite you to participate in a research study on the non-financial performance measurement practices of Canadian municipalities. I am a PhD student at the University of Waterloo in Waterloo, Ontario and this research study is part of my dissertation.

Participation in this interview is voluntary, will take the form of a 60-minute interview via Zoom, and will take place at a mutually convenient time.

By completing this interview, your municipality will:

- Gain access to **cutting-edge** resources on climate accounting, measurement and shared governance produced by the program
- Have the opportunity to join N-ZAP as a pilot city
- Showcase the work and efforts of your sustainability and climate change performance measurement practices
- Have the opportunity to contribute to the climate conversation at a national level

[INCLUDE THIS PARAGRAPH FOR PCP MEMBERS] You have been selected as a case study municipality to participate in an interview based on pre-defined criteria including your participation in the Partners for Climate Protection (PCP) program. Neither participating in, nor deciding not to participate in, this interview will affect your relationship with PCP program.

[INCLUDE THIS PARAGRAPH FOR NON-PCP MEMBERS] You have been selected as a case study municipality to participate in an interview based on pre-defined criteria including the size and location of your municipality.

The primary goal of N-ZAP is to support Canadian municipalities as they monitor, measure and achieve their greenhouse gas (GHG) targets. The aim is to help ensure that municipal emissions reduction projects, policies and programs are aligned with Canada's national reduction commitments. The objective of this interview is to gain insights into how Canadian municipalities measure their progress towards climate mitigation and related sustainable development goals.

Please take a few moments to review the **attached information letter** and to schedule an interview through this [Acuity Scheduling link](#) by **November 17th, 2023**. The questions in the interview focus on sustainability and climate change performance measurement, indicator selection process,

progress reporting and communication, indicator themes/sectors, and performance measurement data. The interview responses will be used by the University of Waterloo, the Federation of Canadian Municipalities' Green Municipal Fund (FCM) and ICLEI Canada to improve climate change mitigation performance measurement tools and for academic research conducted by N-ZAP, including Leah Feor's PhD dissertation. This project has been reviewed and received ethics clearance through the University of Waterloo Research Ethics Board.

If you have any questions about participation in this research study, please feel free to contact Leah Feor at lfeor@uwaterloo.ca. For questions about N-ZAP, please contact Dr. Amelia Clarke at amelia.clarke@uwaterloo.ca.

We are looking forward to hearing from you and learning more about your municipality's progress towards advancing Canada's climate commitments. Thank you for your time and cooperation,

Leah Feor, MEB

PhD Candidate, Sustainability Management
School of Environment, Enterprise and Development (SEED)
University of Waterloo
[Municipal Net-Zero Action Research Partnership \(N-ZAP\)](#)

N-ZAP is a research partnership funded, in part, by the Government of Canada through the Climate Action and Awareness Fund (CAAF) and jointly led by the University of Waterloo, the Federation of Canadian Municipalities' Green Municipal Fund (FCM) and ICLEI Canada, working with 11 other academic institutions, and 9 other national organizations and 13 municipal partners. Working Group 2 is co-chaired by Dr. Jeffrey Wilson, University of Waterloo and Megan Meaney, ICLEI Canada.

Appendix D.3: Information Letter

You have been invited to participate in an interview that aims to **gain insights into how Canadian municipalities measure their progress towards climate mitigation and related sustainable development goals**. These interviews are part of the [Municipal Net-Zero Action Research Partnership \(N-ZAP\)](#) project.

The interview questions relate to the following themes: sustainability and climate-related performance measurement, indicator selection process, progress reporting and communication, indicator themes/sectors, performance measurement data, and measurement and reporting challenges. The interview responses will be used by the University of Waterloo, the Federation of Canadian Municipalities' Green Municipal Fund (FCM) and ICLEI Canada to improve climate mitigation performance measurement from the Canadian perspective and for academic research. The name of your municipality and your role will be identified in research papers and reports as a study participant. Some responses from your interview may be included in research papers and reports with attribution to your municipality. All quotes attributed to your municipality will be validated prior to inclusion and will not be published without your permission.

By agreeing to participate in the study you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

The interview will be **approximately 60 minutes** long and can be scheduled at your convenience using Acuity, an online scheduling software. The interview questions will be made available to you prior to the scheduled interview. You have been selected as the interviewee for your municipality because your role includes performance measurement responsibilities. If you would like to consult with colleagues prior to our interview, please feel free to do so. If you would like to have your colleague(s) join the scheduled interview, please let us know in advance by contacting Leah Feor by email at lfeor@uwaterloo.ca.

The interview will be hosted through Zoom, so you can join the interview through a laptop, or you can dial in by phone. Zoom has implemented technical, administrative, and physical safeguards to protect the information provided via its services from loss, misuse, and unauthorized access, disclosure, alteration, or destruction. However, no Internet transmission is ever fully secure or error free. If you prefer not to complete this interview through Zoom, please contact our research assistant, **Leah Feor**, by email at lfeor@uwaterloo.ca, and we will make arrangements to provide you with another method of participation, such as a phone interview.

Participation in this study is voluntary. **You may decline to answer any questions that you do not wish to answer, and you can withdraw your participation by contacting Leah Feor lfeor@uwaterloo.ca.** There are no known or anticipated risks from participating in this study for you and your municipality. **After you have participated in the interview on behalf of your municipality, you may also withdraw your interview responses until data are submitted for publication as part of a research study or report.** The data will be stored for at least 10 years on password-protected computers of researchers and a shared Dropbox Folder with restricted access by only researchers from this project.

This study has been reviewed and received ethics clearance through the University of Waterloo Research Ethics Board (REB #45590). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca.

Should you have any questions about your involvement in this research, please contact **the N-ZAP project manager, Samantha Hall Linton**, by email at shlinton@uwaterloo.ca.

If you have any general comments or questions related to the N-ZAP project, please contact **Dr. Amelia Clarke**, N-ZAP Project Lead, at 519-888-4567 ext. 48910 or by email at amelia.clarke@uwaterloo.ca.

If you would like to receive a copy of the results from this study, please confirm your contact information during the interview so that we may follow up with you.

Thank you for your consideration.

N-ZAP is a research partnership funded, in part, by the Government of Canada through the Climate Action and Awareness Fund (CAAF) and jointly led by the University of Waterloo, the Federation of Canadian Municipalities' Green Municipal Fund (FCM) and ICLEI Canada, working with 11 other academic institutions, and 9 other national organizations and 13 municipal partners. Working Group 2 is co-chaired by Dr. Jeffrey Wilson, University of Waterloo and Megan Meaney, ICLEI Canada.

Appendix D.4: Follow-up email

Subject: Follow-up: Interview: Measuring climate action in Canadian municipalities

Sender: N-ZAP Researcher (Leah Feor)

CC: Dr. Amelia Clarke, ICLEI staff

Dear (Title Name),

I hope this email finds you well. I am following up with you to see if you have any questions about the interview that you were invited to participate in by a member of the [Municipal Net-Zero Action Research Partnership \(N-ZAP\)](#) research team on (INSERT DATE). This interview is part of the N-ZAP project and aims to gain insights into how Canadian municipalities measure their progress towards climate mitigation and related sustainable development goals.

Participation in this interview is voluntary, will take the form of a 60-minute interview via Zoom, and will take place at a mutually convenient time.

Please take a few moments to review the attached information letter and to schedule an interview through this Acuity Scheduling link by (DATE AND TIME). The questions in the interview focus on sustainability and climate change performance measurement, indicator selection process, progress reporting and communication, indicator themes/sectors, and performance measurement data. The interview responses will be used by the University of Waterloo, the Federation of Canadian Municipalities' Green Municipal Fund (FCM) and ICLEI Canada to improve climate change mitigation performance measurement tools and for academic research conducted by N-ZAP, including Leah Feor's PhD dissertation. This project has been reviewed and received ethics clearance through the University of Waterloo Research Ethics Board.

If you have any questions about participation in this research study, please feel free to contact Leah Feor at lfeor@uwaterloo.ca. For questions about N-ZAP, please contact Dr. Amelia Clarke at amelia.clarke@uwaterloo.ca.

Thank you for your time and cooperation,

Leah Feor, MEB

PhD Candidate, Sustainability Management

School of Environment, Enterprise and Development (SEED)

University of Waterloo

[Municipal Net-Zero Action Research Partnership \(N-ZAP\)](#)

N-ZAP is a research partnership funded, in part, by the Government of Canada through the Climate Action and Awareness Fund (CAAF) and jointly led by the University of Waterloo, the Federation of Canadian Municipalities' Green Municipal Fund (FCM) and ICLEI Canada, working with 11 other academic institutions, and 9 other national organizations and 13 municipal partners. Working Group 2 is co-chaired by Dr. Jeffrey Wilson, University of Waterloo and Megan Meaney, ICLEI Canada.

Appendix D.5: List of interview questions

Note to interviewee: Below are the questions that will be asked throughout your 60-minute interview. The numbered questions are the key questions whereas the lettered sub-questions are prompts to help with your response. Thank you for your participation in our study. If you have any questions, please reach out lfeor@uwaterloo.ca.

1. Please state your role and how long you have been in it.
 - a. Which department are you part of?
2. What is the length of time you have been working on indicators and/or performance measurement?
 - a. For your municipality?
 - b. In your career?
3. What is the process that your municipality has in place to measure its sustainability and climate change performance?
 - a. Do you currently use indicators to measure performance?
 - b. Other than you, who else is responsible for measuring sustainability and climate change performance?
 - c. Which other departments in your municipality do you work with to measure sustainability and climate change performance?
 - d. Do you work with any consultants or external organisations when measuring sustainability and climate change performance?
4. How do you select the indicators used for measuring sustainability and climate change performance?
 - a. Do you have indicator selection criteria?
 - i. If so, who developed/approved it?
 - b. Who is involved in the indicator selection process (internal and external)?
 - c. How often do you review/update your indicators?
 - d. How have the indicators that you use changed over time?
 - i. Have your strategic priorities changed?
 - ii. Has more data become available?
5. Is there anything specific or unique about your municipality or province/territory that influences your indicator selection?
6. **Would you be open to sharing your indicator selection material with me after this interview? We are asking for these materials so we can better understand the way your municipality selects indicators; it will help us contextualize the answers you gave in this interview.**
7. Which sustainability and climate change themes do you cover with your indicators?
 - a. Green economy?
 - b. Nature-based solutions?
 - c. Social justice?
 - d. Transportation (including active transportation)?
 - e. Energy?
 - f. Housing?
 - g. Waste management?

- h. Land-use planning?
 - i. Conservation?
8. **Would you be open to sharing your sustainability and climate change indicators with me after this interview? We are asking for these indicators to analyze them and consider their inclusion in the PCP tool, which is a web-based greenhouse gas emissions reduction quantification tool.**
 9. Where do you obtain the data that your municipality uses to measure sustainability and climate change performance?
 - a. Do you use internal operational data?
 - b. Do you use Statistics Canada data (including Census data)?
 - c. Do you use provincially sourced data (i.e., from provincial agencies)?
 - d. Do you use locally sourced data (i.e., consumption data from utilities, transportation surveys, etc.)?
 - e. Do you use AI-generated data?
 10. How do you communicate the progress of your sustainability and climate change performance?
 - a. How often do you communicate progress with internal stakeholders?
 - b. How often do you communicate progress with external stakeholders?
 11. **Would you be open to sharing your most recent progress reports or equivalent on your municipality's sustainability and climate change performance (reports to both internal and external stakeholders)?**
 12. Do your indicators allow you to compare your municipality's sustainability and climate change performance with the performance of other municipalities?
 - a. Do you compare your performance results to other municipalities with similar characteristics (i.e., population size, location)?
 - b. Do you compare your performance results to other municipalities in Canada?
 - c. Do you compare your performance results to other municipalities globally?
 13. What measurement and reporting challenges do you face?
 - a. What challenges do you face when measuring sustainability and climate change performance?
 - b. What challenges do you face during the indicator selection process?
 - c. What challenges do you face when gathering data required to measure sustainability and climate change performance?
 - d. What challenges do you face when communicating progress with internal stakeholders?
 - e. What challenges do you face when communicating progress with external stakeholders?
 14. Is there anything specific or unique about your municipality or province/territory that might make measurement and reporting more challenging?

End of interview

Appendix D.6: Thank-you email

Subject: Thank you for participating in the N-ZAP interview

Sender: Interviewer

Dear (Title Name),

Thank you for taking the time to participate in the [Municipal Net-Zero Action Research Partnership \(N-ZAP\)](#) interview. We appreciate your time and are pleased that your local government's voice has been captured and will contribute to the national climate conversation, helping advance progress in reducing local GHG emissions.

[ONLY INCLUDE THE NEXT PARAGRAPH IF THEY AGREED DURING QUESTIONS 7, 10, and/or 12]

As discussed during the interview, I would be grateful if you could share materials that outline your indicator selection process, indicators currently in-use, and your municipality's most recent sustainability and/or climate change progress report by [INSERT DEADLINE].

Work on the N-ZAP project progresses steadily every day and we will be sure to notify you as our resources, workshops, and updates about measurement practices become available. You will be added to the N-ZAP e-newsletter which comes out two to three times per year. If you noted that you are interested in piloting our tools or being a pilot city during the interview, we will follow up with you soon with more information.

Should you have any questions about your involvement in this research, please contact Samantha Hall Linton, Project Manager, N-ZAP at shlinton@uwaterloo.ca. If you have any general comments or questions related to the N-ZAP project, please contact Dr. Amelia Clarke, N-ZAP Project Lead, at 519-888-4567 ext. 48910 or by email at amelia.clarke@uwaterloo.ca.

This study has been reviewed and received ethics clearance through the University of Waterloo Research Ethics Board (REB # 45590). If you have questions for the Board contact the Office of Research Ethics at 1-519-888-4567 ext. 36005 or reb@uwaterloo.ca.

Thank you for your time and cooperation,

Leah Feor, MEB

PhD Candidate, Sustainability Management
School of Environment, Enterprise and Development (SEED)
University of Waterloo
lfeor@uwaterloo.ca

N-ZAP is a research partnership funded, in part, by the Government of Canada through the Climate Action and Awareness Fund (CAAF) and jointly led by the University of Waterloo, the Federation of Canadian Municipalities' Green Municipal Fund (FCM) and ICLEI Canada, working with 11 other academic institutions, and 9 other national organizations and 13 municipal partners. Working Group 2 is co-chaired by Dr. Jeffrey Wilson, University of Waterloo and Megan Meaney, ICLEI Canada.

Appendix E: Deductive and inductive coding description by performance measurement process category (Paper 2)

Performance measurement step	Sub-category	Codes	How codes were selected
<i>Prioritizing</i>	Measurement focus (coded inductively)	-Buildings (beyond data for GHG emissions calculation) -Climate adaptation and resilience -Climate mitigation and GHG emissions -Energy conservation and transition (includes OReg) -Sustainable development (broadly defined) -Environmental sustainability (waste, water – other than emissions related) -Transportation (other than emissions related)	Codes were based on the measurement areas referenced by the interviewee when responding to the interview questions. The interviewee(s) go beyond simply mentioning a measurement area, their response indicates some level of focus.
<i>Prioritizing</i>	Indicator themes (coded inductively)	-Adaptation, resilience, and public safety -Asset management and infrastructure -Biodiversity, ecosystems, and nature -Buildings -Community action, engagement, and well-being -Economic development and green economy -Education -Energy and transition -Equity, diversity, and inclusion (EDI) -Governance, innovation, and leadership -Health and wellness -Housing -Land-use and development -Mitigation and GHG emissions -Transportation and mobility -Waste management	Codes were based on the interviewee(s) responses during interviews and the supplementary documents shared by participants (i.e., plans and reports). The large group was coded first since they had the largest representation of areas of measurement, and a preliminary list of indicator themes were established to code the medium and small group with.

Performance measurement step	Sub-category	Codes	How codes were selected
<i>Selecting Indicators</i>	Use of indicator selection criteria (coded inductively)	-No -Yes (informal) -Yes (formal)	Codes were based on the interviewee(s) responses. Once the codes were established, all cases were coded again to capture the frequency counts.
<i>Selecting Indicators</i>	Indicator selection criteria (coded deductively)	-Comparable to other jurisdictions -Comparable to targets -Cost-effective -Data availability and quality -Relevance -Representative -Responsiveness -Scientifically valid -Unambiguous	Codes were pre-defined using the indicator selection criteria established by Maclaren (1996b).
<i>Selecting Indicators</i>	Involvement of internal and external stakeholders in the indicator selection processes (coded inductively)	-Internal stakeholder involvement -Internal and external stakeholder involvement -No involvement mentioned during interview	Codes were based on the interviewee(s) responses. Once the codes were established, all cases were coded again to capture the frequency counts.
<i>Obtaining Data</i>	Data sources (coded inductively)	-internal operational data (i.e., surveys, utility consumption data) -locally sourced data (i.e., regional government, locally owned landfill) -provincially sourced data (i.e., Ministry of Transportation) -nationally sourced data (i.e., Statistics Canada's Census data, Environment Canada and Climate Change) -Third-party data (i.e., Kalibrate, academic institutions, Google)	Codes are based on the interviewee(s) responses. Once the codes were established, all cases were coded again to capture the frequency counts.

Performance measurement step	Sub-category	Codes	How codes were selected
		-AI-generated data (i.e., Environmental Insights Explorer) ⁷	
<i>Interpreting Data</i>	Approach to analysis (coded deductively)	-Norms and targets • Time dimension (e.g., measuring progress over time) • Comparisons with other municipalities • Scientific standards (e.g., net-zero by 2050) • Political and ideological (e.g., SDGs) -Breakouts and aggregation -Causal analysis	Codes were pre-defined using three interpretive strategies described in Van Dooren et al., (2010).
<i>Reporting</i>	Format of the reports (coded inductively)	-CDP Cities (cross-referenced with CDP website) -Dashboard -Provincial reporting framework -Report (includes GHG inventory) -Report card	Codes were based on the interviewee(s) responses. Once the codes were established, all cases were coded again to capture the frequency counts.
<i>Reporting</i>	Reporting frequency (coded deductively)	-Annually -As-needed basis -Greater than once per year -Less than once per year -Not reporting	Codes were pre-defined by the authors. If more than one frequency was mentioned by the interviewee, the greatest frequency was selected.
<i>Reporting</i>	Audience – recipients of the reporting (coded inductively)	-General public -Internal departments and staff -Municipal council and committees -Other levels of government	Codes were based on the interviewee(s) responses. Once the codes were established, all cases were coded again to capture the frequency counts.

⁷ <https://insights.sustainability.google/?hl=en-US>

Appendix F: Example of the data structure (Gioia et al., 2013) used to develop proposed shortlist indicators (Paper 3)

1st order code (original indicator)	2nd order code	3rd order code		Proposed indicator (#25 from the shortlist)
Quantity of residual material from the residential sector destined for landfill annually in kg/capita	Residential waste for landfill	Waste to landfill		Quantity of residual material from the residential sector destined for landfill annually per capita (kg/capita)
Per capita waste generation	Per capita waste generation	Waste to landfill		
Tonnes of garbage generated annually	Tonnes of garbage generated annually	Waste to landfill		
Curbside Waste Generation	Curbside Waste Generation	Waste to landfill		
Waste stream: solid waste disposal	Disposal rate	Waste to landfill		
Average amount of curbside waste disposed per households (kg/year)	Curbside Waste Generation	Waste to landfill		
153 kg of waste generated per household	Waste generated per household	Waste to landfill		
Residential Waste Going to Landfill	Residential Waste Going to Landfill	Waste to landfill		

Appendix G: Shortlist indicators (Paper 3)

Indicator #	Proposed Indicators (see comments)	Activity sector	Theme	Number of municipalities using the indicator	Type of indicator (logic model)
1	Natural gas consumption per capita (m3/year/person)	Buildings	Natural gas	2	Output
2	Average yearly electricity consumption per capita (kWh/year/person)	Energy, electricity, and outdoor lighting	Energy consumption	2	Output
3	Savings achieved through the implementation of energy (efficiency) initiatives (dollars/year/capita)	Energy, electricity, and outdoor lighting	Energy consumption	2	Outcome
4	Annual renewable electricity generated per capita (kWh/year/person)	Energy, electricity, and outdoor lighting	Renewable energy	4	Output
5	Total installed renewable electricity generation capacity (MW)	Energy, electricity, and outdoor lighting	Renewable energy	3	Output
6	Local Air Quality Health Index (AQHI)	Other	Air quality	5	Outcome
7	Percentage of impervious area within the municipal boundaries	Other	Built environment	2	Outcome
8	Percentage of tree canopy coverage within the municipal boundaries	Other	Canopy coverage	11	Outcome
9	Number of trees planted per year on public property	Other	Canopy coverage	6	Output
10	Percentage of greenspace and natural areas within the municipal boundaries	Other	Natural infrastructure	5	Outcome
11	Percentage of protected greenspace and natural areas within the municipal boundaries	Other	Natural infrastructure	3	Outcome

Indicator #	Proposed Indicators (see comments)	Activity sector	Theme	Number of municipalities using the indicator	Type of indicator (logic model)
12	Annual water consumption per capita (L/year/person)	Other	Water conservation	3	Output
13	Percentage of residents commuting by active transportation and public transit	Transportation	Active/public transportation	5	Outcome
14	Total distance (km) of sidewalk, bike lanes and multi-use trails network	Transportation	Active transportation	5	Output
15	Percentage of road network with a sidewalk	Transportation	Active transportation	3	Outcome
16	Number of electric vehicles (community scale) per capita	Transportation	Electrification	5	Output
17	Percentage of fleet vehicles and municipal equipment that are electric	Transportation	Electrification	2	Output
18	Use of EV chargers (hours charging, kWh consumed)	Transportation	Electrification	2	Output
19	Number of EV charging stations per thousand people for public use	Transportation	Electrification	4	Output
20	Savings (\$ and/or GHG) achieved through electrification of the municipal fleet	Transportation	Electrification	2	Outcome
21	Percentage of households within 400 metres of a regular service public transit stop	Transportation	Public transportation	2	Outcome
22	Number of transit rides per capita	Transportation	Public transportation	7	Outcome
23	Vehicle kilometres travelled (VKT, km/year/capita)	Transportation	Vehicle use	2	Output

Indicator #	Proposed Indicators (see comments)	Activity sector	Theme	Number of municipalities using the indicator	Type of indicator (logic model)
24	Percentage of municipal residential waste diverted from landfill annually	Waste	Waste diversion	12	Output
25	Quantity of residual material from the residential sector destined for landfill annually per capita (kg/capita)	Waste	Waste to landfill	7	Output
26	Progress towards GHG emissions reduction targets	GHG general	General emissions	2	Impact

Appendix H: Indicator evaluation matrix questionnaire (Paper 3)



N-ZAP WG2 - Indicator Evaluation Matrix Questionnaire

This form is used to collect data from N-ZAP Working Group 2 (WG2) during the February 28, 2025, WG2 Indicator Selection Meeting. The goal is to select a parsimonious list of climate-mitigation indicators using the general criteria outlined below. The selected indicators aim to complement the existing Partners for Climate Protection (PCP) tool, which focuses on corporate or community greenhouse gas (GHG) emissions inventory. Indicators are selected using an indicator evaluation matrix that contains seven general selection criteria defined with input from WG2 and literature.

Definitions of general criteria used to select indicators. Sources: (MacLaren, 1996a, 1996b; Tanguay et al., 2010) and input from WG 2.

Responsive • Facilitates timely action by decision-makers • Useful for tracking progress and matching it with costs (cost/benefit analysis) • Responsive to local needs (local context)

Relevant to the needs of potential users • Alignment with the broader community to facilitate "buy-in" • Alignment with data needs of stakeholders (for measuring their own goals) • Accessible to various stakeholder groups and educational backgrounds • Not all indicators will be useful to all stakeholders (focus on key users)

Relevant to stated goals • Useful for tracking progress towards broader goals and vision (e.g., climate and net-zero goals) • Useful for comparing performance to others with shared goals • Promotes accountability (evidence of doing what was promised) • Aligns with work being done/planned by the municipality

Availability of quality data • Data to measure the indicator currently exists • Dependent on data from other levels of government • Proxy data is likely still required since data availability is an ongoing challenge that requires improvement

Comparable to thresholds or targets • Facilitates the tracking of progress • Useful for adjusting actions • Reflects local context

Comparable with other jurisdictions • Used by more than one municipality • Allows senior managers and elected officials to compare performance against other municipalities • Common indicators allow for enhanced comparability • Allows for benchmark comparisons

Unambiguous • Derived from unambiguous data and methods • Indicators that are ambiguous to certain users could be improved through communication strategies (not all indicators will be understood by all stakeholders)

Tell us about you

These details are collected to track the completion of this form only. Your name and information will not be disclosed when presenting the results of this indicator evaluation matrix.

1. Enter your full name *

2. Enter your affiliation *

3. Enter your position title *

Buildings

• Emissions from municipal-operated buildings and commercial and residential buildings with the territorial boundary of the municipality.

4. Select the general criteria that are met for the following indicator:

Natural gas consumption per capita (m³/year/person) [output indicator used by two (2) sample Canadian municipalities (n=21)] *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

Energy, electricity, and outdoor lighting

• Alternative community energy systems or renewable energy; emissions from outdoor lighting and other energy systems.

5. Select the general criteria that are met for the following indicator:

Average yearly electricity consumption per capita (kWh/year/person) [output indicator used by two (2) sample Canadian municipalities (n=21)] *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

6. Select the general criteria that are met for the following indicator:

Savings achieved through the implementation of energy (efficiency) initiatives (dollars/year/capita) [outcome indicator used by two (2) sample Canadian municipalities (n=21)] *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

7. Select the general criteria that are met for the following indicator:

Annual renewable electricity generated per capita (kWh/year/person) *[output indicator used by four (4) sample Canadian municipalities (n=21)] **

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

8. Select the general criteria that are met for the following indicator:

Total installed renewable electricity generation capacity (MW) *[output indicator used by three (3) sample Canadian municipalities (n=21)] **

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

Other

• Includes water and wastewater services, ecological services and natural infrastructure, and air quality, among others

9. Select the general criteria that are met for the following indicator:

Local Air Quality Health Index (AQHI) [outcome indicator used by five (5) sample Canadian municipalities (n=21)] *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

10. Select the general criteria that are met for the following indicator:

Percentage of impervious area within the municipal boundaries [outcome indicator used by two (2) sample Canadian municipalities (n=21)] *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

11. Select the general criteria that are met for the following indicator:

Percentage of tree canopy coverage within the municipal boundaries *[outcome indicator used by eleven (11) sample Canadian municipalities (n=21)]* *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

12. Select the general criteria that are met for the following indicator:

Number of trees planted per year on public property *[output indicator used by six (6) sample Canadian municipalities (n=21)]* *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

13. Select the general criteria that are met for the following indicator:

Percentage of greenspace and natural areas within the municipal boundaries *[outcome indicator used by five (5) sample Canadian municipalities (n=21)]* *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

14. Select the general criteria that are met for the following indicator:

Percentage of regulatory-based protected greenspace and natural areas within the municipal boundaries *[outcome indicator used by three (3) sample Canadian municipalities (n=21)]* *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

15. **Select the general criteria that are met for the following indicator:**

Annual water consumption per capita (L/year/person) [output indicator used by three (3) sample Canadian municipalities (n=21)] *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

Transportation

• Emissions from municipal-owned-and-operated vehicles and private and commercial vehicles within the municipality.

16. Select the general criteria that are met for the following indicator:

Percentage of residents commuting by active transportation and public transit *[outcome indicator used by five (5) sample Canadian municipalities (n=21)]* *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

17. Select the general criteria that are met for the following indicator:

Total distance (km) of sidewalk, bike lanes and multi-use trails network *[output indicator used by five (5) sample Canadian municipalities (n=21)]* *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

18. **Select the general criteria that are met for the following indicator:**

Percentage of road network with a sidewalk *[outcome indicator used by three (3) sample Canadian municipalities (n=21)]* *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

19. **Select the general criteria that are met for the following indicator:**

Number of electric vehicles (community scale) per capita *[output indicator used by five (5) sample Canadian municipalities (n=21)]* *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

20. **Select the general criteria that are met for the following indicator:**

Percentage of fleet vehicles and municipal equipment that are electric *[output indicator used by two (2) sample Canadian municipalities (n=21)] **

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

21. **Select the general criteria that are met for the following indicator:**

Use of EV chargers (hours charging, kWh consumed) *[output indicator used by two (2) sample Canadian municipalities (n=21)] **

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

22. **Select the general criteria that are met for the following indicator:**

Number of EV charging stations per thousand people for public use [output indicator used by four (4) sample Canadian municipalities (n=21)] *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

23. **Select the general criteria that are met for the following indicator:**

Savings (\$) and/or GHG achieved through electrification of the municipal fleet [outcome indicator used by two (2) sample Canadian municipalities (n=21)] *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

24. **Select the general criteria that are met for the following indicator:**

Percentage of households within 400 metres of a regular service public transit stop *[outcome indicator used by two (2) sample Canadian municipalities (n=21)]* *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

25. **Select the general criteria that are met for the following indicator:**

Number of transit rides per capita *[output indicator used by seven (7) sample Canadian municipalities (n=21)]* *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

26. **Select the general criteria that are met for the following indicator:**

Vehicle kilometers travelled (VKT, km/year/capita) *{output indicator used by two (2) sample Canadian municipalities (n=21)} **

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

Waste

- Emissions from landfills and other waste-related activities.

27. Select the general criteria that are met for the following indicator:

Percentage of municipal residential waste diverted from landfill annually [output indicator used by twelve (12) sample Canadian municipalities (n=21)] *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

28. Select the general criteria that are met for the following indicator:

Quantity of residual material from the residential sector destined for landfill annually per capita (kg/capita) [output indicator used by seven (7) sample Canadian municipalities (n=21)] *

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

General GHG

- Indicators related to GHG emissions in general rather than a specific activity sector (e.g., GHG emissions per capita)

29. **Select the general criteria that are met for the following indicator:**

Progress towards GHG emissions reduction targets (percentage of target achieved)
*[impact indicator used by two (2) sample Canadian municipalities (n=21)] **

- ☐ Responsive
- ☐ Relevant to the needs of potential users
- ☐ Relevant to stated goals
- ☐ Availability of quality data
- ☐ Comparable to thresholds or targets
- ☐ Comparable with other jurisdictions
- ☐ Unambiguous
- ☐ All of the above
- ☐ None of the above

Appendix I: Delphi technique details (Paper 3)

Working Group 2 membership list:

- Academic co-chair
- Project co-chair
- Academic researcher (x3)
- Research assistant
- Project staff (x2)
- Municipal staff (x2)

Meeting Dates	Topic(s) covered
December 13, 2022	• Initial meeting • Introduction to N-ZAP and Working Group 2
February 28, 2023	• Sustainability and climate-related Indicator frameworks
May 3, 2023	• Annual N-ZAP meeting • Case study selection
June 9, 2023	• Case study selection • Interview questions
September 7, 2023	• Interview questions
February 28, 2024	• Interview updates • Indicator selection criteria
April 30, 2024	• Indicator selection criteria
May 16, 2024	• Annual N-ZAP meeting
October 22, 2024	• Indicator screening consensus meeting #1 (Academic co-chair, research assistant, and project staff only)
November 26, 2024	• Indicator screening consensus meeting #2 (Academic co-chair, research assistant, and project staff only)
February 28, 2025	• Indicator evaluation matrix
May 15, 2025	• Annual N-ZAP meeting

Appendix J: List of journals (Paper 1)

Journal Name	# of Articles	Journal Name	# of Articles
American Journal of Evaluation	1	Journal of Rural Studies	1
Annals for Istrian and Mediterranean Studies	1	Journal of Small Business and Enterprise Development	1
Annals of Global Health	1	Journal of Social Entrepreneurship	2
Annual Review of Environment and Resources	1	Journal of Sport Management	1
Australian Journal of Public Administration	1	Journal of the International Society for Southeast Asian Agricultural Sciences	1
Canadian Journal of Administrative Sciences	1	Journal of Urban Affairs	1
Canadian Journal of Nonprofit and Social Economy Research	1	Land	1
Cities	1	Management and Marketing	1
Community Psychology in Global Perspective	1	Marketing Intelligence and Planning	1
Conservation Biology	1	Media and Communication	1
Cultural Trends	1	MethodsX	1
Development Engineering	1	Michigan Journal of Community Service Learning	1
Development Southern Africa	1	Nonprofit and Voluntary Sector Quarterly	1
Entrepreneurship Theory and Practice,	1	Public Management Review	1
Environmental Impact Assessment Review	2	Qualitative Research in Accounting and Management	1
Evaluation and Program Planning	1	Quality—Access to Success	1
Evidence and Policy	1	RAUSP Management Journal	1
Globalization and Health	1	Renewable Agriculture and Food Systems	1
Habitat International	1	Research Evaluation	1
Historical Social Research	1	Research in International Business and Finance	1
IPE Journal of Management	1	Science, Technology, and Human Values	1
Irish Journal of Sociology	1	Social and Environmental Accountability Journal	1
Journal of Business Ethics	1	Social Enterprise Journal	1
Journal of Cleaner Production	1	Social Indicators Research	1
Journal of Cultural Heritage Management and Sustainable Development	1	Sustainability	5
Journal of Environmental Planning and Management	1	Sustainability Accounting, Management, and Policy Journal	1
Journal of Extension	1	The Foundation Review	1
Journal of International Agricultural and Extension Education	1	The Journal of Arts Management, Law, and Society	1
Journal of Librarianship and Information Science	1	Total Quality Management, and Business Excellence	1
Journal of Management	1	Voluntas	1
Journal of Public Budgeting, Accounting, and Financial Management	1	World Development	1

Appendix K: List of measurement models (Paper 1)

Measurement Model			
1	Adaptive social impact management	35	Multi-dimensional controlling model
2	Added value and scalability model	36	Multiple-constituencies approach
3	ASIRPA	37	Ongoing assessment of social impacts (OASIS)
4	Balanced scorecard	38	Outcome evaluation approach
5	Best available charitable option (BACO)	39	Payback framework
6	Business Impact Assessment (BIA)	40	Post-project reflection
7	CFICE—Accounting for impact	41	Programme evaluation
8	Charity analysis framework	42	Public action value chain (SGMAP)
9	Co-axial matrix	43	Public value mapping (PVM)
10	Community capitals framework	44	Public value scorecard
11	Community Impact (CI) Evaluation	45	Quality evaluation of creative placemaking
12	Community impact evaluation (CIE)	46	Question-and-evidence matrix
13	Community score card	47	RAPID Outcome Assessment
14	Composite measure for the social values of sport (CMSVS)	48	RCT-based evaluation
15	Conceptual assessment framework	49	REF (H2020)
16	Contribution analysis	50	Ripple effect mapping
17	Cost benefit analysis (CBA)	51	SAFA—Sustainability Assessment of Food and Agriculture
18	Data-collection tool development	52	SHARE IT
19	Kirkpatrick model	53	SIAMPI
20	Ecological footprint	54	SIMPLE
21	Economic survival framework	55	Social accounting and audit (SAA)
22	European Foundation for Quality Management (EFQM)	56	Social enterprise balanced scorecards
23	Eco-Management and Audit Scheme (EMAS)	57	Social footprint measurement
24	Evaluation grids	58	Social impact assessment (SIA)
25	Evaluative framework	59	Social impact measurement model
26	Framework for participatory impact assessment	60	Social performance framework
27	Fuzzy comprehensive evaluation (FCE)	61	Soft outcome universal learning (SOUL)
28	Global impact investing rating system (GIIRS)	62	Social return on investment (SROI)
29	GPS for social impact	63	Structural equation modelling
30	Global Reporting Initiative (GRI)	64	Sustainability quick-check model
31	Impact reporting and investment standards (IRIS)	65	Sustainable balanced scorecard
32	Impact value chain	66	TBL accounting
33	Logic model development	67	The B impact rating system
34	Measuring impact framework	68	VIS