



Research article

Encouraging green infrastructure at Ontario universities: What's policy got to do with it?

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Abstract: In this paper, and via a case study in Waterloo, we explore policy's role in encouraging green infrastructure (GI) adoption in Ontario universities. More specifically, we evaluate the relationship between policy and GI, and determine the policy level required to successfully implement GI. We employed a qualitative research approach of semi-structured, open-ended interviews (n=8) to understand better participants' views towards existing GI policies and frameworks. We find that multi-level government collaboration, regulatory frameworks and incentives and funding mechanisms are key themes influencing GI adoption. Interviews revealed that municipal incentives are essential in encouraging GI implementation on a local scale. However, federal and provincial factors are also crucial for the long-term establishment of GI. We conclude that policy is essential, and that multi-level collaboration is required to implement GI across Ontario's universities. With little published research there is in this area suggests the importance of government policy, especially at the municipal level, in terms of getting GI projects built. Yet, there are key gaps in our understanding, including the role of provincial and federal policy.

Keywords: policy; green infrastructure; universities; multi-level collaboration; funding mechanisms; regulatory frameworks; certifications; incentives

1. Introduction

Universities both contribute to and are impacted by climate change. Their campuses are energy

and emission intensive [1–3] and are surrounded by impervious surfaces (e.g., flat rooftops, walkways, parking lots), which significantly contribute to urban flooding challenges, and surface heat [4,5]. In Ontario, Canada, universities are realizing the importance of ‘greening’ their campus to mitigate these problems and raise awareness of climate change impacts [4,6]. These developments are collectively known as green infrastructure (GI), what Benedict and McMahon [7] define as “an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations” (p.12). Alongside universities’ moves toward GI development is a growing interest in the adoption of policies, guidelines, standards and laws across Ontario to ensure that green and sustainable practices are integrated into the built environment or infrastructure [8]. While the percentage of institutions with a green infrastructure (GI) policy in Ontario is relatively low, the usefulness of policy to engage and successfully facilitate sustainability initiatives on campuses is promising [8,9]. Yet, in-depth discussions around the role of policy in universities’ GI is notably absent from the literature. In Canada, complex relations with all three forms of government (municipal, provincial and federal), has led to a lack of clarity around what level policy should be implemented to best support GI development. Indeed, the little published research in this area suggests the need for more understanding of this question of ‘levels’, and in particular, what level of government is best positioned to encourage, require and ultimately develop GI in the most effective ways.

Here, we aim to address this gap in our understanding and develop some practical recommendations for policymakers, universities and community groups interested in developing GI projects and addressing climate change targets. We do so through a case study set in Waterloo in Ontario, Canada that explores the complexities around how GI policy at municipal, provincial and federal levels might be best understood and navigated to help universities. For this study, we developed two major objectives: i) to evaluate the relationship between policy and GI on university campuses to better understand the importance of policy in responding to climate change in Ontario, and ii) to explore the level of policy (municipal, provincial and/or federal) required to successfully implement GI across Ontario’s universities. Guiding this research is our definition of policy; is a set of rules and expectations to guide consistent decision-making, providing a common language and structure [10]. Our initial scan of major policies relevant to Universities in the Waterloo Region (University of Waterloo and Wilfrid Laurier University), included the City of Waterloo’s ‘Environment First Policy,’ adopted in 1985, as a precedent setting for initiating an ecological planning and restoration framework for the Region [11]. The Policy enacted a series of strategic actions including environmental rehabilitation projects, changes to municipal policies and a citywide monitoring strategy, which provides guidance for environmental and community health endeavours for Waterloo [11]. In 2004, the municipal office of the City of Waterloo conducted a Feasibility Study for the City-Wide Implementation of green roofs, to pursue environmental rehabilitation projects as an opportunity to enhance environmental health, aligning with the goals in the 2001 Environmental Strategic Plan for the City [11]. Since their 2004 report, the City of Waterloo continues to acknowledge and encourage the implementation of Green ‘Stormwater’ Infrastructure, as a form of Low Impact Development (LID) innovative solutions to mitigate stormwater runoff [12]. Much less was known about provincial and federal level policy pertaining to GI in the Region, prior to a deep reading of the literature in this area.

Across the following pages, we first present our literature review, which describes what is known about the relationship between GI, urbanization, university campuses and climate change [4,5,13,14]. We then turn to the Research objectives and methods section, where we outline our case study, including how we used semi-structured qualitative interviews with sustainability industry

professionals (n=8) to understand various perspectives of GI development on a university campus. Next, we share the results from our study before turning to the Discussion and Conclusion sections, where we summarize our work, its significance and identify areas for future research.

2. Literature review

2.1. *Climate change, cities, and universities*

The impacts of climate change are intensifying globally. Climate change and cities are also inextricably linked, in terms of being both: i) a major source of emissions that have created the problem, and ii) where many urban communities are among the most vulnerable to its effects [4,15]. Among the problems being seen are more frequent and severe storms and heat waves—both of which require projects that help with stormwater management (SWM) and the ‘heat island’ effect [16]. During significant storm events in most cities around the world, conventionally designed flat roofs rapidly discharge stormwater (SW) into municipal storm sewer systems, exceeding the capacity of existing infrastructure [17]. In addition, outdated SW drainage systems and insufficient green space in cities amplify local flooding challenges, including those related to erosion and water contamination [9]. Contributing to both the release of carbon emissions and the absorption of more of the sun’s heat, the concentration of older buildings, impervious paving and dark surfaces and a lack of green space in cities also causes a rise in surface temperatures [18]. As a significant contributor to greenhouse gas emissions, universities are often located within or near city centers and are typically large institutions with high imperviousness, dense infrastructure and high energy use [4]. However, universities are also in a unique and crucial position to conduct research and disseminate climate change information that can help to reduce emissions and help the world adapt [4,16].

Recent years have seen more than 7000 universities and colleges sign a letter to the United Nations declaring a climate emergency [19]. In Canada, the Ontario Institute for Studies in Education (OISE) prioritizes embedding sustainability and climate action into their governance, institutional facilities, services, research, curriculum and community engagement, beginning with declaring a climate emergency [16,20]. Dating back nearly 35 years, the first declaration on Sustainability in Higher Education was made by the Association of University Leaders for a Sustainable Future [21,22]. Over 350 universities across 40 countries signed, committing themselves to integrating environmental sustainability into their higher education practices [21]. Research has shown that these declarations have led to positive interactions between universities and international regulatory outcomes, influencing universities’ sustainability performance, campus leadership [21,22].

Universities’ climate change and sustainability initiatives align with the institutional position of higher education in the broader societal context, including its level of influence in provoking the profound economic and political transitions needed to address a warming planet [9]. Ralph and Stubbs [23] argue that universities play a fundamental role in addressing climate emergencies by demonstrating best practices in their operations—that is, what McCowan [4] writes to “practice what they preach” (p.16). This means developing new forms of technology and using renewable energy for its operations [4] and to align sustainability efforts with the triad of education, research and community engagement to reduce energy emissions [21,24,25]. This type of change can be complex and difficult to accomplish quickly, as for universities to comprehensively address climate emergencies, campus management, research, and curriculum all need to be embedded within one another [23,26,27].

2.2. Universities and green infrastructure

Moving from announcements and declarations to tangible climate action, universities in Ontario have adopted GI to mitigate the impacts of SW runoff and urban heat island effects [5,28–30]. According to a report from the OECD, encouraging GI is vital for institutions in order to integrate economic, social and environmental policies to sustain growth in a healthy environment [31]. Otherwise known as campus ‘greening’ [4], the development of GI projects is often driven by an ethical obligation [6,29] and includes the adoption of SWM systems, vegetation on rooftops, community gardens, installing pervious pavement and the use of renewable energy systems across university campuses [5,10,32]. Hunter and colleagues [33] include GI as a category of urban green space interventions that can address climate change and provide environmental and health co-benefits for local communities. Indeed, GI on a university campus can provide many benefits within and outside the local academic community [21,23,30,34]. This is due to the “multiplier effect” universities have on their society, demonstrating best practices, research and educating future communities and decision-makers to produce long-lasting societal and environmental change [23,26]. Attempts to build GI on university campuses can be stymied or slowed by a variety of barriers, including financial limitations and inadequate understanding and awareness of GI opportunity to address sustainability issues [23,34]. Richardson and Lynes [28] conducted a case study of the University of Waterloo, examining institutional decision-making processes. Their research helped point to the need for university policies that maximize building efficiency for the long-term operating budget. This was due to an equal lack of incentives at the facility and faculty levels to reduce long-term maintenance and energy costs [21]. In their mixed methods study of institutional green building policies in North America, Cupido and colleagues [8] cite an insufficient understanding of the cost, performance and implementation of GI, where there are perceived negative financial implications due to the absence of incentives [21,35]. Justifying the initial implementation, maintenance and operational costs without appropriate incentives, remains difficult [8,36,37].

Cupido [8,38] has examined policy as a primary driver in adopting GI across US and Canadian universities. They determined a growing interest in adopting policies, guidelines, standards and laws across university campuses to integrate green practices into their built environment [8]. In their doctoral research, Cupido [38] argues that for projects to get built, university administration must champion GI projects and policies. Leadership must come from those with decision-making authority for new campus building constructions [28]. In addition, GI legislation and collaborative municipality-university partnerships can lead to long-term climate change planning [34].

2.3. Government policy and green infrastructure

As suggested above, university-level GI policy can be impactful, yet limited in terms of its scope and power to enact change [8,28]. Outside of university campuses in Canada, government-led GI policies are beginning to emerge across all three levels of government [26,34].

2.3.1. Federal

The Canadian federal government does not formally have a national GI policy, nor a national infrastructure policy with explicit GI goals [39]. It also does not currently have designated GI units

within or across the central agency level departments. The federal government does however have some jurisdiction related to GI and environmental policy capacity and federal GI infrastructure funding for provinces and municipalities [39,40]. In the past two decades, there have been some developments at the federal level in understanding the importance of GI. Investments in infrastructure and green municipal funding, including the Green Infrastructure Fund (2009) and the new Natural Infrastructure Fund (2021) represents a huge investment and opportunity in the coming decade for Canada. However, there is no data available on the portion of this funding has gone towards green, grey and blue infrastructure, respectively [39].

In addition to political barriers, there is also a disconnect between federal government, provincial and municipal bureaucratic institutions with GI infrastructure management authorities and responsibilities [40,41]. Due to this, implementation of GI has been slower in Canada because of the lack of statutory and regulatory foundations, and political leadership from the federal government [41].

2.3.2. Provincial

The provincial government of Ontario has expressed similar investment and understanding of the importance of GI to that of the federal government. The Green Investment Fund (2022) was released under Ontario's five-year Climate Change Action Plan and targeted projects that addressed climate change and contributed to economic growth, aligning with environmental policy objectives [40]¹. In addition to provincial investment funds, financial incentives and policies are used to encourage the uptake of GI. In North America, incentive policies are distributed into “subsidies (23%), obligations by law (18%), SW fee discount (15%) and sustainability certifications (15%)” [37; p.12]. Liberalesso and colleagues [37] claim that a match between agendas and incentive policies must be made to compensate for green infrastructure's high implementation and maintenance costs. Overall, the provincial government appears to prioritize GI, acknowledging GI in its Municipal Infrastructure Assets (2017) and the Voluntary Carbon Offsets Program (2017), noting that GI would align with other sustainable development goals and provide co-benefits².

2.3.3. Municipal

Last, at the municipal level, GI policies are most often emerging as bylaws and energy-saving incentives to achieve economic and environmental effects on a larger scale [5]. For example, in Ontario, 23 municipalities have acknowledged GI in their Official Plans and have committed to prioritizing the use and application of these developments in their land use planning policies [30]. Taking a wider view of North America, Green Roofs for Healthy Cities identify how municipal policies can vary. For example, some municipalities have enacted bylaws (e.g., Toronto Green Roof Mandate), credits and permits (e.g., Chicago) for installing GI compliant with design and functional standards or requirements. Other municipalities have financial incentives, grants, rebates (e.g., New York City), SW reduction fees and property taxes (e.g., Washington, DC). Given this success and our lack of

¹ Government of Ontario (2016) Green Investment Fund. Last updated on March 7, 2023, at <https://www.ontario.ca/page/green-investment-fund>

²Ontario Green Infrastructure Coalition (2021) Provincial Policy Progress Timeline. Retrieved on July 9, 2023, from <https://greeninfrastructureontario.org/policy-progress>

knowledge of municipal-university collaboration in GI policy, there is a critical opportunity to learn more about how we might involve universities within existing municipal policies, and the future of policy planning [42]. Involving universities can present valuable partnership opportunities in implementing, inspecting and researching GI and may help gain further interest and support when universities adopt green innovations into their teaching and research [42].

3. Research objectives and methods

In the section above, we reviewed the literature on GI in universities and how policies and incentives [10,43] can help overcome the barriers to adoption [19]. Yet, there are many unanswered questions in this relatively nascent literature, including the level at which policy should be implemented to best encourage GI, and at what scale (municipal, regional) we need to focus on to successfully bring GI into university planning processes [8,21,25,34,44]. As mentioned above, given the state of existing research and need for more understanding of universities and GI development, this research had two related objectives:

- 1) To evaluate the relationship between policy and GI on university campuses to better understand the importance of policy in responding to climate change in Ontario.
- 2) To explore the level of policy (municipal, provincial and/or federal) required to successfully implement GI across Ontario's universities.

By working to address each objective, we sought to answer our more general research question: what is the role of policy in adopting GI by Ontario's universities? While guided by this question and objectives, we also leaned into a grounded theory approach in order to ensure we generated new findings from the data rather than preconceived hypotheses [44].

3.1. Data collection

We chose a qualitative study approach, comprised of eight in-depth, semi-structured and open-ended interviews³ [45,46] with relevant GI professionals. These participants included University of Waterloo and Wilfrid Laurier University staff and faculty with involvement in, and/or deep knowledge of, GI at the institutional level. Participants were initially selected from the lead author's network of contacts. The rationale to stop data collection at eight interviews was based partially on the practical consideration of limited time to obtain data, but we also felt we had reached thematic saturation [47].

Our study was reviewed and approved by the University of Waterloo Research Ethics Board. All study details were provided to participants before their participation. The identity of the participants remained confidential, and as seen in the results below, were assigned a pseudonym when interview quotes are used. During each interview, participants were asked about their opinions and experiences as they relate to GI, policy and development. The interviews featured 10 open-ended questions accompanied by prompts and sub-questions relating to three overarching areas of interest:

- 1) Participant's engagement or knowledge of GI
- 2) Opinions on current and future opportunities for GI policies
- 3) Recommendations for current and future GI policies

³ The open-ended interviews allowed the participants to express their views on existing policies and frameworks related to green infrastructure

3.2. Data analysis

After transcription, each interview was placed into NVivo software to aid in organization, coding and analysis. Qualitative thematic analysis was chosen to best understand our interviews and address our study's major objectives. Qualitative analysis in general is said to provide a platform to evaluate GI in universities [25,38]. Thematic analysis identifies, analyzes and reports patterns (themes) and we chose it because we aimed to analyze the data without preconceived categories [48,49] and better organize and link participants' ideas into meaningful clusters, allowing new insights to emerge [49].

4. Results

The most prevalent themes are presented below and were chosen to provide insight into political frameworks that might best influence the adoption of GI across Ontario's universities. Our findings revealed key themes, including those related to multi-level government collaboration, regulatory frameworks and incentives and funding mechanisms.

4.1. Multi-level government collaboration

Through initial stages of data analysis, it became clear that adopting GI across university campuses depends largely on supportive policy frameworks at all levels of government. In conversations with those such as "Peter," it was evident that political leadership could be leveraged if all levels of government had devices pointing in the same direction. When asked about the ways in which GI development can scale on university campuses, he pointed to the need for all governments to work together.

"Peter": "At the provincial level or a federal level...you can get scale [of GI] and you can get consistency and equivalency across lots of jurisdictions."

Other participants clarified that for collaboration to work well across multiple levels of government, clear roles and responsibilities were needed. Based on these findings, Figure 1 was created to represent roles and connections. The diagram was generated using a hierarchical clustering algorithm that grouped similar themes based on their frequency and the intensity of participant responses. Federal standards and a national definition of GI should be set to maintain consistency of GI development and its language. GI should be also aligned with existing climate change strategies and the funds available. Supporting the national standard, provincial governments should change their building codes to include a GI minimum design. Once GI is implemented, there needs to be regulation (e.g., LEED) in place to ensure compliance. To support this, provincial incentives can be used to praise performance and can be additionally provided when buildings exceed the bare minimum. At the municipal level, SW charges can be enacted to charge building owners for their SW runoff. To save costs, building owners can implement GI mechanisms.

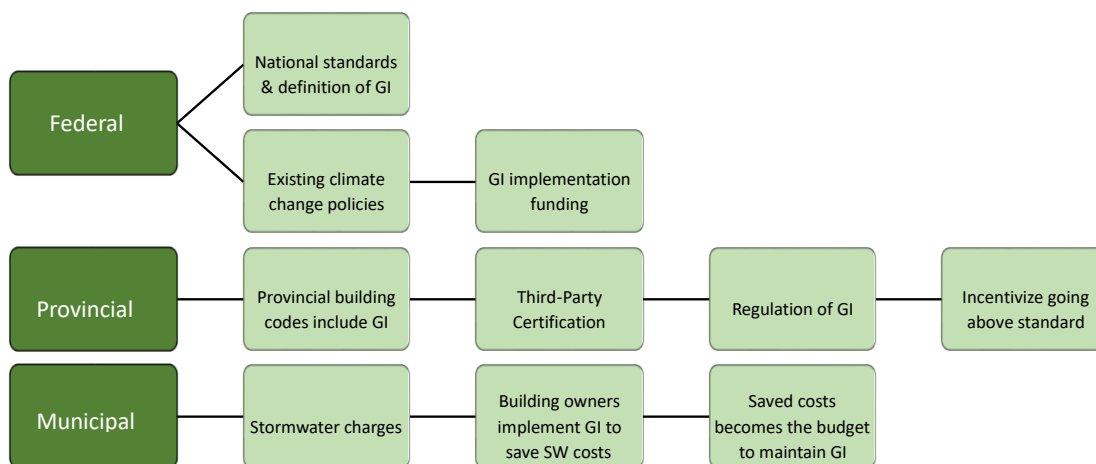


Figure 1. Policy motivations for Green Infrastructure (GI) on university campuses.

4.2. Federal-level policy

Analysis revealed the crucial need for the federal standardization of GI under climate change policies. Participants emphasized that a federal green building standard was needed to provide clarity and consistency in the language and meaning of GI across university campuses. This included “Harry” who shared:

“Harry”: “There are prevailing standards [already] out there, [we] do not need to rewrite these rules. [instead], how can we effectively apply them, incentivize them and get what we want as a result?”

Participants also stressed that federal standardization would facilitate the development of performance metrics and monitoring protocols, essential for promoting GI planning and design guidelines. Many emphasized that leveraging climate change policies would promote the implementation of GI, where standardization would ensure effective outcomes.

In conjunction with standardization, interviews revealed that federal funding was seen to be a critical component of a successful GI implementation strategy across universities. As “Anne” highlighted, federal funding was seen as necessary for GI to be equitable across Canada:

“Anne”: “It would have to be federal [for] it to be equitable because there’s gonna be huge differences between somewhere like Newfoundland and what Ontario can do. There’s also gonna be different needs, but I think eventually, if you are gonna have an equitable rollout for Canada, [funding] would have to start at the federal level.”

4.2.1. Funding should consider the whole lifecycle

Participants emphasized the importance of federal funding that supported not only the implementation of GI projects but also considered the project’s entire life cycle, including ongoing operations and maintenance costs. As “Barb” explained, the funding for GI projects differs from traditional infrastructure projects because the capital investment, ongoing operations and maintenance costs tend to be much higher:

“Barb”: “Green infrastructure costs are a little bit different than traditional infrastructure. Usually, infrastructure funding really prioritizes capital investment because infrastructure projects are

expensive to get off the ground. Whereas with green infrastructure, the capital investment is needed [in addition to] the ongoing operations and maintenance costs... And so, finding the money for those sort of full lifecycle of the green infrastructure assets can be a challenge.”

Others including “Carl” explained that, it was necessary to demonstrate a life cycle that included the longevity of GI assets:

“Carl”: “We have to show a life cycle; we can’t be turned away by that initial high cost. What are the savings in the long run?... And that’s sometimes difficult for politicians, especially, to get their heads around.”

Further, “Anne” emphasized that contrary to current approaches she sees, GI projects should be treated like any other infrastructure project, with appropriate operating expenses considering the entire life cycle:

“Anne”: “You have to treat [GI] the same way we do any other kind of infrastructure, where you have operating expenses that are appropriate to maintain and care for that infrastructure over its life cycle.”

That is, in her view and the view of other participants, to ensure the long-term success and sustainability of GI projects, ongoing funding must be allocated appropriately.

4.3. Provincial-level policy

Participants we spoke with emphasized that provincial-level building codes must be updated to include a minimum requirement for GI implementation. “Peter” explained:

“Peter”: “To push green infrastructure and sustainable buildings, [a building] code is hugely important...When they develop something like the building code or the federal government develops the building code, these are largely prescriptive and performance requirements that apply in any context. They’re not site dependent. So, buildings in Ontario need to meet a certain minimum level of efficiency as defined by a bunch of technical standards [to] be approved.”

“Claire,” highlighted the significance of implementing changes even if development plans were not yet in place. She mentioned:

“Claire”: “[it is crucial to] update the building codes so that every building is built to be able to support [GI], even if they don’t have the capital to install it right then. Just having that option when it is needed.”

In line with this sentiment, all participants emphasized the necessity of taking proactive measures in building infrastructure to facilitate the adoption of GI, even if the resources to implement them were not available. However, to support the changes made to the building code, the participants stressed that provincial funds should have been made available.

4.3.1. Voluntary provincial funding creates a level-playing field

Provincial-level policy emerged as a critical factor in creating a level playing field for incentivizing developments through voluntary funding and rebates. One participant, “Leon,” described his experience when he tried to raise awareness of the value of GI at the provincial (Ontario) level.

“Leon”: “The reason for [the] province was because that is the area of government that influences the municipalities...Municipalities are [the] creation of the province. That is where the law comes from... So, if you could convince a province, then they could do the work to convince their subordinate

governments [the] municipalities.”

“Anne” added that: “It is absolutely necessary to have a mechanism to encourage or regulate the use. And that’s been really tricky for a number of cities to actually implement that.”

However, participants recognized that there was no one-size-fits-all approach to provincial policy/legislation. Rural towns had different needs than larger cities. For instance, “Claire” explained the challenges of mixing a provincial program into something municipally managed in her example of SWM. She said:

“Claire”: “The province can provide funding for things, but it wouldn’t necessarily be able to be involved in measuring your stormwater capture on a monthly [or a] yearly basis. So, the province would have to be more involved in funding or rebate as opposed to an ongoing credit system. And that’s sort of where funding programs come and are a bit more effective because it’s voluntary.”

4.3.2. Certification, regulation and incentives

Most participants recognized that certification was critical in ensuring the quality and effectiveness of GI projects and promoting commitment, accountability and credibility in the design, implementation and management of these systems. In addition, as “Harry” stated, third-party certification and verification were necessary to ensure that GI projects met the minimum standards. “Harry” also noted that provincial incentivization significantly encouraged building owners to implement GI beyond the minimum requirements.

“Harry”: “Regulation sets a minimum and then incentivizes performance above the minimum... You just have to go through the process of certification...and those incentives, if you want to go above that, you know, to LEED gold or Green Globes, three or four-star, three or four globes, then there’s a little bit of an incentive. If you also want to do [a good] certification, there’s a little bit more of an incentive. It’s that principle of a nudge.”

However, several participants noted that such certification had some limitations. As “Harry” himself pointed out, certification ended when the building was completed, and there was no guarantee that GI would continue to perform as intended afterwards. The cost of certification also remained a barrier because of the miscommunication regarding the longevity of the benefits.

4.4. Municipal-level policy

Interview data showed that targeting the municipal level could generate short-term local action to influence GI implementation. As “Barb” explained:

“Barb”: “Locally, looking at incentive program works because then it’s directly tied into, you know, municipal budgets, and you can really directly see the sort of results and offsets within your community.”

Yet several participants recognized the challenge of competing priorities, staffing challenges and long-term budget constraints, which may limit the longevity of municipal influence on GI. Participants also highlighted the importance of leveraging provincial building codes to encourage GI implementation. As “Claire” explained, if there is an Ontario building code in place that encompasses GI:

“Claire”: “all [of] the municipalities have to follow it as a baseline, but then they can build on it. They can never go below it, but they can go above it.”

In this way, “Claire” demonstrated the potential for municipalities to use building codes as a framework to promote and enforce the implementation of GI measures while allowing for additional measures based on local needs and conditions.

4.4.1. Green infrastructure bylaws and mandates

To gauge perspectives on actual municipal GI policies, participants were asked how they felt about the City of Toronto’s green roof mandate. Several participants highlighted that bylaws were beneficial in outlining clear and measurable targets, and could increase the amount of green roof development. However, some participants, like “Stanley,” noted a lack of long-term validation:

“Stanley”: “The mandate will get it built. I agree with that it helps. [But] there’s no mandate to maintain. There’s no long-term validation that it’s working. You can build it and then take it out, and no one would know.”

Another participant, “Leon”, mentioned a need for clear and consistent performance metrics and evaluation criteria post-installation. He explained:

“Leon”: “It’s easier to pass a law...you can have the policy, but if you don’t have the policy regulated, then you don’t have anything.”

Many participants recognized the potential for municipal policy to incentivize GI but also noted that legislation could become a “box-ticking” exercise rather than a meaningful tool for promoting GI benefits. “Stanley” suggested that a maintenance incentivization program would be more effective, explaining that incentives may have better outcomes than mandates in encouraging GI on a municipal level.

4.4.2. University-municipal collaboration

Last, interviews also shed light on the potential of municipal interventions to encourage GI policy on university campuses. One key suggestion was made by “Harry,” who argued for the need for a post-secondary sustainability renewal initiative to institutionalize GI at universities. He suggested:

“Harry”: “[this initiative should be] cleverly structured so that it’s available to any university or college and there’s a step up that’s an incentivized program.”

He went on to explain that such an initiative could be successful if it includes a scenario where universities can get matching funding from the province, providing enough incentive to pursue GI.

5. Discussion

The overall goal of the study presented here was to provide empirically driven insight into the role of policy in effectively mobilizing GI at Ontario’s universities. To do so, we interviewed eight professionals in the GI industry, then used thematic analysis to determine the most prevalent and important trends. Results emphasized the crucial role of political leadership in adopting GI across various levels of government. Our findings have significant implications for Ontario’s universities, as they can benefit from implementing green building standards, updated building codes and provincial funding. Furthermore, the study suggests that municipalities can be crucial in promoting GI on university campuses. Ontario universities can move towards a more sustainable future by considering these implications and taking necessary actions. Here in the paragraphs below, we provide a deeper

reflection on the research process and results, including an examination of the study's limitations and recommendations for future research.

5.1. Importance of multi-level support of green infrastructure

Our results revealed that successfully adopting GI on university campuses in Ontario depends heavily on supportive policy frameworks at all three levels of government: Federal, provincial and municipal. Political leadership across all levels of government can leverage scale, consistency and equivalency in adopting GI. The federal level was considered critical for standardization and funding, while the provincial level could create a level playing field for incentivizing GI through voluntary funding and rebates. Influenced by federal and provincial governments, the municipal government plays a major role in mobilizing local action. However, interviewees told us that clear roles and responsibilities are needed to facilitate collaboration across multiple levels of government.

Among others, Cupido [36] has argued that legislation and collaboration between municipalities and universities were needed to truly institutionalize GI. During the interviews, participants were asked for their opinions towards this statement, on whether they felt it would be a positive response if a municipality had implemented a policy. Results indicated that university funding for GI comes from the provincial and federal governments, not municipal governments. Therefore, municipalities have little leverage over the universities and their building developments. However, universities are like a 'city within a city', which share a neighborhood relationship with municipalities. The interviews with participants showed a consensus on the importance of municipal incentives in encouraging GI on a short-term and local scale. However, federal and provincial factors are also—and likely more—crucial for their long-term establishment. Municipal incentives were also discussed with the idea of leveraging SWM challenges as a SW charge presented as an opportunity for encouraging GI on university campuses. Additionally, regulatory frameworks, incentives and funding mechanisms were emphasized for promoting GI initiatives.

5.2. Implications for Ontario's universities

We found that multi-level governance is critical to encourage the institutionalization of GI on university campuses. There are several implications for Ontario universities including the need for a green building standard, updated building codes, provincial funding and certification, and municipal interventions for SWM.

The results indicated that there needs to be a green building standard on the federal level to provide clarity and consistency in the language and definition of GI. This would make it easier for universities to understand and implement GI policies effectively. This conclusion is based on participants' emphasis that standardization would facilitate the development of performance metrics and monitoring protocols, which they deemed essential for promoting GI planning and design guidelines. Developing performance metrics and monitoring protocols can help universities track their progress toward sustainability goals and adjust where necessary. In addition, by emphasizing the alignment of the green building standard with climate change strategies, universities may be more likely to see the value of implementing GI to contribute to more significant sustainability efforts. Study participants also emphasized that federal funding was necessary to ensure equity across regions with varying financial resources and infrastructure needs, and that comprehensive funding needs to consider

the entire life cycle of GI, including ongoing operations and maintenance costs.

On the provincial level, our findings focused on the importance of updated building codes, provincial funding and certification to regulate and promote the adoption of GI. Participants emphasized the need for building codes to include a minimum requirement for GI implementation. Participants also believed that provincial-level funding and rebate incentives would help create a ‘level playing field’ for incentivizing developments, encouraging more universities to invest in GI projects.

Certification was also deemed critical in ensuring the quality and effectiveness of GI projects and promoting commitment, accountability and credibility in the design, implementation and management of these systems. Participants believed that while third-party certification and verification can ensure that GI projects meet minimum standards, certification does not guarantee continued performance. Indeed, it was argued that ongoing monitoring and maintenance are necessary. Provincial incentivization is therefore crucial to encourage universities to surpass minimum requirements and invest in sustainable infrastructure.

Regarding municipal interventions, our study’s major implications for Ontario universities include the fact that targeting the municipal level could generate short-term local action to influence GI implementation. However, findings also point to competing priorities, staffing challenges and long-term budget constraints that may limit the longevity of municipal influence on GI. Leveraging provincial building codes could provide a framework to promote and enforce the implementation of GI measures while allowing for additional measures based on local needs and conditions.

Participants were asked how they felt about the City of Toronto’s unique green roof mandate. They suggested that such a policy could be beneficial in outlining clear and measurable targets for GI projects to follow and increasing the amount of GI development. However, many shared a concern that there may be a lack of long-term validation that the infrastructure is working.

The wider implications for GI across Ontario universities regarding municipal policy include the view that incentives may have better outcomes than mandates. However, most participants believed that if a mandate were to be implemented, it should be integrated with local organizations and building code requirements. In addition, interviewees highlighted the need for clear and consistent performance metrics and evaluation criteria post-installation to avoid GI becoming a “box-ticking” exercise. Universities must also ensure that their GI projects are designed and implemented to achieve measurable and meaningful outcomes and promote campus sustainability.

The interviews also shed some light on the potential of municipal interventions to encourage ‘better’ GI policy. For example, a participant suggested a post-secondary sustainability renewal initiative to institutionalize GI on university campuses. Such an initiative could be successful if it includes a scenario where universities can get matching funding from the province, providing enough incentive to pursue GI. This could lead to increased investment in GI on university campuses and further promote sustainability practices in the education sector. First, however, universities must take advantage of such initiatives and prioritize GI projects to ensure long-term sustainability and environmental responsibility.

5.3. Limitations and future research

In this study, we employed a qualitative research approach, conducting semi-structured, open-ended interviews with eight participants initially selected from the researcher’s network of contacts. Therefore, a clear limitation of this study is that the sample size was relatively small, and the

participants were not randomly selected, both of which may introduce a sampling bias and limit the [quantitatively driven] generalizability of the findings. We acknowledge the small sample size likely does not represent all perspectives towards the GI industry, and since the participants were selected from the researcher's network of contacts, so there may have been a bias toward individuals with similar viewpoints or experiences. The study's rationale for only including eight participants was partially based on the practical consideration of timing, whereby we had just ten weeks for data collection. This constraint may have limited the depth of the study's findings and conclusions, as more participants may have provided more diverse perspectives and insights.

While not dismissing these shortcomings altogether, we suggest that part of our study's perceived shortcomings may come from a quantitative perspective of what constitutes 'good' or rigorous research. Too often does qualitative research, like the study presented here, get assessed via quantitative measures including generalizability or external validity. Instead, and in line with the arguments brought forth by Baxter and Eyles [50], we conducted our study with an eye toward the criteria related to qualitative rigor, credibility, transferability, dependability and confirmability. It is here where our strategies of purposeful sampling, context-bound experiences and the inclusion of multiple researchers, work to improve our study's rigor.

Participants in this study identified several areas for future research to explore the implications of private credit trading, maintenance and regulation frameworks, and municipal SW charges on the outcomes of GI across Ontario's universities. Building on these findings, there is a need for further research to explore the financial aspects of implementing GI on university campuses, including the cost-savings benefits and the implications of private credit trading, maintenance and regulation frameworks. To effectively incentivize the maintenance of GI, additional analysis is needed to determine the most effective approaches. There is also an opportunity to expand research beyond SWM to explore the potential for GI to address other sustainability challenges on university campuses, such as energy use and waste management. Additionally, there is a need for further research on the potential for multi-level government collaboration in other regions and contexts.

6. Conclusion

We suggest that the adoption of GI on university campuses in Ontario, Canada is heavily dependent on supportive policy frameworks at federal, provincial and municipal levels of government. We found that while federal standardization and funding were critical, the provincial level could create a level playing field for incentivizing GI developments through voluntary funding and rebates. Municipalities were also identified as crucial in promoting GI on university campuses, although they needed more leverage over universities' building developments. Results also identified several implications for Ontario-based universities, including the need for a green building standard, updated building codes, provincial funding and certification. Furthermore, the study highlights the importance of regulatory frameworks, incentives and funding mechanisms for promoting GI initiatives. Effective collaboration across multiple levels of government was also found to be crucial, although clarity in roles and responsibilities is necessary to mitigate potential friction. Overall, our results emphasize the importance of political leadership in adopting GI and the need for collaboration across various levels of government to promote sustainability. By considering the study's implications and taking necessary actions, universities in Ontario—and beyond—can move towards a more sustainable future.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

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Conflict of interest

We have no conflicts of interest with regard to the research presented here.

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