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RESEARCH

Characterising the development trends driving sustainable neighborhoods

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Abstract

Most self-proclaimed sustainable neighborhoods cover various concepts pertaining to the economic, social, environmental, and institutional pillars of sustainability. Depending on the developers' motivations, these concepts can be integrated unevenly. This study develops a framework to characterise the gap between what is advocated as necessary for sustainable neighborhoods and what is marketed as sustainable neighborhoods. A framework based on a sustainable neighborhood typology is developed using the Canadian province of Quebec as a case study. This is based on the main concepts underlying the four pillars of sustainability, but from a practical perspective. An analysis of sustainable initiatives (n = 29) shows a clear prioritisation of urban morphology on individual livability at the expense of participatory governance and sustainability awareness, especially for large projects promoted by private developers. A co-occurrence analysis suggests that smaller projects manage to integrate more sustainability aspects. The framework can be used to identify similarities and differences between development types for developing practical policy measures. This research highlights the importance involving public and private stakeholders at the early planning stage, in order to design more integrated projects.

Policy relevance

A gap is revealed between what is defined as urban sustainability and what is actually delivered by developers. Citizen participation is generally beneficial, but often lacking. There is scope for policymakers to provide compelling encouragement to build citizen involvement into the planning processes, particularly for larger neighborhood developments. From the example of the province of Quebec, this can take several forms. In some cases, more incentives from the public sector to involve citizens at the early stage of planning is favorable. This can allow stakeholders to outline the development strategy in neighborhoods. In other cases, municipalities can involve residents through a charter or regular local meetings. This requires more systemic municipal approaches to urban sustainability. Evidence suggests that local relocation of food and/or energy production can lead to successful cases of citizen participation and social solidarity.

Keywords: developers; governance; neighborhood; participation; planning; stakeholders; urban development; Canada

1. Introduction

Sustainability in urbanism, and particularly in neighborhood planning, is built upon a long history of research and experiments in urban planning, environmental engineering, architecture, and social sciences (Sharifi 2016). At the beginning of the 20th century, decades before the current conception of sustainability even existed, European urban planners already worked on developing livable neighborhoods (Choguill 2008; Rohe 2009). Indeed, cities were then dangerous, unsanitary, and prone to devastating epidemics. Neighborhood planning was first investigated by utopians and visionaries; their aim was to reconcile urban dwellers with nature, and to improve a quality of life hampered

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by the Industrial Revolution. Ebenezer Howard proposed the development of Garden Cities, small, autonomous, circular urban developments with alternate layers of urban services and green spaces, located on the periphery of big cities (Howard 1985). Clarence Perry initiated the Neighborhood Unit movement in 1929, which aimed to enhance community involvement and socialisation by placing schools and public facilities at the center of a district's physical arrangement (Perry 1929). Decades later, ever-increasing concerns for environmental degradation and resource depletion added ecological aspects to the list of design principles, first at the city scale (Sharifi 2016). For example, the Aalborg Charter, signed in 1994 by hundreds of European cities, gave a first overview of the boundaries defining modern sustainable urbanism for cities, which included encouraging resource-efficient infrastructure (buildings, public transit), improving air, water and soil quality, preserving biodiversity, while ensuring the creation of long-term jobs and social justice (ICLEI 1994).

As a result of this multidisciplinary development, several definitions and applications of sustainable neighborhoods exist today (Holden, Li, & Molina 2015; Reyes Nieto *et al.* 2018). There is a consensus within the scientific community that sustainable neighborhoods must integrate the three pillars of sustainability (Gibson 2006a), defined in the Brundtland Report (WCED 1987) and later included in the Aalborg Charter. These pillars refer to the economic, social, and environmental dimensions of sustainable development (Komeily & Srinivasan 2015; Sharifi 2016). A fourth pillar, the institutional dimension, is also often added to ensure that all stakeholders are consulted and contribute to a project's design and implementation (Zhang, Yung, & Chan 2018).

In practice, the plethora of terms describing initiatives (*e.g.* green, livable, smart, resilient, zero energy, low carbon, or even autonomous) suggests that most projects fall short of encompassing all sustainability dimensions (de Jong *et al.* 2015). The pillars of sustainability also allow room for interpretation and may have different meanings for different stakeholders. For example, a social neighborhood may refer to multiple issues (Dempsey *et al.* 2011). It can aim to redress social injustice (Medved 2018), to promote social interactions and an art of living together (Valegeas 2015) or just to offer a good place to live, in which the residents' aspirations and needs are met through an adapted built environment (Castillo, Holden, & Skates 2016). These different representations are not mutually exclusive. However, their potential prioritisation by different stakeholders reflects changing motivations that can restrain sustainability to one or two core concepts (Seeliger & Turok 2015).

Few studies have gathered empirical evidence on how these different perceptions of sustainable urbanism intervene in neighborhood planning. Souami (2009) and Pareja-Eastaway & Winston (2017) compared sustainable communities across Europe, revealing how key sustainable issues differ from each country. In particular, Souami analysed 60 eco-neighborhood initiatives and noted two main models of development. In Northern European countries, environmental footprints and green standards are key, whereas in Southern European countries, projects demonstrate a greater concern for patrimonial conservation and a lower preoccupation for environmental concerns. Mapes & Wolch (2011) found that most of the studied 29 American sustainable communities primarily fostered a sense of community and environmentally friendly solutions. At a larger scale, Joss (2011) highlighted the high-tech/clean-tech direction taken by many eco-cities worldwide in response to the carbon crisis. These studies do not provide detailed insights into the particular ways in which sustainability is conceptualised in different projects, nor do they consider the interconnections that could partially explain the potential prioritisation of some concepts in the developers' strategies.

The objective of this study is, thus, to provide a quantitative framework to reveal the different types of development that are promoted and undervalued in practice, as well as their interconnections. The evidence from this research will help to identify the gap between sustainability theory and what actually happens in practice.

This study builds multidimensional profiles for sustainable neighborhood initiatives marketed by key project stakeholders. The procedure adapts and expands an existing typology from six to 10 development types of sustainable neighborhoods (Holden *et al.* 2015). Since each development type is an archetypal interpretation of what a sustainable neighborhood should be according to different stakeholders, this typology is particularly adapted to unveil the perceptions of developers. It brings a complementary and practical perspective to the usual economic, environmental, social, and institutional sustainability dimensions by focusing on the outcome of sustainable urbanism (*i.e.* what type of neighborhoods do stakeholders want) instead of defining its characteristics (social–economic–environmental). Using this expanded approach, a total of 29 self-proclaimed sustainable initiatives in the province of Quebec (Canada) were analysed. The analysis assesses the sustainability features highlighted by developers in the projects descriptions to derive an identity card for each initiative.

The paper is structured as follows. The next section considers an expanded sustainable neighborhood typology, the procedure developed to implement it, and the case studies. The multidimensional average profile of the sustainable initiatives is then described as well as the interconnections made by developers between various sustainability concepts. Finally, the implications of the developed approach and the results are presented.

2. Methods

2.1 A typology based on developers' perceptions

Following and expanding the framework developed by Holden *et al.* (2015), the proposed typology is centered on the developers' perceptions of sustainable urbanism. This framework provides a multidimensional view of the underlying

principles characterising a sustainable neighborhood project. Holden *et al.* proposed a typology of seven limiting cases, each limiting case being an:

> instance of neighborhood development that poses a challenge to certain expressed principles of ecourbanism, while exhibiting other outcomes that fulfill the intent of one expressed principle in particular. (Holden *et al.* 2015: 11421)

A limiting case thus constitutes a corner of the sustainable urbanism boundaries which are applied in practice. However, since the term 'limiting case' can be confusing outside the scope of this study, the term 'development type' is used instead.

Table 1 presents the sustainable neighborhood typology. Based on a literature review and observations driven from case studies, the initial typology was expanded from seven to 10 development types. Development types 1 and 5–9 derive from the initial typology (Holden *et al.* 2015). Their descriptions are also provided in **Table 1**.

The development type focused on environmental protection was divided into three subcategories (development types 2–4) since in sustainable urbanism, ecological considerations refer to three distinct concepts rooted in how the discipline emerged and evolved through time (Sharifi 2016). Type 2 is the idea of nature-embedded communities, whose origins date back to the beginning of the 20th century with Howard's Garden Cities. In their extreme form, projects in this subcategory include remote natural retreats promoting calm and privacy, and projects dedicated to the conservation of natural habitats. Type 3 aims to minimise the environmental footprint. This has been (and still is) the focus of many sustainable initiatives, which often promote advanced building design and technological innovation. Type 4 focuses on the urban form and urban mobility, such as transit-oriented developments (TOD) and pedestrian-oriented developments (POD) projects. Inspired by New Urbanism, type 4 is centered on more compact and less car-dependent urban settings (Sharifi 2016).

Table 1: Descriptions of 10 development types of sustainable neighborhoods.

	Development type	Description
1	Economic development	An attractive opportunity for the city's and/or region's business development, in one or several sectors (services, industry, tourism); financial viability is one of the claimed priorities
2	Natural space	A privileged and unique experience to be in contact with natural habitats and urban ecosystems. An operation to make the urban space greener
3	District with a lighter environmental footprint	Technology-based solutions to increase buildings' efficiency in energy, water and materials consumption. The target is a less polluting district
4	Compact urban environment	A walkable, well-connected and well-designed urban space in order to reduce the dependence on motorised vehicles. Limiting urban sprawl by rehabilitating brownfield sites is encouraged
5	Community with a high quality of life	A project oriented towards livability and wellbeing thanks to a comfortable and safe built environment, adapted for socialisation purposes
6	Diverse urban area	The value of the community lies in its social and cultural diversity as well as in the opportunities offered by mixed-use buildings and diverse housing types
7	Self-sufficient community	A self-reliant and autonomous community that promotes a way of living free from the dependence on external hinterlands (supply security)
8	Equal society	A socially inclusive neighborhood with special attention paid to redressing injustice and inequalities in favor of vulnerable citizens (low income, children, elderly, disabled)
9	Participatory governance	A place where the community is the key actor of its development, open to deliberative consultations, collective decision-making and community-based management of facilities
10	Learning environment	A collective project characterised by a sense of responsibility towards futures generations. The transfer of knowledge and new sustainable practices are encouraged through education, formation, research and innovation

Source: Adapted from Holden *et al.* (2015).

Finally, the learning environment (type 10) was added to the existing typology. The ability to choose present actions that favor the opportunities for future generations (intergenerational equity) is an important aspect of sustainability (Gibson 2006b; Luederitz, Lang, & Von Wehrden 2013). This long-term perspective requires that the knowledge and sustainable practices accumulated in one generation be effectively transferred to the next. Continuous education but also experimentation and innovation (technological, social, organisational) are parts of the socio-ecological transition that modern societies are facing. Sustainable neighborhoods are places where citizens are encouraged by their community to gain new skills and practices in sustainable consumption and planning; these may help sustain the community in the long term (Bradbury & Middlemiss 2015).

2.2 Data source analysis

To determine the share of each development type in the profile of a sustainable neighborhood project, a systematic approach was developed (**Figure 1**).

The first two steps consisted of matching each development type with corresponding concepts and keywords. These steps defined which particular concerns were specific to one development type and how these concerns were translated in a project's description. For example, the economic development type (1) refers to concerns related to attracting investments, creating jobs, and encouraging the local economy. These concepts can be textually present in the project descriptions, but they can also be characterised by other keywords. For example, encouraging a local economy can be highlighted by developers with words such as 'shops,' 'restaurants,' 'tourism,' or 'industrial development.'

The Leadership in Energy and Environmental Design and Neighbourhood Development (LEED-ND) design tool was used as a baseline for the concepts' definition. It is a well-known North American certification framework that grants

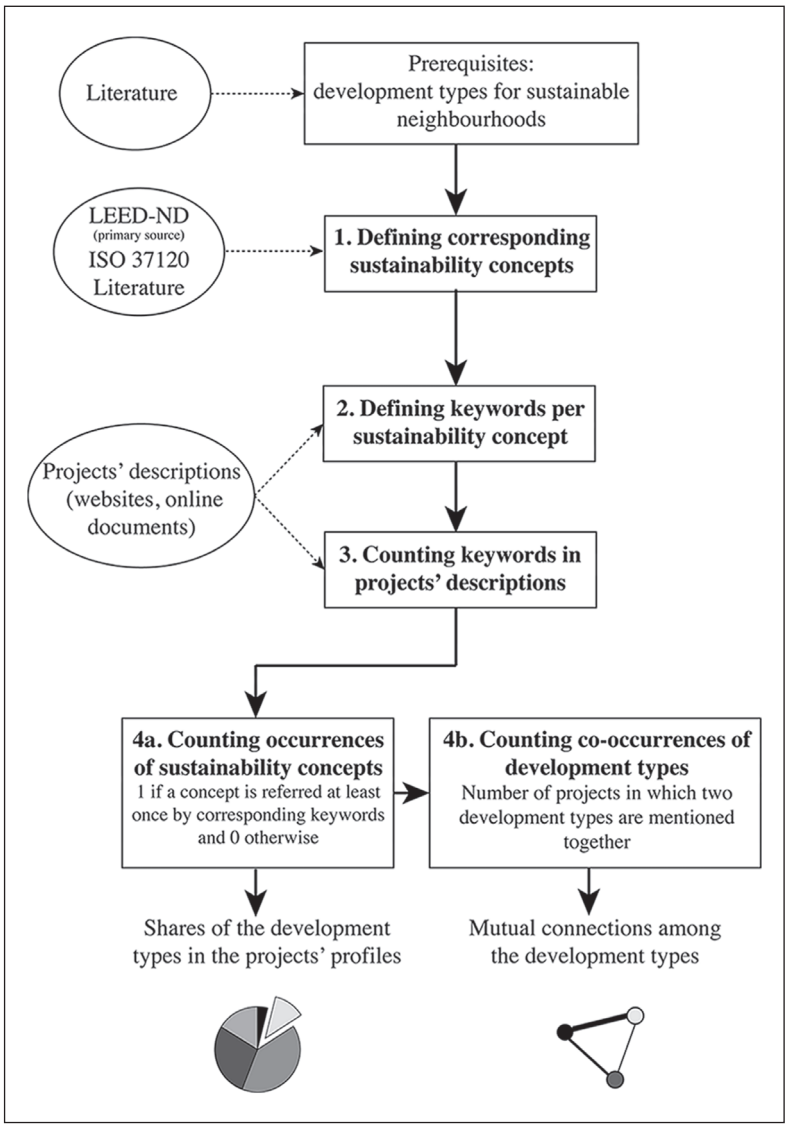


Figure 1: Approach developed to determine the share of development types in sustainable neighborhood profiles and to perform their co-occurrence analysis.

credits depending on the ability of the neighborhood project to fulfill various sustainability criteria. Developed by the US Green Building Council (USGBC), this rating system consists of 56 prerequisites and credits divided into three main categories: smart location and linkage; neighborhood pattern and design; and green infrastructure and buildings (USGBC 2018). Two supplemental categories address innovation and design process, and regional priorities. These categories were examined to define the concepts related to each development type (**Table 2**). This initial list was then extended to include additional sustainability concepts not found in LEED-ND, but present in other models of neighborhood sustainability assessment (Cloutier *et al.* 2018; Feleki, Vlachokostas, & Moussiopoulos 2018; Moroke, Schoeman, & Schoeman 2019) or inspired by metrics used in relevant standards from the ISO (2014). LEED-ND mainly addresses neighborhood design and environmental concerns (development types 2–4), with an effort on building multifunctionality and social mix (**Table 2**). A comparison with other sources of urban sustainability assessment highlights, however, a lack of metrics in the economic, governance, and self-sufficiency categories.

The keywords attached to each concept are listed in the Tables A1 and A2 in Appendix A. The keyword definition was mainly based on the case studies themselves. It was an iterative process, which was fed continuously as more case studies were analysed.

The next step consisted of counting the keywords in the project descriptions. An algorithm developed for this purpose using Python v3.7 retrieved the keywords directly from the project descriptions. Two types of analysis were then carried out (**Figure 1**). First, the occurrence of sustainability concepts was counted in the following manner: as long as at least one keyword was mentioned, the corresponding concept, and consequently the corresponding development type, became part of the project's profile. Relying on the presence of the concept in the text and not on its number of repetitions ensured that results were less dependent on the document format and style (*e.g.* length). The number of concepts was added for each development type and then compared with the total number of concepts identified in the project, giving the share of each development type, *i.e.* the neighborhood's profile. **Table 3** shows an application of this procedure for the reference case where all concepts in each development type are mentioned.

The second type of analysis focused on the interconnections among development types. The objective here was to identify the instances where developers presented a development type in conjunction with others, which helped to show the relationships between them. This was done by counting their co-occurrences, *i.e.* calculating the number of projects where two development types were mentioned concurrently.

2.3 Case studies

The proposed typology was applied to the province of Quebec (Canada). Quebec has no label or official statement defining a sustainable neighborhood. The most active regional actor in the sector is the non-profit organisation Vivre en Ville, which defined guiding principles based on the official French label (Vivre en Ville 2013). There is no obligation for every self-proclaimed sustainable urban project to comply.

Since no official database exists, the initiatives were found on the internet between May 2015 and May 2016, and later updated in 2019, using the French-equivalent keywords of 'sustainable neighborhood' (*quartier durable*), 'green neighborhood' (*quartier vert*), 'ecological neighborhood' (*quartier écologique*), and 'eco-neighborhood' (*éco-quartier*). The initiatives were selected if they met at least two criteria: the project had to include more than one building and must have sufficient information available. Some projects were excluded if they were abandoned (*e.g.* bankruptcy, arrested development, *etc.*). In total, 29 sustainable neighborhood projects were included in the analysis.

The selected case studies and their main features (type, area size, number of residential units) are reported in Table A3 in Appendix A. In comparison with sustainable neighborhoods found in other countries (Flurin 2017), several of the selected case studies are much larger in size. Six of them cover an area of more than 100 ha, *e.g.* le Vertendre project (445 ha). This is because projects were selected regardless of their size, based on the existence of a single, coherent development strategy implemented for an area located within the administrative boundaries of a municipality. In Quebec province, this can result in low-density projects far from urban centers. Although projects of this scale differ from existing definitions, they are consistent with the scope of this study and qualify as self-proclaimed sustainable neighborhoods.

As the size of a project can likely influence its development strategy (Rauscher & Momtaz 2015), it is accounted for in the results through the 'number of residential units' parameter. Based on this parameter, the case studies are divided into two categories depending on whether the number of residential units is above or below 1000. This threshold is somewhat subjective; it was chosen based on the project descriptions of the case studies because it appears to be the order of magnitude above which the selected projects are considered 'major developments.' Hence, in this analysis, projects with more than 1000 residential units are considered large developments. **Figure 2** shows the geographic repartition of the selected case studies in the province. It can be seen that 60% of the initiatives are located in the Montreal Metropolitan Community, either within Montreal itself (10 projects) or in the surrounding cities (seven projects). Moreover, all large projects are also located in this region.

The project descriptions used to build the neighborhoods' profiles were for the most part promotional (*i.e.* marketing) websites and associated documents produced by key actors (developers or their agents) involved with each project. These promotional websites and documents are assumed to represent the aspects that project stakeholders spent time

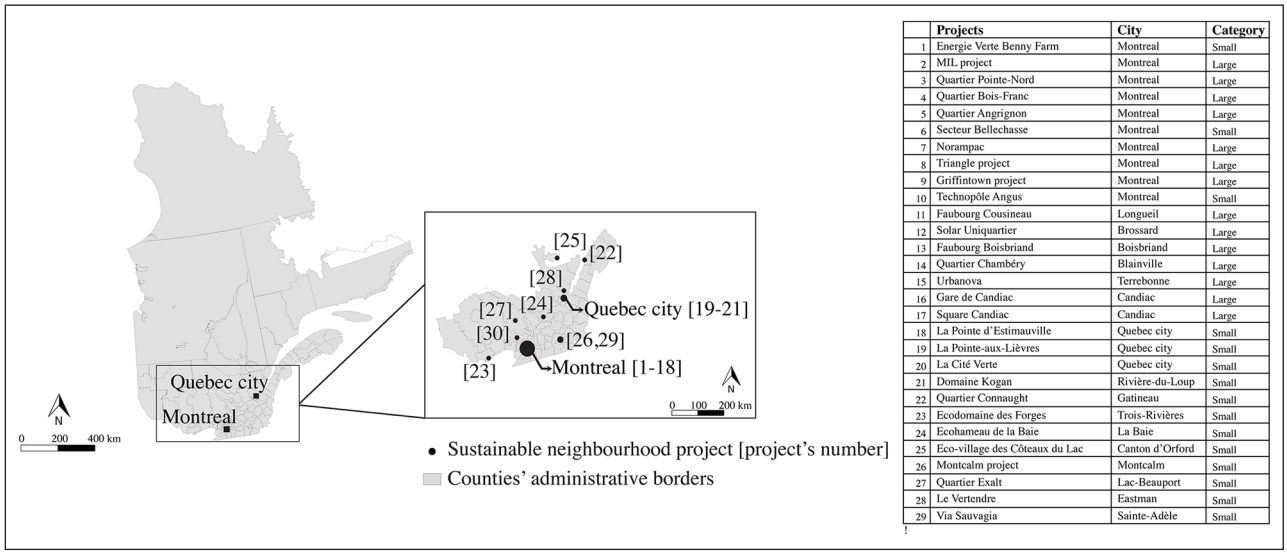
Table 2: Sustainability concepts attached to the 10 development types.

Development type	Sustainability concepts from LEED-ND	Additional sustainability concepts found in the literature
Economic development	Local economy	
		Sound financial investments (ISO 2014)
		Creation of jobs (ISO 2014)
Natural space	Wildlife protection	
	Natural habitat protection	
	Green spaces	
District with lighter environmental footprint	Energy management	
	Water management	
	Waste management	
	Air emissions management	
Compact urban environment	Transit facilities	
	Soft mobility	
	Car-dependency reduction	
	Densification	
Community with high quality of life	Built environment quality	
	Cultural and recreational services	
	Safety, health and security	
		Sense of place and belonging (Axelsson *et al.* 2013; Cloutier *et al.* 2018)
Diverse urban area	Socioeconomic diversity (based on age, income level)	
	Mixed-use buildings	
	Housing and business diversity	
	Food production/security	
Self-sufficient community		On-site water treatment (ISO 2014)
		Energy production/security (Lufkin, Rey, & Erkman 2016)
		Other local supply (Bogunovich 2009)
Equal society	Affordability (housing, transport)	
	Care for targeted population (children, elderly, disabled)	
		Intragenerational solidarity[a] (Feleki *et al.* 2018; Gibson 2006b)
Participatory governance	Open consultations	
		Fostering residents' engagement (ISO 2014)
		Collective decision-making and ownerships of services (Gibson 2006b; Moroke *et al.* 2019)
Learning environment	Education and training facilities	
	Research and innovation	
		Awareness programs (Gibson 2006b)

Notes: [a] Support was offered to people affected by unemployment, poverty, lack of access to education, training and leisure.
LEED-ND, Leadership in Energy and Environmental Design and Neighbourhood Development.

Table 3: Total number of concepts per development type and the resulting shares in the reference case.

	Development type	Total number of concepts	Share for the reference case (%)
1	Economic development	3	8.8%
2	Natural space	3	8.8%
3	District with a lighter environmental footprint	4	11.7%
4	Compact urban environment	4	11.7%
5	Community with a high quality of life	4	11.7%
6	Diverse urban area	3	8.8%
7	Self-sufficient community	4	11.7%
8	Equal society	3	8.8%
9	Participatory governance	3	8.8%
10	Learning environment	3	8.8%
	Total	34	100%



	Projects	City	Category
1	Energie Verte Benny Farm	Montreal	Small
2	MIL project	Montreal	Large
3	Quartier Pointe-Nord	Montreal	Large
4	Quartier Bois-Franc	Montreal	Large
5	Quartier Angrignon	Montreal	Large
6	Secteur Bellechasse	Montreal	Small
7	Norampac	Montreal	Large
8	Triangle project	Montreal	Large
9	Griffintown project	Montreal	Large
10	Technopôle Angus	Montreal	Small
11	Faubourg Cousineau	Longueil	Large
12	Solar Uniquartier	Brossard	Large
13	Faubourg Boisbriand	Boisbriand	Large
14	Quartier Chambéry	Blainville	Large
15	Urbanova	Terrebonne	Large
16	Gare de Candiac	Candiac	Large
17	Square Candiac	Candiac	Large
18	La Pointe d'Estimauville	Quebec city	Small
19	La Pointe-aux-Lièvres	Quebec city	Small
20	La Cité Verte	Quebec city	Small
21	Domaine Kogan	Rivière-du-Loup	Small
22	Quartier Connaught	Gatineau	Small
23	Ecodomaine des Forges	Trois-Rivières	Small
24	Ecohameau de la Baie	La Baie	Small
25	Eco-village des Côteaux du Lac	Canton d'Orford	Small
26	Montcalm project	Montcalm	Small
27	Quartier Exalt	Lac-Beauport	Small
28	Le Vertendre	Eastman	Small
29	Via Sauvagia	Sainte-Adèle	Small

Figure 2: Spatial distribution of the selected initiatives in the province of Quebec.

and effort to implement, *i.e.* the aspects they believe must be included in a sustainable development plan, despite the risk that promotional documentation may only focus on marketable achievements, and exclude any mention of the decision-making process, stakeholder involvement, or certain environmental aspects. The consulted sources were websites dedicated to the project, stakeholder's websites describing the project, master planning documents, descriptions from a specialised third-party website (Vivre en Ville, Eco-habitation), and press articles. When available, promotional websites dedicated to the project were selected as the primary source of information. When dedicated websites were unavailable, the websites of other stakeholders (*e.g.* the city, non-profits involved in the project's development) were used. Stakeholder's websites do not primarily aim to market the project, but nevertheless focus on its quality and benefits, which is consistent with the first type of sources. Information from outside sources not directly linked to the main stakeholders (specialised third-party websites, press articles) was disregarded. In only one case (Norampac) was a document written by developers for purposes other than marketing included since no other alternatives were available. Table A4 in Appendix A gives an overview of the type and word count of each source document. It also mentions the project stakeholder who published the document, either the developer or another main stakeholder. In many cases, developers offered a development plan based on urban sustainability to address local concerns for a better urban environment. Owing to its recent de-industrialisation, Montreal has many brownfield sites close to the city center. Their revitalisation into new residential sites is often the pretext for ambitious sustainable initiatives (Benali 2012). Only one project is developed exclusively by a non-profit—the Habitations communautaires Loggia—to build affordable

community housing in the Bellechasse district of Montreal. It should, however, be noted that private developers may have different degrees of freedom regarding which sustainable features they addressed depending on the project, which may influence the types of development observed. For example, some projects are closely overseen by public and/or non-profit organisations, which are in fact the main stakeholders. The landowner of the Benny Farm project, the state-owned Canada Lands Company, shows a strong social responsibility towards residents, and this attitude is reflected in the project development (Gillis, Saliba, & Pouzet 2010). Other projects are less constrained by sustainability requirements, other than abiding the city's sustainable development plan for densification and public transport access (*e.g.* the Solar Uniquartier project). Another category of developers is individuals wishing to build autonomous communities with specific attributes, such as for the Eco-village des Côteaux-du-Lac and the Ecohameau de la Baie.

3. Results

3.1 Average neighborhood profile

Aggregating the results of all case studies reveals the average profile of sustainable neighborhoods in Quebec province (**Figure 3**), along with the standard error resulting from the heterogeneous case studies. This result is compared with the reference sustainable neighborhood, whose profile encompasses all the sustainability concepts defined in **Table 2**.

Results suggest that in Quebec province, the average sustainable neighborhood profile (as marketed by the main stakeholders) does cover every development type, but to various degrees (orange line). Compared with the reference case (black line), the profile is clearly more oriented towards four sustainability dimensions: a compact urban environment (21%), an increased quality of life (17%), the reduction of the environmental footprint (14%), and proximity to nature (13.5%). The aspects 'compact urban environment' and 'increased quality of life' diverge the most from the reference case, and thus are the main cause of the gap between theoretical and marketed sustainable neighborhoods. These aspects also show the highest variance among case studies, as indicated by the standard error (dotted orange line).

3.2 Sustainability concepts

Figure 4 characterises the concepts stakeholders refer to when they market a particular type of neighborhood. It shows the results for both categories of projects (smaller and larger than 1000 residential units).

The 'compact neighborhood' development type (4) is a recurrent feature for both categories of projects, but especially for large developments where it is dominant. Allowing easy transit access, promoting soft mobility and mitigating urban sprawl are particularly important concerns for these projects usually located at the heart or near urban centers.

However, these concepts do not necessarily preclude car use. Explicit actions to reduce the reliance on private transport (such as limited parking spots and specific street designs) are included in only one-third of the initiatives.

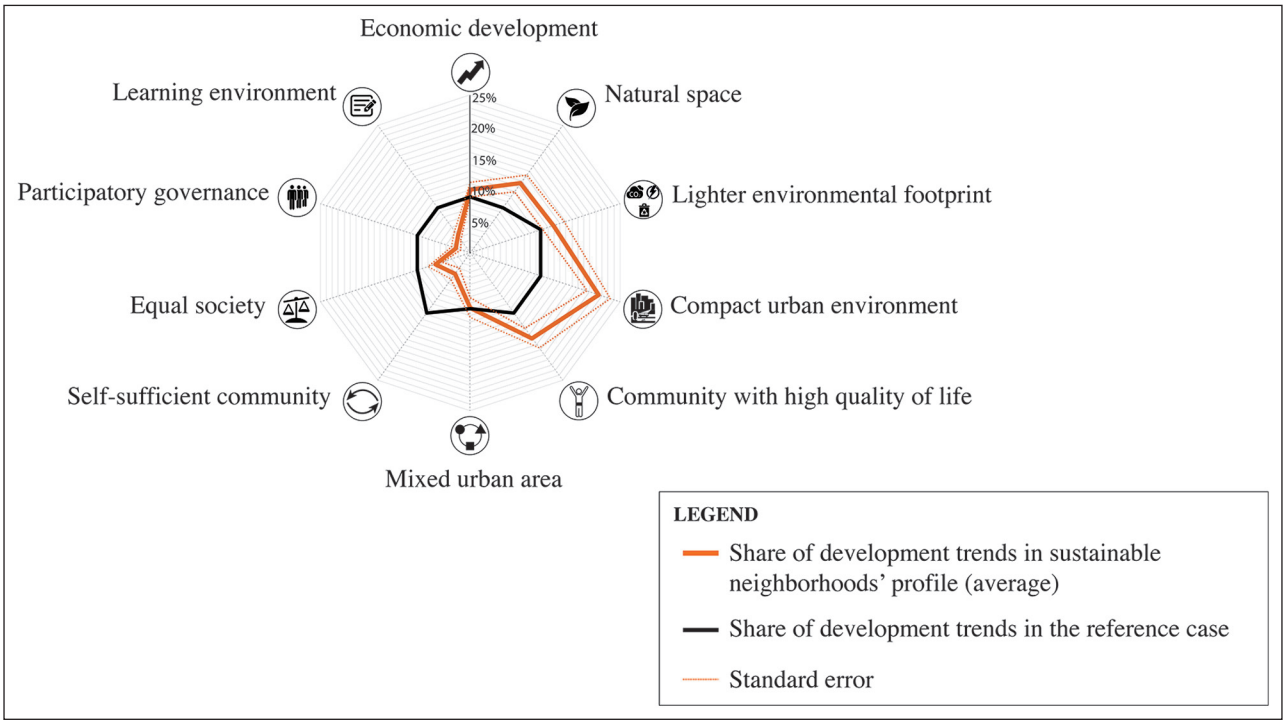


Figure 3: Average profile of sustainable initiatives in the province of Quebec according to the 10 development types, with standard errors. The profile of the reference case is provided for comparison.

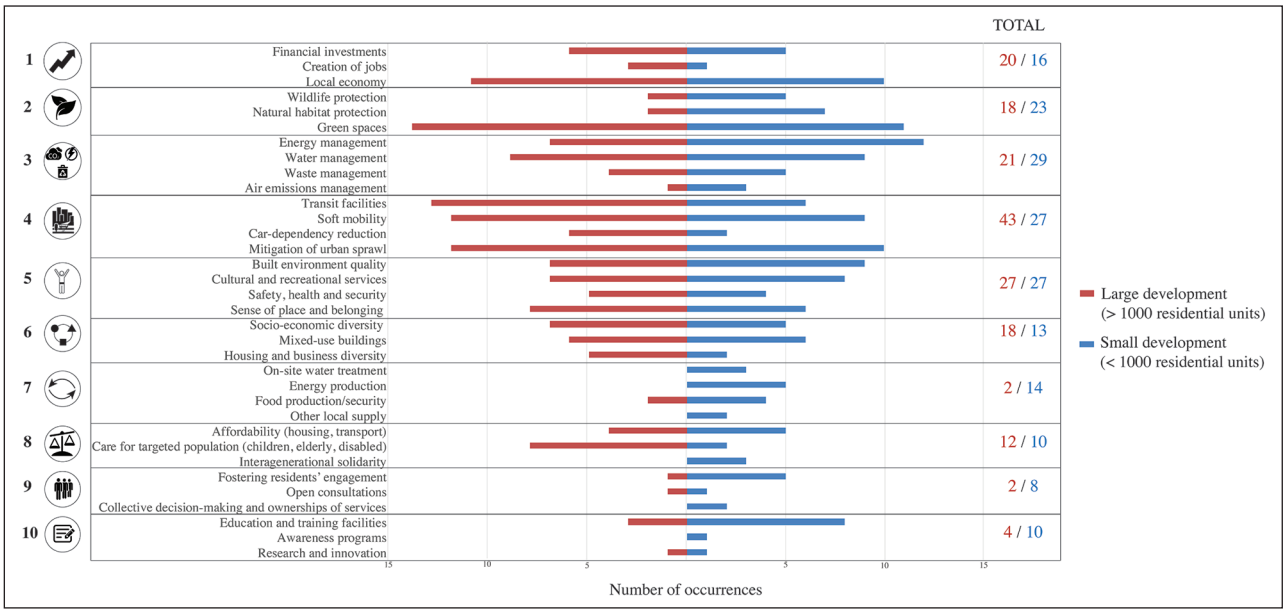


Figure 4: Number of occurrences of sustainability concepts in the case studies for large and small developments: 1, economic development; 2, natural space; 3, lighter environmental footprint; 4, compact urban environment; 5, community with a high quality of life; 6, diverse urban area; 7, self-sufficient community; 8, equal society; 9, participatory governance; and 10, learning environment.

Energy and water management are also important priorities in development strategies, with energy efficiency and rainwater collection both mentioned 19 times in total. In comparison, only six cases refer to solid waste management via recycling or the use of recycled materials. While efficiency measures can be considered recurrent concerns in both small and large projects, it is a significant feature to the small projects' profile (29 occurrences), whereas it only ranks third for large projects (21 occurrences), behind compacity and an increased quality of life. For the 'increased quality of life' aspect, both types of projects grant equal importance to urban architecture and design (comfort, aesthetics, quality) and infrastructure for recreation purposes.

At the other end of the spectrum, several aspects of sustainable planning are seldom included in most of the analysed case studies. Except for concerns related to social networking, the so-called social dimension of sustainability is in the vast majority neglected. Implementation of a participative governance, education and, to a lesser extent, incentives for social equity are not well integrated in development strategies. **Figure 4** shows that collective management of infrastructure, open consultations, fostering awareness, and promoting innovation are the least mentioned aspects in all the case studies, but to varying degrees depending on the project size. Results suggest that small development projects from the sample tend to focus more on fostering resident engagement (five occurrences against one for large projects) and establishing education and learning facilities (eight occurrences against three). They also adopt several self-sufficient strategies regarding water, energy, and food supplies (14 occurrences against two). Small developments present a more complete approach towards nature conservation, looking at wildlife and natural habitat protection as well as integrating green spaces, whereas large developments mainly focus on the latter.

Finally, the economic and diversity aspects remain relatively well addressed in both categories of projects and in total, although they relate more to large-scale initiatives (**Figure 4**). In particular, promoting the benefits of a local economy through proximity of services is quite common in large or small projects, as well as efforts to encourage a socioeconomic diversity in the neighborhood.

3.3 Co-occurrence of development types

Figure 5 presents the co-occurrences of development types, which indicate their mutual connection in the projects' profiles. Results are given for large (**Figure 5a**) and small (**Figure 5b**) developments. A higher frequency of co-occurrence between development types is indicated by a thicker and darker link.

The co-occurrence analysis confirms the previous findings and sheds more light on the differences between small and large projects. First, greening the urban space and/or preserving natural ecosystems seem to be the most common concepts since the development type 2 is at the center of both meshed networks (77 connections in total for large developments and 86 for small ones). Nature and its environmental benefits can thus be seen as facilitating factors for other development types. In large developments, proximity to nature is primarily addressed through its integration within a more compact urban design, for instance to foster soft mobility. These two types (2 and 4) then form a basis to establish a community with a high quality of life (type 5), an aspect with which they have the highest number of connections. Promoting a dynamic local economy (1) and reducing the environmental footprint (3) are strongly related

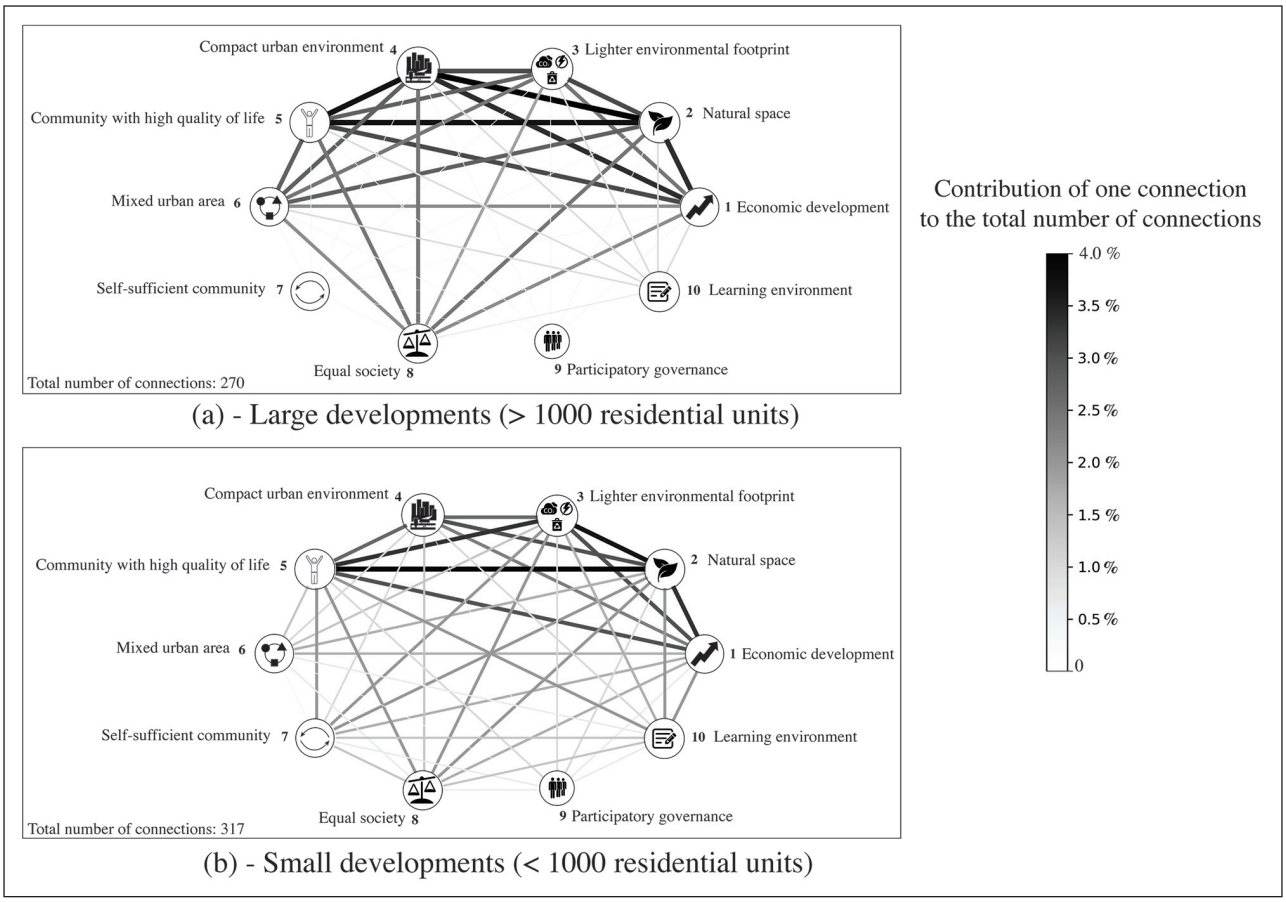


Figure 5: Co-occurrence of the development types for **(a)** large developments and **(b)** small developments in Quebec province. The co-occurrence is the number of projects in which two development types are mentioned together.

to this primary network. In smaller projects, the highest numbers of connections are found for types 2 and 5 and for types 2 and 3. This suggests that proximity to nature and livability issues are also embedded for the majority of projects, but not necessarily through urban design. It also confirms that concerns for energy and water management (the results are shown in **Figure 4**) are more recurrent for projects of this size.

A striking difference between **Figure 5a** and **b** is the degree of connections between the primary network described previously (types 1–5) and the other development types. In large projects, the diverse (6) and social equity (8) types are integrated in most development strategies. Education and learning are mentioned by a minority of projects, whereas issues related to participative governance (9) and self-sufficiency (7) present weak links with all other types. This indicates that more than being overlooked, these issues are not distinctly associated with sustainability in most large sustainable neighborhood projects. In contrast, self-sufficiency is included in the development plans of several small communities, with distinct interconnections to the communities' quality of life, environmental footprint, and natural space. Self-sufficiency also often accompanies more integrated governance aspects, even though this is not systematic for each project. The connection between types 7 and 9 is weak. Nevertheless, the self-sufficient community type presents interesting connections with equal society and learning environment, suggesting that a significant number of projects (5) manage to combine these three usually overlooked aspects. However, self-sufficient projects present no characteristics of mixed urban spaces.

Overall, the co-occurrence analysis results demonstrate that small projects present a more complex interconnection network than large projects. Larger projects establish their strategy on a few key recurrent aspects: compact urban design, proximity to green spaces, and an enhanced livability for residents. Smaller projects also share key aspects centered on the proximity of natural spaces and residents' wellbeing, and often include other considerations related to energy and food security, education, learning processes, or governance. Interestingly, governance issues are the only social aspect not clearly connected to other social aspects (types 8 and 10, for example).

4. Discussion

4.1 Framework approach

The approach presented in this paper allows the quantitative analysis of development trends that make up the development strategy of sustainable neighborhood projects. As shown for Quebec province, it helps to assess the

sustainability concepts valued and underestimated by stakeholders, and it highlights how they are combined or integrated in practice, which is a current gap in the literature. One strength of the approach adopted here is that it relies on a framework that translates sustainable development into actual practice that can be easily grasped by developers and other stakeholders. A project is indeed rarely described as purely economic, environmental, institutional, and/or social. Or if it is, it can bring confusion as to the project's ins and outs since the social and environmental dimensions encompass various concepts and some common sustainability features are clearly transversal such as mixed-use buildings and energy security.

Nevertheless, the limitations of the approach, with implications for its wider use, must be mentioned. First, the project profiles presented here depend on the sustainability concepts included in the framework, which could be refined for different contexts, or as new literature emerges. Second, when comparing different projects, the projects' profiles rely on keywords found in descriptions that may be written by different stakeholders. This can lead to two types of biases: one due to the description format (*e.g.* its length); and another due to its author, who might have a particular perception of sustainability.

The first type of bias was addressed by plotting the word count per description against the number of keywords retrieved (as defined in Tables A1 and A2 in Appendix A); and the number of concepts derived from the keywords. There is a correlation between the word count and the number of keywords: overall, the greater the word count, the more keywords are included (especially for long descriptions). However, there is no clear link between the total word count and the number of sustainability concepts referred to in the text. This is because only the presence of each keyword was considered, regardless of the number of times it appeared in the document. This makes the method robust enough to account for various text formats.

The second type of bias especially affects the interpretive insights that can be drawn regarding the influence of the project size on development strategies. Different project size can involve different types of stakeholders in charge of promoting the project. Among the 29 included initiatives, larger projects tend to be promoted by private companies (the developers), often with a dedicated website, while the marketing of smaller projects more commonly involves other types of stakeholders such as individuals (eco-villages) or non-profits (Energie Verte Benny Farm, the Bellechasse project). This a specificity of the sample and no generalisation can be drawn at this stage on a clear relation between the size of the project and its development strategies without including all relevant stakeholders. Nevertheless, regardless of the size, project profiles with different stakeholders are deemed comparable since it was assumed that: all stakeholders plan and document their project in good faith, limiting greenwashing strategies (*e.g.* false claims) to preserve brand image and integrity; and stakeholders promote and publicise all efforts they make towards sustainability.

4.2 Results for Quebec province

Results showed that sustainable development strategies slightly differ between small and large projects. Developments with more than 1000 residential units are primarily marketed on issues related to compacity/densification, proximity to green spaces, and residents' comfort and wellbeing. This approach closely relates to a popular strategy in sustainable neighborhood planning, which was inspired by New Urbanism and is also characteristic of several developments in the United States (Mapes & Wolch 2011) and South Africa (Seeliger & Turok 2015). New Urbanism seeks to solve environmental problems and bring social cohesion through changes in physical design (Sharifi 2016), including minimised car dependence, increased public transportation, well-designed open spaces, and greater quality of the built environment. Mixed-use buildings are also common features of this type of developments, which are common in Quebec province.

However, like other New Urbanism projects that suffered criticisms regarding their lack of citizen involvement (Irazábal 2012; Sharifi 2016), large developments in Quebec province show almost no integration or connections to the 'participatory governance' development type. The only notable exception is the Urbanova project, where the municipality engaged residents by designing a charter to ensure environmentally friendly practices, from the use of volatile organic compound (VOC)-free paints to parking space restrictions (Terrebonne Municipality 2014). Two reasons could explain this absence in the other case studies. First, some elements of citizen involvement or consultation may have actually been part of the development strategy, but developers did not find them useful for marketing purposes. In Montreal, for example, public forums held by the Office de consultation publique de Montréal (OCPM) during the planning stage are common for projects where the municipality is involved, but they would not necessarily appear in the project descriptions. Second, private developers of large projects may consider some elements of participatory governance to be beyond their responsibility, or even too risky to be included in their investment plan (Seeliger & Turok 2015). This is the case for collective ownership, working committees, or different forms of cooperation happening after the completion of the project. If it is agreed that citizen involvement is generally beneficial, then there is scope for policymakers to provide more compelling incentives to foster this particular aspect into planning processes on large eco-community developments.

The comparison with smaller developments offered interesting insights in this regard. This subset presented notable differences from the larger projects: more evidence of concerns regarding self-sufficiency and education/learning issues, more participatory governance representation, and fewer New Urbanism characteristics such as

compact and mixed-use developments. In contrast to larger projects, these particular features may be a specificity of small developments in Quebec province. The presence of three eco-villages (Ecohameau de la Baie, Eco-village des Côteaux-du-Lac and the Montcalm project), which promote self-reliance, citizen commitment, and ecological values, usually remotely from urban agglomerations (Barton 1998) can partly explain this trend. But beyond eco-villages, which remain hardly scalable in the realm of sustainable neighborhoods, one urban case stands out by its inclusion of the neighborhood's operations. At the Energie Verte Benny Farm project in Montreal, the renewable energy and water system is managed by a committee of residents and technical experts who decide how the financial gains from energy and water savings are redistributed within the neighborhood (L'OEUF 2019). This was achieved through a joint approach of planning between a state-owned company, an architecture firm, private developers, and citizen committees, which resulted in the creation of a non-profit managing the daily operations of the neighborhood. From this successful example, larger developments could benefit from allocating more resources to include different types of stakeholders in the planning process, especially if this joint approach lays the foundations for future activities in the neighborhood.

A feature of smaller projects worth considering is that they all engage in different forms of proximity (Bahers & Durand 2017), consistent with their size, that contributes to the meshed network observed in **Figure 5b**, *i.e.* a more integrated development strategy. In mainstream planning, proximity is considered generally through the lens of compactness, as a solution to mitigate urban sprawl. For the three eco-villages and the Energie Verte Benny Farm project, geographic proximity is also linked to the relocation of food and/or energy supply closer to final consumers. The proximity of such production activities constitutes an opportunity for residents to be included in the infrastructure's management (community gardens, energy production), and to make collective decisions for its planning and operations. This organisational proximity between residents, which is facilitated by the design of the built environment, may assist their long-term commitment to the project. Exploring different forms of proximity in projects (geographical, but also organisational) could be a relevant starting point to integrate further currently undervalued sustainability concepts in development strategies.

Finally, more guidance could be drawn from the proposed framework by using different clustering strategies. Rather than by size, the case studies could be clustered using other parameters such as geographic location or socioeconomic factors (income or education levels), which can influence the success of different development strategies (Adkins *et al.* 2017; Rivera *et al.* 2017). This could lead to new insights into how different parameters influence (or are correlated with) the development of a sustainable neighborhoods' profile. The relative differences resulting from the comparison could also help devise better-adapted, more specific recommendations for the context of each case study.

5. Conclusions

A new method was developed to identify which aspects of sustainable development are incorporated into development strategies by the main stakeholder involved in a project's development (the developer, municipality, or public organisation), and in which combinations. Profiles of sustainable initiatives were created according to 10 aspects.

The profiles showed clear prioritisation and minimisation of different sustainability aspects. This suggests a gap between what constitutes a sustainable neighborhood and what is marketed as such. Considerations for environmental aspects (*e.g.* compactness, reduced environmental footprint, proximity to nature) and the comfort and wellbeing of residents are prevalent in most projects, to varying degrees depending on the project size (small/large) and the associated stakeholders. However, other social aspects are underrepresented in the project profiles, especially participatory governance (*e.g.* concepts of citizen consultation, participation, and collective management of the neighborhood).

The distinction between small and large projects, which can involve various key stakeholders, offers interesting insights. In general, smaller projects show higher degrees of interconnections between sustainability aspects. Committed individuals or groups of individuals who founded small developments in Quebec province showed how relocating food and/or energy production can create opportunities for education and learning (Ecohameau de la Baie) and increased citizen participation (Eco-village des Côteaux-du-Lac). In a small precinct in Montreal, a joint approach to planning between a state-owned company, an architecture firm, private developers, and citizen committees resulted in a collectively managed, energy self-sufficient neighborhood. In other cases, municipalities can act to complement the developers' vision of sustainability by engaging residents beyond the completion of the project, for instance through incentives or mechanisms encouraging best sustainable practices (*e.g.* community charter, local meetings).

The revealed gap in marketed durability aspects comes as no surprise, as most projects were created by private developers (especially in large projects) who may have limited control on some long-term aspects of sustainability. Since the private developers' remits often exclude citizen involvement beyond the planning stage, there is potential for the public sector (policymakers and planners) to create a process for stakeholder participation in the creation, implementation, and operation of large new neighborhoods. This complementary effort could help achieve more complete and interconnected sustainability profiles. Further developments of the approach adopted in this study could help better understand what parameters lead developers to include or exclude certain sustainability aspects from their projects.

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Competing interests

The authors have no competing interests to declare.

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A. Appendix A

A.1 Keywords retrieved in the projects' descriptions

Tables A1 and A2 present the keywords defined for each development type and used to analyse the projects descriptions. Different versions of a same idea were included in the list, but are not reproduced in the tables. For example, 'energy efficiency' and 'eco-efficiency' were used indistinctly by developers with the same meaning. Some words taken alone could lead to different interpretations than that intended. For example, 'consultations' appeared sometimes for consultations between the developers and the municipality, whereas residents' consultations were the notion looked for. To avoid confusion, each problematic keyword was re-contextualised with the original text.

Table A1: Keywords for development types 1–5.

Type 1 Economic development	**Type 2 Natural space**	**Type 3 Smaller environmental footprint**	**Type 4 Compact urban environment**	**Type 5 Community with a high quality of life**
Rentability	Biodiversity	Energy efficiency	Public transport	Comfort
Viability	Fauna	Clean energy	Bus	Esthetics
Investments	Flora	Wind energy	Metro	Modern
Shops	Ecological corridors	Solar energy	Active transportation	Socialisation
Commercial	Ecosystems	Biomass	Bikes	Common values
Tourism	Natural area	Geothermal energy	Narrow streets	Conviviality
Hotel	Natural habitat	Water savings	Roads reduction	Community areas
Luxury	Forest	Rainwater collection	Proximity of services	Public places
Jobs	Parc	Recycling	Densification	Recreation
Industries	Green space	Reuse	Brownfield rehabilitation	Culture
	Greening	Carbon dioxide		Safety
		Air emissions		Security
		Climate change		Healthcare

Table A2: Keywords for development types 6–10.

Type 6 Diverse urban area	**Type 7 Self-sufficient community**	**Type 8 Equal society**	**Type 9 Participatory governance**	**Type 10 Learning environment**
Multigenerational	Self-sufficient	Affordability	Concertation	Education
Social mix	Independent	Social housing	Participation	Training
Mixed use	Self-production	Equity	Involvement	Scientific
Multifunctional	Autonomy	Childcare	Open deliberations	Experimental
Housing diversity	Community gardens	Elderly	Cooperation	Chair
	Urban agriculture	Universal access	Self-governance	Awareness
	Local goods	Social support	Community management	
	Local materials	Solidarity	Activism	

A.2 Characteristics of the case studies

Table A3 lists the main characteristics of the sustainable initiatives included in the analysis. Revitalisation and new development projects are evenly represented (16 *versus* 14). The projects size is, however, extremely heterogeneous, from fewer than 20 housings to upwards of 8000.

Table A3: Selected case studies and their characteristics.

Project	City	Type of development	Area (ha)	Residential units
Energie Verte Benny Farm	Montreal	Revitalisation	7.3	797
MIL project	Montreal	Revitalisation	38	1300
Quartier Pointe-Nord	Montreal	New development	9.2	1600
Quartier Bois-Franc	Montreal	Revitalisation	260	8000
Quartier Angrignon	Montreal	Revitalisation	Unknown	3000
Secteur Bellechasse	Montreal	Revitalisation	Unknown	166
Norampac	Montreal	Revitalisation	4.2	1163
Triangle project	Montreal	Revitalisation	40	3200
Griffintown project	Montreal	Revitalisation	84	8200
Secteur Ouest de Pierrefonds	Montreal	New development	365	5500
Technopôle Angus	Montreal	Revitalisation	8.3	360
Faubourg Cousineau	Longueil	New development	63	3500
Solar Uniquartier	Brossard	New development	Unknown	4000
Faubourg Boisbriand	Boisbriand	Revitalisation	102	1700
Quartier Chambéry	Blainville	New development	250	3000
Urbanova	Terrebonne	New development	83	1200
Gare de Candiac	Candiac	New development	113	2300
Square Candiac	Candiac	Revitalisation	16	1400
La Pointe d'Estimauville	Quebec City	Revitalisation	8.4	782
La Pointe-aux-Lièvres	Quebec City	Revitalisation	12	910
La Cité Verte	Quebec City	Revitalisation	9.3	800
Domaine Kogan	Rivière-du-Loup	Revitalisation	2.8	220
Quartier Connaught	Gatineau	Revitalisation	40	800
Ecodomaine des Forges	Trois-Rivières	New development	29	41
Ecohameau de la Baie	La Baie	New development		15
Eco-village des Côteaux du Lac	Canton d'Orford	New development	22	18
Montcalm project	Montcalm	New development	109	n.d.
Quartier Exalt	Lac-Beauport	New development	19	166
Le Vertendre	Eastman	New development	445	35
Via Sauvagia	Sainte-Adèle	New development	Unknown	247

Table A4: Projects' descriptive documents.

Project	Main stakeholder (description sources)	Type of document	Words	Keywords	Sustainability concepts	Reference
Energie Verte Benny Farm	Other (non-profit)	Website	1263	26	15	http://www.loeuf.com/fr/projects/benny-farm-green-energy-benny-farm/
MIL project	Developer (university)	Website	3063	42	12	http://ville.montreal.qc.ca/pls/portal/docs/PAGE/proj_urbains_fr/MEDIA/DOCUMENTS/20110200_ResumeAnalyseFTF_CampusOutremont.pdf

(Contd.)

Project	Main stakeholder (description sources)	Type of document	Words	Keywords	Sustainability concepts	Reference
Quartier Pointe-Nord	Developer (private)	Website	2404	48	16	https://pointenord.com/a-propos/
Quartier Bois-Franc	Developer (private)	Website	1197	40	8	https://www.boisfranc.com/projet/#histoire
Quartier Angrignon	Developer (private)	Website	922	15	8	https://habitermontreal.com/quartier-angrignon-un-lieu-ou-vivre-au-carrefour-de-la-ville-et-de-la-nature
Secteur Bellechasse	Developer (non-profit)	Website	426	19	12	http://www.habitation.gouv.qc.ca/fiches_de_projet/fiches_projets_dd/habitations_communautaires_loggia.html
Norampac	Developer (private)	Layout presentation	6548	92	17	https://ocpm.qc.ca/sites/ocpm.qc.ca/files/pdf/P44/1a3a.pdf
Triangle project	Other (public)	Online public presentation	831	24	11	http://ville.montreal.qc.ca/pls/portal/docs/PAGE/ARROND_CDN_FR/MEDIA/DOCUMENTS/20170116_PRESENTATIONSOIREE25JANV_SP.PDF
Griffintown project	Other (public)	Online public presentation	2947	58	17	http://ville.montreal.qc.ca/pls/portal/docs/PAGE/ARR_SO_FR/MEDIA/DOCUMENTS/PR%C9SENTATION%20DU%20PROJET%20GRIFFINTOWN%20PAR%20LE%20COMIT%C9%20EX%C9CUTIF%20%C0%20LA%20VILLE%20DE%20MONTR%C9AL.PDF
Technopôle Angus	Developer (private)	Website	489	24	15	https://www.technopoleangus.com/quartier/ecoquartier
Faubourg Cousineau	Developer (private)	Website	832	16	8	http://www.faubourgcousineau.com/eco-quartier/
Solar Uniquartier	Developer (private)	Offline presentation document	232	14	6	–
Faubourg Boisbriand	Developer (private)	Website	782	23	8	http://www.voirvert.ca/projets/projet-etude/le-developpement-du-faubourg-boisbriand
Quartier Chambéry	Developer (private)	Website	2054	24	12	https://chambery.blainville.ca/projet-immobilier-chambery
Urbanova	Other (public)	Online presentation document	2052	41	14	https://www.urbanova.ca/uploads/engagement-social-residents-urbanova_de0105.pdf
Gare de Candiac	Other (public)	Website	1013	52	16	https://candiac.ca/fr/106/TOD_de_la_gare
Square Candiac	Other (public)	Website	1580	32	14	https://candiac.ca/fr/35/Square_Candiac_le_Montcalm
La Pointe d'Estimauville	Other (public)	Website	424	21	14	https://www.ville.quebec.qc.ca/apropos/planification-orientations/amenagement_urbain/grands_projets_urbains/ecoquartiers/destimauville.aspx

(Contd.)

Project	Main stakeholder (description sources)	Type of document	Words	Keywords	Sustainability concepts	Reference
La Pointe-aux-Lièvres	Other (public)	Website	773	19	8	https://www.ville.quebec.qc.ca/apropos/planification-orientations/amenagement_urbain/grands_projets_urbains/ecoquartiers/pointe_aux_lievres.aspx
La Cité Verte	Developer (private)	Website	646	14	9	https://ssq.ca/fr/cite-verte/a-propos
Domaine Kogan	Developer (private)	Online presentation document	2246	34	14	https://villerdl.ca/uploads/PDF/Domaine_Kogan.pdf
Quartier Connaught	Developer (private)	Website	802	47	17	http://www.habitationsbouladier.com/connaught/fr/le-projet/le-quartier/
Ecodomaine des Forges	Developer (individuals)	Website	248	16	10	http://www.ecodomainedesforges.com/ecodomaine-des-forges
Ecohameau de la Baie	Developer (individuals)	Website	1654	34	14	http://www.greb.ca/GREB/Ecohameau_de_La_Baie.html
Eco-village des Côteaux du Lac	Developer (individuals)	Offline presentation document	4079	89	15	–
Montcalm project	Developer (non-profit)	Website	1298	28	16	http://www.terravie.org/?page_id=18
Quartier Exalt	Developer (private)	Website	284	9	8	https://www.quartierexalt.com/projet/
Le Vertendre	Developer (private)	Website	742	15	6	https://levertendre.com/chalets/
Via Sauvagia	Developer (private)	Online presentation document	743	18	4	https://docs.wixstatic.com/ugd/fd69d8_f66c8416e5c54857aca26450c79250ce.pdf

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