



Research paper

A sensitivity analysis to methodological variation in indicator-based urban sustainability assessment: a Quebec case study



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ABSTRACT

Methodological factors are often acknowledged for their impact on the urban sustainability assessment outcomes. The significance of this impact, however, divides those who assign it great importance; to the point of compromising any attempt at sustainability benchmarking using indicators, from those who regard it as having a relatively limited role. In this paper, we aim to contribute to this debate by assessing how methodological choices could influence the variation in the outcomes of indicator-based urban sustainability benchmarking. The paper starts with a literature review outlining the evolution of the approaches adopted since the pioneering experiences in the '90s to show a convergence in indicators and data over time. Subsequently, by using the data of the 25 most populous cities in Quebec, we empirically analyse the sensitivity of the cities' sustainability scores to 18 combinations of estimation techniques, and observe consistency within the outcomes while maintaining general patterns regardless of the approach used. The results suggest that methodological choices play a limited role in the urban sustainability assessment outcomes. Thus, other determinants beyond the evaluation methods are most likely involved and therefore should be a major focus in future research agendas.

1. Introduction

Since the beginning of the 90s, several cities around the world have adopted integrated policies to improve their performance in the environmental, social and economic spheres, which together are regarded as the triple bottom line of urban sustainability. Today, what are considered as sustainable cities have two main features. First, their negative effects on the natural environment are among the lowest, owing, for instance, to the implementation of effective policy for the management of air quality, water consumption, waste recycling, energy consumption and the preservation of green spaces. Second, on the socioeconomic front, they offer favourable conditions for households, businesses, activities and visitors, including, for instance, affordable housing; jobs; a safe environment; accessible, affordable, quality education and health care; and heritage preservation (Emelianoff and Stegassy, 2010).

Considering the necessary investments in terms of time, money and actions to simultaneously achieve these objectives, many cities have begun to monitor their performance in these areas by using tools such as dashboards with context-specific indicators or by adopting generic indicators for benchmarking that enable comparisons with other cities (Baker, 2007). In a review of 150 international examples of such

benchmarking analysis – including those developed by Siemens, the Ethisphere Institute, and the Natural Resources Defense Council – Moonen and Clark (2013) argue the relevance of the use of generic indicators, which serves several purposes. It allows for territorial marketing by offering the best cities with opportunities to promote their good practices. It helps enhance the effectiveness of strategic urban planning by highlighting the main weaknesses, which can then be considered in the planning process (Bonges, 2015). Finally, because the cities are accountable to taxpayers, generic indicators become a tool to illustrate the city's willingness to make practices more transparent (Koller, 2006). However, it should be noted that convergence in assessment and better comparability from benchmarking analysis can raise an isomorphism among benchmarked organizations, which calls for greater transparency as to the context, purpose and outcome of the performance comparison of cities (Ammons and Roenigk, 2015).

Many indicator-based approaches have been developed in this respect. They differ in several ways, including: i) the choice, nature and the number of indicators; ii) the data used to quantify the indicators, and iii) the subsequent computation method to estimate the overall sustainability score. Given the diversity resulting from the combination of these aspects, the assessment and benchmarking outcomes are unquestionably likely to vary from the use of one approach to the next.

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However, the magnitude of this variation, which illustrates the impact of the methodological factors on the evaluation of urban sustainability, is subject to two different points of view, which we address in this paper.

According to authors like McManus (2012) and Meijering et al. (2014), the process of selecting and quantifying a set of sustainability indicators plays the central role in reporting cities' sustainability. From such point of view, the significance of these factors could make the observed results unreliable and prone to leading to the wrong interventions in terms of policy decisions. This has resulted in the mobilisation of considerable research on the methodological aspects of urban sustainability evaluation, with the aim of seeking for the most comprehensive assessment approaches. In contrast, other studies recognise the impact of the choice of methodology and estimation technique, but assign to it a relatively circumscribed functioning in the production of cities' sustainability reports by acknowledging the ineluctability of methodological constraints, as in any social sciences research project, and by discussing the fact that these constraints are not enough to fully compromise the observed results and radically influence the main trends (Singh et al., 2009; Gasparatos and Scolobig (2012); Floridi et al., 2011). This point of view can be further illustrated by a simple identification of the leading cities in existing international urban benchmarking initiatives, for example the one compiled by Moonen and Clark (2013), which includes the results of 150 distinctive assessment approaches from both academic (e.g. Matthiessen et al., 2010) and business-oriented organizations (e.g. Economist Intelligence Unit, 2012). While international comparisons of cities often disregard the context and operational environment, this compilation includes approaches based on various contexts, frameworks and purposes, thus allowing for the highlighting of several constantly outperforming cities, such as Copenhagen and Amsterdam in Europe, Portland and Seattle in the United States, and Vancouver in Canada. Such observations raise potential path dependency issues, as the compiled approaches may mimic each other or base their suitability by cross-referencing. It also raise the hypothesis that the role of methodological factors in the sustainability assessment approach outcomes could be somewhat limited.

This paper contributes to the above debate by proposing an assessment of how methodological choices could influence the variation in the outcomes of indicator-based urban sustainability benchmarking. Our analysis mainly focuses on the techniques for estimating the overall sustainability score. In this respect, we have applied different estimation techniques to the sustainability indicators of the 25 most populous cities in Quebec, as compiled by Rajaonson and Tanquay (2009) and have measured the sensitivity of the observed performance to 18 generated combinations of aggregation, standardisation and weighting methods, with the hypothesis that some general trends are maintained regardless of the method used. In such case, we argue that there are factors beyond methodological issues that explain why, in terms of sustainability policy and practice, the success of the best cities does not always seem to be reproducible, even for similar cities. The remainder of this paper is as follows:

In Section 2, we present a literature review with a focus on the progress in indicators set and data that occurs since the early experiments of cities in developed countries. Section 3 sets the analytical framework adopted to determine the extent to which the sustainability performance of the 25 largest cities in Quebec is sensitive to different computation techniques. The subsequent data and methodology are described in Section 4. Section 5 discusses the results, which show a relatively strong consistency in the outcomes of the use of different computation techniques. Finally, we conclude and raise some implications of our findings for future research.

2. Literature review

It is generally acknowledged that cities' performance, as reported through the use of sustainability indicators, are mainly dependent on

the methodological approach, which primarily involves the process of selecting the indicators, and the data used to quantify them (Maclaren, 1996; Boulanger, 2004; Coelho et al., 2010; Cruz and Marques, 2014; Huang et al., 2015). Progress observed over time in both aspects is discussed in the following subsections.

2.1. Evolution of the process of selecting indicators

One component of urban sustainability assessment is the process of selecting indicators. Several methodologies have been reviewed in meta-analyses addressing issues relating to their nature, conceptualisation and analytical scope (Ness et al., 2007; Singh et al., 2009; Tanguay et al., 2010; Moreno Pires et al., 2014; Huang et al., 2015; Nieto et al., 2017). Another way to look at these reviews is to assign a particular focus on the timeline of the compiled methodologies, which allows highlighting the difference between early experiments, somewhat polarised between environmental-based and anthropogenic-based approaches, and the most recent initiatives, which show convergence toward a more integrated perspective regarding both dimensions of sustainability. One of the most recent reviews is found in Huang et al. (2015), where 30 urban assessment approaches are grouped and analysed according to their respective framework, either based on dashboards or a single composite indicator. Another way we looked at Huang et al.'s data, regardless of these aspects, is to classify the approaches on a timeline. This allows for the observation of four general trends.

First, the early approaches developed between 1989 and 2001 appear more diverse, with studies adopting a more environmentalist perspective and others following a path based on an anthropocentric vision of sustainability. In the first case, greater value is assigned on the preservation of natural resources and the reduction of the environmental impact, with a goal of offering the same development opportunities to future generations (King et al., 2000). Thus, the suggested indicators generally evaluated the pressure exerted by urban activities on the natural environment, and included indicators relating to air pollution, the consumption of energy and water, and the level of recovery of residual materials (Bossel, 1999; King et al., 2000). In the studies pursuing a path toward sustainability based on an anthropogenic vision, greater importance is assigned to the socioeconomic development of the city through the creation of wealth and infrastructure and the provision of high-quality services (Allen, 2009). Hence, the indicators used to measure the achievement of these objectives tend to evaluate the quality of life or the level of availability of services and public facilities (Allen, 2009). As the indicators from these two perspectives do not necessarily measure the same objects, their outcomes are likely to be quite different. This has been highlighted by Cherchye and Kuosmanen (2004) in a study of the correlations between the early sustainability-oriented indexes, including the *Human Development Index*, the *Human Welfare Index*, the *Health-Adjusted Life Expectancy*, the *Ecological Footprint*, and the *Ecological Sustainability Indexes*, which shows negative correlations between the environment-based and the anthropocentric-based indexes.

Second, the more recent studies, seem to adopt integrated approaches, where indicators relating the environmental and the socioeconomic dimensions of urban sustainability are assessed simultaneously. In Huang et al. (2015)'s review of existing urban sustainability assessment, 18 out of 21 approaches developed between 2001 and 2014 are sharing such integrated vision, owing to their demonstrated ability to assess the multiple underlying objectives of urban sustainability. Also, indicators' selection criteria such as SMART (i.e., simple, measurable, acceptable, relevant, time-bound) has become consistent within existing studies (Bossel, 1999).

Third, convergence in the number, nature or choice of indicators have been demonstrated in other studies, although the link between fewer indicators being tracked and improvement in urban sustainability assessment is yet to be demonstrated. For instance, in a review of 17

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