Using sustainability indicators for Urban Heritage management: a review of 25 case studies

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In this paper, we analyze 25 case studies that specifically discuss and propose sustainability indicators. We look at how the indicators are used across these practices and identify differences and commonalities that will lead to the development of key indicators. On the one hand, our analysis reveals the existence of three dichotomies, respectively between: i) scientific and policy-led approaches to select indicators; ii) anthropocentric and environmental-oriented vision of sustainability and iii) quantitative and qualitative orientation of the indicators. On the other hand, we identify 20 common indicators based on their widespread use and their ability to cover the environmental, economic, and sociocultural dimensions of urban heritage. Finally, these observations underline the common characteristics of sustainability indicators in urban heritage beyond the differences in context.

Introduction

Current research on the management of urban heritage following its conservation process is characterized by a growing number of studies that aim to provide an overview of how to assess the sustainability of existing practices. This dominant focus of the research has contributed to the development of indicators and approaches to sustainable development (SD) in this field. In addition, it has assisted with the implementation of policies and development strategies based on the assessment of the indicators.

However, given the multiple definitions of SD and the different interpretations of heritage at the urban scale, the approaches to sustainable heritage management have grown significantly. The growth of such approaches is often associated with the fact that each building, site, and urban area has its own characteristics, requiring the use of customized indicators. When the latters become too specific however, issues of credibility may arise as the indicators could be manipulated to serve a political purpose. For instance, one can assess their sustainability performance by using only indicators that display good results.

In addition, issues of comparability become problematic, as the diversity of indicators that are used do not allow for comparison across different location and size of buildings or sites. Such issues are challenging for governments, as it becomes difficult to establish a systematical diagnosis of local needs for future investments and policy purposes.

This variety of case studies calls for the development of a research agenda in this field dedicated to the search for optimal indicators to capture the multidimensionality of sustainability. In this context, our paper presents an analysis of an inventoryof recent case studies in this field proposing the use of indicators.

We look at how the indicators are used across these studies. Thus, weidentify for differences and commonalities, which leads to the development of an optimal set of indicators that policy makers and local authorities could use to assess sustainability in the management of urban heritage.

The remainder of the paper is divided as follows. In Section 2, we present the general conceptions underpinning sustainable heritage management and the challenges presented by its evaluation using indicators.In Section 3, we present the issues in bridging urban heritage management and sustainability indicators, which is the basis of our analysis. Section 4 describes our methodology.Section 5 reports the results of our approach and discusses the main implications. We demonstrate that despite the variety of case studies, it is still possible to identify general patterns and commonalities that lead to the development of key indicators. The conclusion follows.

Urban heritage management and sustainability indicators

There are various conceptions of urban heritage and its conservation, and a variety of definitions have succeeded one another (Giovannoni, 1998). In general, urban heritage conservation is defined as the conservation and development of public spaces and the monumental heritage of the public domain. In addition, it likely encompasses private property, if the latter is subject to conservation process. For example, Berthold and Mercier (2013) conducted a study for the Old Town district in the city of Quebec. They reveal how real estate speculation can become the subject of discursive construction through which the conservation of the heritage successfully occurs via the conservation of private property within a historic district.

Urban heritage management follows the conservation process, which is generally carried out based on potential costs of preservation and projected level of tourist attraction (Rocher, 2003) as well as ideologies (Berthold, 2012). In this latter case, the heritage is inserted into a system of values based on factors such as knowledge and disciplinary specializations that underlies political action. Research in this field have also shown that several categories of participants are likely to be involved in a conservation and management process, including public authorities, interest groups, and citizens (Drouin, 2005). Such diversity of actors often increases social interactions and conflicts. As a result, conservation and management processes are likely to favor certain groups and exclude others based on the interactions between the stakeholders (Graham, Ashworthand Tunbridge, 2000).

More recently, new parameters have been added to urban heritage management given the growing importance assigned to SD or sustainability in contemporary urban policies (Tweed and Sutherland, 2007). Therefore, economic, ideological and normative parameters have been progressively complemented with environmental and sociocultural considerations. As a result, sustainability has become increasingly more challenging for both researchers and policy makers. A growing number of studies are addressing conceptual and methodological issues related to the integration of economic, sociocultural and environmental assessment (Agyekum-Mensah et al., 2012) as well as issues related to the pragmatic use of such assessments as input in policies and urban development strategies (Zanchetiand Hidaka, 2012). As we argue in the next section, part of the challenge, which raises theses issues, stems from the measurement of SD by using indicators.

The concept of sustainable development took root in the 1970s with the growth of the environmentalist movement. However, it is mainly because of the Brundtland report, which was published by the World Commission on Environment and Development (WCED) that the concept is found at the heart of international political agendas. In this report, sustainable development is defined as "development that meets the need of the present generation without compromising the ability of future generations to meet their own needs" (WCED, 1990: 43). Its implementation is reflected by harmonious development, with respect to environmental, economic, and sociocultural dimensions, over time (Tweed and Sutherland, 2007). However, in 30 years of research and application, its interpretations have multiplied due to its broad and ambitious definition. Two years after the publication of the Brundtland report, there were more than 60 definitions and in 1996, more than 300 definitions were identified (Rajaonson and Tanguay, 2009). Despite such a vast array of interpretations of the concept, certain common principles emerged and were developed over the years. For instance, poverty reduction, abandonment of unsustainable mode of consumption, and protection and management of natural resources have been pointed out as the main objectives of sustainable development (Boutaud, 2004). Furthermore, according to Boutaud (2004), nothing is done in the policy arena without the label of sustainable development. It is therefore no wonder that the concept has been repeatedly questioned and redefined.

Given the lack of consensus surrounding the concept of sustainability, especially at the urban scale, research in this field proposed its transposition into dimensions and measurable indicators in order to allow for a more transparent definition and interpretation (McLaren, 1996; Tanguay et al., 2010). In this perspective, the Venn diagrams are widely used to represent and introduce the concept of sustainable development (Connelly, 2007). The latter is schematized in Figure 1 as an overlap of three circles representing economic, sociocultural and environmental concerns, respectively. Compared to other

approaches (e.g., in terms of resources and capital), this representation has the advantage of expressing the concept as a form of balance between the developments of each dimension. It also reflects the interdisciplinarity required in its implementation (Boulanger, 2004).
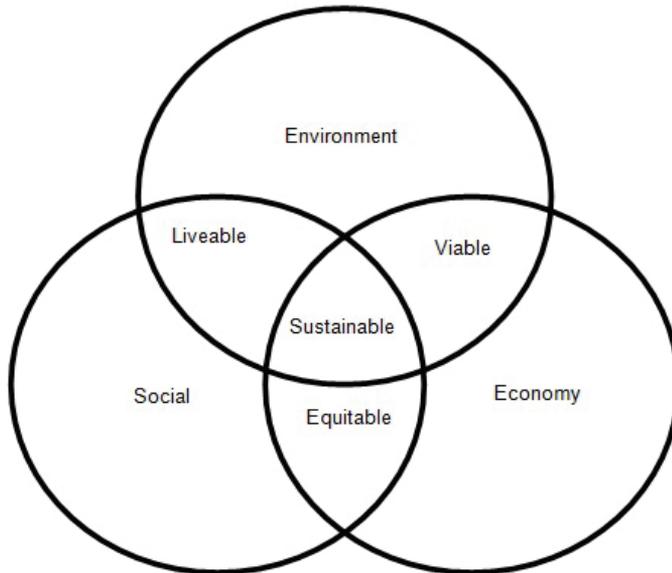

Figure 1. Conceptualization of SD.

Each dimension is generally broken down into several domains or themes and each theme in turn, is associated with different indicators. The passage from dimensions to indicators raises several issues, one of which is the question of usefulness. It is generally acknowledged that the choice of one or several indicators to inform on a theme, must take into account their usefulness (Holman, 2009). As informational tools, the indicators are used to quantify and synthesize complex phenomena falling under the three traditional dimensions of SD and to organize the information in order to give it a political meaning (e.g., benchmarking) (Bouni, 1998). The indicators are designed to allow for environmental and socio-economic assessment in order to support projected urban SD strategies. At the same time, key indicators appear to be a system of information with a political character. Therefore, the information vehicle is likely to be organized in such a way that it crosses the "world of research and science to be integrated with that of the policy" (Bouni, 1998: 21). In this perspective, subjectivity is inevitably introduced in view of the fact that the indicators chosen depend on, despite the use of relevant selection criteria, the targeted users and objectives related to the analysis process. As a result, the procedure for the production of indicators is closely linked to the need for information in policy elaboration.

Indicators however, are not the only tools used to assess sustainability (Ness et al., 2007 provides a discussion of and a comparison between the different families of tools to assess sustainability). Also, like any tools, indicators have both limitations and advantages. For instance, they do not allow to account for the impact of a change in policy or the impact of the implementation of a specific project, unless they are designed to assess actions and government programs (Ness et al., 2007). Additionally, they may not replace essential tools such as cost-benefit analysis, risk and vulnerability assessment, or dynamic analysis of a system (Ness et al., 2007), which are all essential and complementary to one another from a sustainable development assessment point of view. However, indicators are generally recognized for their simple character and their analytical effectiveness in that quantitative data generally fall within the three pillars of sustainable development (Ness et al., 2007). A grid of common indicators can play an important role in information systems in ensuring that the assessment truly reflects the values and concerns identified at a local level or municipal level, as well as at a higher level (Tanguay et al., 2010). Unlike statistics held by the public administration (i.e., local or municipal), the indicators are an instrument of democratic evaluation rather than a management tool in the hands of only the authorities. In this regard, they generally perform two functions: They constitute a basis of information for political decision-making (internal use for municipalities); as well as contribute to the development of a common language covering the concept of SD and of its constituent dimensions (external use for all categories of potential users). In some themes reflected by the indicators, the authorities may have the power to perform changes, while in others it does not.

Together with the challenges of usefulness, the development of sustainability indicators also depends on the constraints of observations and measurements. In fact, several inevitable compromises limit the effectiveness of the indicators and lead to changes in objectivity. For example, we must take into account the request for concise information by users while simultaneously using a consistent methodological approach and considering the supply of data. From a scientific viewpoint, this compromise is often reflected by the use of fewer indicators that are less explicit; the data is then used to calculate information for the scale of the desired analysis (Singh et al., 2009). For example, poverty is commonly measured with the aid of economic indicators such as income distribution and household expenses, since the statistical data referring to these indicators are easily accessible (Rajaonson and Tanguay, 2009). Yet, poverty also has social and cultural dimensions (e.g., related to issues of exclusion and education). For these dimensions, there are several other indicators that are just as relevant, whose measures, if they are available, sometimes require calculations or more complex adjustments (Boulanger, 2004). As we will see in the next section, such adjustments are often necessary, especially in the context of our approach, which aims to bridge the use of sustainability indicators into urban heritage management.

Bridging urban heritage management and sustainability indicators

In the field of urban heritage, sustainability is a relatively recent issue. The growing interest it raises amongst academics is rooted to: i) the political pressures resulting from the adoption of new frameworks based on SD in contemporary urban planning, and ii) the pressures from communities claiming the environmental and cultural needs of the society together with the economic interests (Garatet al., 2005).

The research toward a more sustainable urban heritage management and conservation is still in an exploratory phase (Faddy, 2010;Rodersand Van Oers, 2014). It requires a prior step, which is to develop assessment tools, like SD indicators, and specify a general framework, which will enable to bridge the use of sustainability indicators and urban heritage management.The literature on sustainable management of urban heritage often focus on one or two dimensions of sustainable development, rather than proposing a holistic approach covering the three pillars (i.e., environment, sociocultural, economic). For instance, focusing on the environmental dimension, Liao and Jones (2010) have stressed the need to situate the problem of sustainable conservation in the context of climate change. Judson et al. (2010) have compiled a review of studies that have tried to measure the environmental performance of ancient buildings from a qualitative perspective (based upon established certifications, such as LEED) and a quantitative perspective (e.g., Life Cycle Assessment). From another perspective, focusing on the built environment, Faddy recalled the central problem posed by urban housing density to the sustainable conservation of urban heritage: "Conventional wisdom is that sustainability equals an acronym densities (...) some historic suburbs are under threat from a push to accommodate dramatically an acronym densities" (Faddy, 2010: 402). He particularly highlighted the environmental costs (e.g., CO_2 emission impacts) that resulted in the demolition of buildings for the rejuvenation of park real estate from a perspective of densification of central neighborhoods. Su (2010) has proposed a few indicators to measure residential density. Some directly relate to buildings (number of floors, number of residents per building), and others relate to the surrounding environment (number of outdoor public areas, amount of parking). Many other examples exist that focus on other dimensions of sustainable development, such as the economic dimension (Greffe, 2003) and the sociocultural dimension (Volpiano, 2011).

In sum, consideration of the three dimensions of sustainability for a holistic approach has yet to be achieved, as the environmental, economic and sociocultural aspects of sustainability are often analyzed separately. The use of indicators of sustainability is a good starting point to achieve this, considering their flexibility and their ability to translate such complex concepts into measurable information. Further details of our analysis are provided in the following section.

Methodology

Our research is divided into two parts. The first part focuses on the differences between a selection of recent studies related to the assessment of sustainability in urban heritage management using indicators. Complementarily to this, the second part focuses on the search for commonalities in order to develop a set of indicators, which allow for the different trade-off implied by the assessment of sustainability in urban heritage management.

In the first part, using a computer-based research engine, we identify 25 scholarly papers that focused on the use of indicators to bridge sustainability and urban heritage conservation. The selected papers propose indicators for assessing the sustainability of urban heritage conservation. The 25 studies are presented in Table 1, where the main features include aspects such as their geographical context, the frameworks they adopted to organize the indicators (if any), the purpose of the indicators (either conceptual or practical purpose), and their level of application (either to buildings or urban areas). Following this inventory, we extracted the indicators used in these studies and analyzed their characteristics, including their number, choice, and nature. We followed this with a discussion of the results by bringing to light dichotomies between: i) scientific and policy oriented indicators; ii) anthropocentric and environmental perceptions of SD in urban heritage management, and iii) quantitative and qualitative approaches to sustainability assessment.

Table 1. List of the 25 case studies.

References	# of indicators	Framework	Purpose of Indicators	Application	Approach
Rosado Correla&Walliman (2012)	29	Explicit/Implicit criteria	Criteria for intervention	Earthen sites	Experts interviews
Farhanah& Mohamed (2012)	5	-	Assess public perception	Buildings	Public interviews
Yung & Chan (2012)	24	Economic, sociocultural, environmental, political	Adaptive reuse criteria	Buildings	Experts interviews
Suntikul&Jachna (2013)	5	Universal value and significance	Selection of cultural sites	Town center	Experts evaluation
Pendleburyet al. (2009)	10	Universal value and significance	Selection of cultural sites	World Heritage sites	Experts evaluation
Tweed & Sutherland (2007)	8	-	Assess public perception	Built heritage sets	Public interviews
Wang &Zeng (2010)	13	Economic, sociocultural, environmental, political	Evaluation of reuse alternatives	Buildings	Fuzzy Delphi
Volpiano (2011)	8	Characterization, trans-formation, enhancement	Assessment of historic landscape	Landscape	Experts analysis
Peanoet al. (2011)	23	Ecological, historical, visual, land uses, economical	Assessment of landscape transformation	Regional and local scale	Case studies
Phillips & Stein (2013)	8	Gauging, protecting, enhancing, interfacing	Historic resources preservation	Buildings	Literature review
Bullen& Love (2011)	43	Affecting factors, barriers, benefits, negative and positive effects of reuse	Adaptive reuse and conservation	Buildings	Experts interviews
Pons &Roders (2011)	3	Universal value and significance	World heritage nomination	Old town	Stakeholder interviews
Agyekum-Mensahet al. (2012)	8	Project management model and sustainability dimensions	Achieving sustainability in built environment	Built heritage	Experts analysis
Bullen& Love (2009)	10	-	Adaptive reuse and residential regeneration	Commercial buildings	Case study
Lorenz &Lützkendorf (2008)	10	-	Integrating sustainability in property valuation	Properties and assets	Literature review
De Silva & Henderson (2011)	8	Environmental sustainability	Conservation benchmarking	Built heritage	Experts analysis
Judson &Iywe-Raniga (2010)	7	Integrated life cycle framework	Assessing operational performance	Buildings	Case studies
Brooks et al. (2010)	3	-	Retrofit of existing and historic buildings	Buildings	Comparative study
Stubbs(2004)	16	Environmental, social/ cultural, economic, generic	Assessing historic sustainability	Historic areas	Case studies
Elsorady (2012)	22	Maintenance, economics, quality of life, change process	Measuring success of heritage conservation	Building	Case study
Mendes Zanchetti& Hidaka (2012)	3	Key performance indicators	Assessing the state of conservation of heritage	Heritage sites	Weighting from Delphi
Dalmaset al. (2012)	16	Economic, cultural, social and natural capital	Assessing the state of urban heritage	Built heritage	Experts analysis
WTO (2004)	24	Tourism sustainability	Assessing tourism-related heritage	Heritage sites	Experts analysis
Vehbi&Hoskara (2009)	16	Revitalization features	Measuring sustainability level	Urban quarters	Literature review
Landorf (2009)	35	Situation analysis, strategic orientation, community values, stakeholder participation	Site management plan coding	Heritage sites	Content analysis

Based on the search for a trade-off between theses dichotomies, the second part of our approach consist of identifying key indicators by applying two selection criteria to the indicators proposed in the 25 case studies:i) their frequency of use and ii) their systematic coverage of the main rationales of sustainable heritage conservation.The first criterion involved selecting the indicators that were most frequently used among those that were present in the 25 studies. This was done to identify those that were most often mentioned and for which relevance and reliability are recognized within the scientific literature. Additionally, our goal was to include only those that were most frequently used, as those mentioned only by one study were considered specific to a particular context. Since our paper focuses on core indicators, such context specificity was beyond the scope of the present study.

The second criterion, applied to the most frequently used indicators, involved ensuring that the selected indicators covered five aspects of urban heritage management following its conservation, which emerged from the interpretation of two frameworks of indicators respectively developed by Volpiano (2011) and Phillips and Stein (2013):i) characteristics; ii) protection motives; iii) enhancement opportunities; iv) use and impacts and v) policy and regulations.To ensure such consistency, we organized the indicators into a framework consisting of these five categories. In this step, we aimed for an equal number of indicators in each category to prevent weighting issues when the indicators will be measured. Such concern is also thought to contribute to the comprehensiveness of the indicators and to appeal to a broader range of involved stakeholders. Consequently, in order to reach an equal number of indicators in each of the five categories, the list of identified key indicators is likely to be further shortened by applying two sub-selection criteria. First, we retained the most frequently used indicators in each category. Second, to discriminate between indicators with the same frequency of use, we chose one that was able to cover at least two of the environmental, sociocultural, and economic dimensions of sustainability. This was to account for the main characteristics of the indicators in the 25 studies, as it was found that most of the indicators covered at least two of the three pillars of sustainability. Because subjectivity is inevitable in the development of such a set of indicators, we discuss some of the limits of this approach in the concluding section.

Results and discussion

The results of our analysis are twofold. First, we observe a lack of consensus concerning the number of indicators used the choice of indicators and their respective nature. Second, the selection criteria we proposed allows for identifying commonalities in the indicators proposed in the case studies, yet allowing necessary trade-offs between the reported dichotomies. Further details on these two main results are provided in the following sub-sections.

Lack of consensus in the number, choice, and the Nature of indicators

First, a lack of consensus emerged concerning the number of the indicators used. In total, 117 indicators were identified, and each study used between 3 and 29 indicators at a time. Generally, cases that involved various stakeholders used a limited number of indicators. Conversely, studies that were theoretically or conceptually more oriented toward a specific goal, tended to use a larger number of indicators due to their concern with accuracy. In fact, the elaboration of indicators opposed academics and policy makers on the number of indicators to use. The former prefer using a set of numerous yet precise indicators in order to capture the complexity of the assessment process in a sustainability perspective. This often results in sets of indicators that are scientifically valid, but unpopular with policymakers because of their complexity. On the other hand, policy makers recognize a shorter list of indicators. Such consideration allows for the accessibility and comprehensiveness of indicators for a wide range of public and private users. The resulting indicators are often obtained by consensus among stakeholders at the expense of finding neutral, credible, and reproducible assessment tools. These problems exemplify the need for an alternative set of indicators that are both scientifically valid and operational.

Second, our analysis revealed a lack of consensus as to which indicators to use. In fact, given the specificity of each case study, indicators may vary considerably. However, a minimum consistency amongst the case studies was expected, considering the fact that all cases is about assessing heritage sustainability. Thus, 70% of the indicators only appeared in one study, 21% were used in two and 10% were used in three studies. Many indicators were not commonly used because they were very specific to a given building, site, or urban area. In fact, the number of indicators commonly used in more than four studies was quite low (7.6%). These few indicators are the ones whose pertinence and value have been mostly recognized and explained in the case studies.
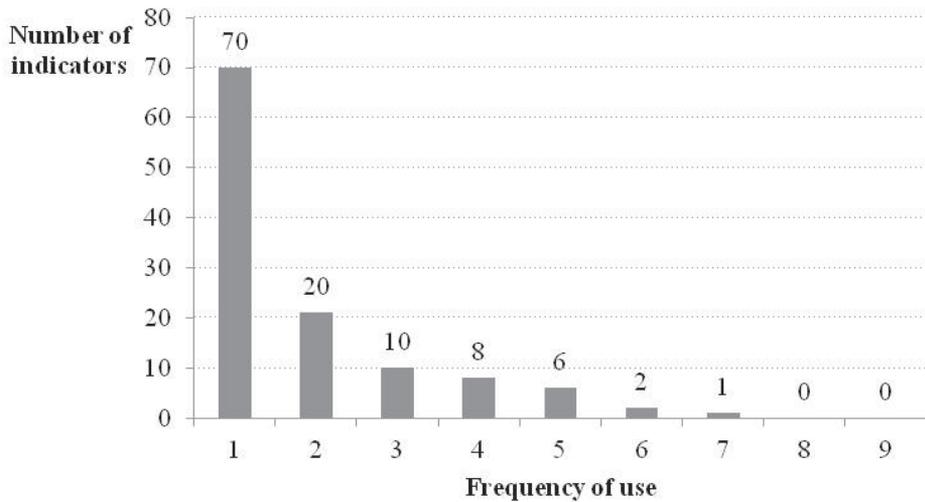
Figure 2. Frequency of use of the 117 indicators.

Additionally, we classified the indicators across the three integrated dimensions of SD. Although we recognize the subjective nature of such an approach, it provides a good idea of the nature and type of indicators that are generally used to assess sustainability in urban heritage conservation. Not surprisingly, the results show that most of the indicators across the case studies overlapped the environmental, sociocultural, and economic dimensions of SD. The results show that 34.74% of the indicators cover the overlapping of the three dimensions, 28.81% cover the overlapping of the sociocultural and the economic dimensions, and 8.47% cover the overlapping of the economic and the environmental dimensions. Such results show that multi-dimensional indicators, which can encompass two to three aspects of sustainability at once, must also be complemented with one-dimensional indicators (e.g.CO_2 emissions).

Furthermore, we made a key finding concerning indicator choice across the case studies. The choice of indicators opposed those with an anthropocentric vision of SD to those that associate sustainability to only environmental concerns. In the first case, authors like Volpiano (2011) emphasize the importance of the perception of visitors and the residents relatively to the impacts of the management of urban heritage on their quality of life. In the second case, environmental issues are placed at the center of sustainable heritage management (e.g.,Lianoand Jones, 2010). Sustainability is then reduced to only environmental interests (e.g., energy consumption). In both cases the conception of SD is insufficient, yet the gap of each vision can be completed through their integration. Additionally, qualitative indicators are often used within anthropocentric perspective of SD, while quantitative indicators are prominent within environmentalist perspective.Furthermore, we observed differencesconcerningscientific and policy-led approaches. Thus, as scientific approaches tend to use more indicators, while policy-led approaches often adopt less indicators to assess SD. These observations have implications in the development of a set of key indicators in sustainable heritage management. Thus, an optimal number of indicators are desirable to allow the trade-off between academic interests in analytical precision and the need of policy makers for practical and synthetic tools. It is also important to maximize the coverage of the different dimensions of sustainable heritage conservation as well as the environmental, sociocultural, and economic concerns of sustainability. Finally, quantitative and qualitative approaches are both relevant. Taking into account all these parameters resulted in the need to take a closer look at the common indicators.

Common indicators

There are not only differences amongst the cases studies; there are also commonalities in the proposed indicators. Such indicators are identified using the selection strategy described in the previous section. The first criterion applied to the indicators is the frequency of use. Amongst the 117 indicators, 48 are common to at least two studies. They are listed in Table 2. Hence, these have the most recognized and demonstrated pertinence and value.

Table 2. Most frequently used indicators.

Indicators	Dimension(s)
Characterization (17 indicators)	
Cultural context	Social
Sense of place and identity	Social
Sensitivity to change	Social
Attachment to place	Social
CO_2 emissions	Environment
Educational value or perceived	Soc-Econ
Historical value or perceived	Soc-Econ
Traditional value or perceived	Soc-Econ
Artistic, aesthetical and harmonious value or perceived	Soc-Econ
Symbolic value	Soc-Econ
Sense of ease and happiness	Soc-Econ
Risks situation	Soc-Econ-Env
Life safety	Soc-Econ-Env
Fragility	Soc-Econ-Env
Accessibility and location	Soc-Econ-Env
Building age	Soc-Econ-Env
Building fabrics, insulation and ability to adapt	Soc-Econ-Env
Protection (9 indicators)	
Public's sensitivity to change	Social
Cost-efficiency	Economic
Viability of recycling existing materials	Econ-Env
Resources and materials consumption reduction	Econ-Env
Authenticity	Soc-Econ
Integrity	Soc-Econ
Uniqueness	Soc-Econ
Spatial compatibility	Soc-Econ
Life span of existing building extension	Soc-Econ-Env
Enhancement (8 indicators)	
Maintenance capabilities	Economic
Opportunity for technical innovation	Economic
Environmental and ecological awareness	Environment
Opportunity for implementing low pollution and energy consumption infrastructure	Econ-Env
Buildings and sites conditions awareness	Soc-Econ
Promotion of actions for further knowledge of historical-cultural heritage	Soc-Econ
Improvement of living conditions and quality of life	Soc-Econ-Env
Benefit of re-use versus re-development	Soc-Econ-Env
Use and Impacts (6 indicators)	
Locals and visitors interests and involvement in conservation	Social
Enhancing the role of communities	Social
Business and functional use	Economic
Investments and tourists appeal	Economic
Potential environmental quality of the surroundings	Econ-Env
Increased urban density	Soc-Econ-Env
Policy and Regulations (5 indicators)	
Social cohesion and inclusiveness	Social
Public perceived consideration of their opinion	Social
Adequate protection and management system	Soc-Econ
Compliance with regulations and building codes	Soc-Econ
Stakeholder inclusiveness and partnership	Soc-Econ-Env

The next criterion consists of insuring that these 48 indicators covers adequately and are equally distributed across the five aspects of sustainable urban heritage management:i) characteristics; ii) protection drives; iii) enhancement opportunities; iv) use and impacts and v) policy, incentives, and regulations.

Thus, 17 indicators relate to the characteristics of heritage buildings and sites, nine cover the protection aspect, eightaddress the enhancement aspect, six relate to the use and impacts of the heritage buildings and sites, and five cover the policy and regulations matters.

For methodological purpose in future applications of these indicators, the list is shortened in order to reach an equal number of indicators across the five aspects of urban heritage conservation. First, we retain the five most frequently used indicators of each dimension. Five were picked because it is the maximum number of indicators that we could retain for the policy and regulation dimension,which has five indicators. Second, to choose between indicators that have the same frequency of use, we chose the ones

that are able to cover at least two of the environmental, sociocultural, and economic dimensions of sustainability. This was to respect the main characteristics of the indicators in the studies, which are mostly covering at least two of the three dimensions of sustainability. At the end of this exercise, 20 indicators were retained —they are listed in Table 3.

Table 3.   Key indicators of sustainable urban heritage conservation.

Indicators	Covered Dimension	Quantitative vs Qualitative	Threshold
Characterization			
Attachment to place	Social	Qualitative	5
Traditional value or perceived	Social-Econ.	Qualitative	5
Artistic, aesthetical and harmonious value or perceived	Social-Econ.	Qualitative	6
Building fabrics, insulation and ability to adapt	Soc-Econ-Env.	Quantitative	5
Protection			
Viability of recycling existing materials	Econ.-Env.	Quantitative	4
Authenticity	Social-Econ.	Qualitative	7
Integrity	Social-Econ.	Qualitative	6
Spatial compatibility	Social-Econ.-Env.	Quant-Qual	5
Enhancement			
Environmental and ecological awareness	Env.	Quantitative	5
Promotion of actions for further knowledge of historical-cultural heritage	Social-Econ.	Qualitative	2
Improvement of living conditions and quality of life	Soc-Econ.-Env.	Qualitative	5
Benefit of re-use versus re-development	Soc-Econ.-Env.	Quant-Qual	3
Use and Impacts			
Locals and visitors interests and involvement to conservation	Social	Quant-Qual	4
Business and functional use	Econ.	Quantitative	3
Investments and tourists appeal	Econ.	Quantitative	2
Increase urban density	Soc-Econ.-Env.	Quantitative	2
Policy and Regulations			
Public perceived consideration of their opinion	Social	Qualitative	3
Adequate protection and management system	Social-Econ.	Qualitative	4
Compliance with regulations and building codes	Social-Econ.	Qualitative	4
Stakeholder inclusiveness and partnership	Soc-Econ.-Env.	Quant-Qual	2

Accordingly, they have four fundamental characteristics. First, they represent the commonly used indicators and whose relevance is recognized and supported by current literature. Thus, they were selected from specific case studies in both academic and policy scope on SD indicators in the field of heritage conservation. Second, they include fairly common environmental, sociocultural and economic aspects. Third, indicators used include seven quantitative indicators and thirteen qualitative ones. These two types of indicators necessary in the assessment of sustainable heritage conservation are well represented in our approach. Finally, they address the major rationale behind heritage management following the conservation process. In fact, they relate to:i) the characteristics of the buildings; ii) their protection; iii) their improvement; iv) their usage and impacts and v) the corresponding policies and regulations, with four indicators each.

Conclusion

This paper builds on the existing literature on sustainability indicators to propose a set of key indicators. From the 117 different indicators we surveyed our approach lead to identify 20 key indicators that are reliable and recognized among academics and policymakers, and are also consistent with the diverse aspects of urban heritage management. Additionally, given the mixture of case studies analyzed, our approach allows obtaining key indicators that merge both quantitative and qualitative information as well as integrate economic, sociocultural, and environmental indicators. In this respect, the research we conducted is contributing to the existing literature in two ways: On the one hand, we exposed some features that divide the growing literature in sustainable heritage management assessment; andon the other hand, we proposed an approach to identify key indicators based on a rationale guided by the search for commonalities and trade-offs across the diversity of the case studies.

For policy makers and local authorities, the development of such indicators presents some advantages. First, it allows minimizing the risk of using indicators that are exclusive, which is often viewed as hiding political intentions (Rametsteineret al., 2010) In addition, local authorities tend to use indicators for which statistics are already available. The adoption of key indicators will encourage them to put more effort into developing data collection methods to provide information that is of higher quality, current, and that allows comparison amongst existing practices and experiences. Such comparison will help support local authorities in sharing their experience and learning from others. For provincial and national

governments, such comparison allows for a more systematic diagnosis of urban heritage issues that affect local areas. As a result, it will become easier to develop general policy strategies.

Nonetheless, such an approach to sustainability indicators has its limits, especially because subjectivity is unavoidable in the choice of indicators, frameworks, and the methods of data analysis (Singh et al., 2009). First, the selection of key indicators is based on a non-exhaustive list of indicators that have been identified through a limited number of case studies. The indicators may not be exhaustive, but they are those of which the relevance has been recognized and advocated for in relevant case studies. Second, different frameworks (e.g., goal-oriented, resources-oriented, capital-oriented) exist through which to organize the indicators(McLaren, 1996). In this study, the choice of the framework was guided by the intention to ensure that the indicators were consistent with the main aspects to be covered when addressing urban heritage conservation. Third, as a result of the existence of so many methods of data analysis, it is important to ensure that the selection of a method is justified and transparent. This study did not include an empirical section where choosing a method appeared to be problematic. In fact, this study was only conceptual and sought to identify key indicators that could serve as an assessment tool for the SD of urban heritage conservation. Nonetheless, it provides a starting point for further research with an empirical basis through which indicators are computed and their usefulness and limits are further discussed.

The integration of SD principles within urban heritage management has only recently gained importance. In fact, municipal authorities and their partners have only begun to integrate the principles of SD in their practices and in their policies of territorial development within the last two decades. However, much information has now been gathered, policies have been implemented and realized, and planning has led to action. At this point, it is time to assess and evaluate empirically the effectiveness of these policies and initiatives that are aimed at SD and heritage conservation.

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