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Research Article

Urban sustainability assessment for vernacular and traditional built environments

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ABSTRACT

Despite the growing literature on sustainability assessment in the urban context, the resulting approaches and methods utilise several differing theoretical frameworks and lack a unifying vision and *modus operandi*. Innumerable tools and instruments have been developed for particular purposes and rather narrow goals. Curiously, these tools and instruments remain unable to trace and assess sustainability in vernacular forms and traditional built environments, even though environments such as these demonstrably possess sustainable principles beside their aesthetic values and spatial qualities.

This paper reviews the theoretical background underpinning the current sustainability assessment methods in the urban context to identify their general limitations and their specific applicability to vernacular and traditional built environments. Also, this paper discusses some of the cultural and spatial qualities of traditional built form to identify its embedded sustainable strategies and practices. The paper concludes with an outline conceptual framework intended to develop general sustainability principles for traditional built forms in response to their natural and cultural contexts.

A literature review of the concepts of sustainability assessment in the urban context and embedded sustainable principles in vernacular and traditional built form is followed by a thematic analysis of its limitations, which feeds into this conceptualisation of a new, principle-based framework. A total of 10 principles of sustainability are proposed to assess sustainability in traditional built environments, taking into account the variation of locality and site-specific context.

1. Introduction

1.1. Urban sustainability, historical background

Over the last few decades, sustainability has become a prominent approach in urban development. The explicit impacts of extended urbanised areas have prompted authorities and decision-makers to search for alternative development approaches. Most of the available sustainability assessment methods and tools have been developed by countries in response to the global call for sustainable development.¹ The effort to measure sustainability in the urban context helps cities to monitor their current sustainability status while also

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encouraging future developments to adopt more sustainable principles and strategies.

The main focus of any development tends invariably to be targeting economic growth, but the call for integrating the natural environment in the planning process arose in the 1970s. The works of Ian McHarg and his book *Design with Nature* in 1969 regarding ecological planning and architecture played an important role in the environmental movement (Kaur & Garg, 2019). Also, the works of Rachel Carson's *Silent Spring* in 1962, and Barry Commoner's *Closing Circle* in 1972 which helped reinforce the modern environmental movements. This wave of writers who came later in 1960s and 1970s discussed the ecological and social impact of global human development. Some of the most influential writers of that period include Jane Jacobs, Herman Daly, Andres Gunder Frank and Whiston Spirm. Beside the report conducted by Limit to Growth team 1972 which was a significant milestone to draw the international attention of implications of unsustainable practices on global scale (Wheeler & Beatley, 2014).

On the other hand, the Brundtland report, following the definition of World Commission on Environment and Development (WCED) in 1987, suggests: “sustainable development meets the needs of the present without compromising the ability of future generations to meet their needs.” The concerns were on the environmental limits on economic and resource sufficiency in the 1980s and inequality between developed and under developing countries. (Moore, 2016). However, certain concepts were developed in this period before the Brundtland Commission, such as eco-development (CIDA, 1979) and the World Conservation Strategy (IUCN, UNEP and WWF, 1980). The eco-development concept encouraged the involvement of local conditions and cultures in the development process, while the World Conservation Strategy promotes habitat preservation in order to have local livelihood security (Gibson, 2006).

Many definitions of the sustainability concept developed since the Brundtland Commission have followed the ‘three pillars’ or ‘triple bottom line’ concept, which involves giving equal importance to environmental, social and economic aspects in any development process (Pope et al., 2004). However, the ‘three pillars’ approach is still not capable of covering key aspects related to local conditions, including region-specific environmental and socio-cultural aspects (Gibson, 2009; Kaur & Garg, 2019).

In the early 1990s, urban sustainability indices and tools had appeared in the scientific and practice fields; specifically, indices were initiated after the Rio Summit of 1992 (Feleki et al., 2018). According to Parris and Kates, (2003), there are more than 500 sustainability indicators developed by both governmental and non-governmental organisations, applicable for variable scales and global, national, provincial and local scopes (Ciegis et al., 2009). The rating system tools were initiated in 2004 originally as sustainability assessments of building ratings, before extended versions were developed to enable the assessment of neighbourhood and built environments such as BREEM communities, CASBEE-UD and LEED-ND (Kaur & Garg, 2019; Sharifi & Murayama, 2015).

Since sustainability and sustainable development is still a divergent concept with no consensus about its definition and implication, various methods and approaches have been developed to assess sustainability in the real world. Some describe sustainability assessment as ‘a process by which the implications of an initiative on sustainability are evaluated, where the initiative can be a proposed or existing policy, plan, programme, project, piece of legislation, or a current practice or activity’ (Pope et al., 2004, p. 595). Others define sustainability assessment as ‘a complex appraisal method ... conducted for supporting decision-making and policy in a broad environmental, economic and social context, and transcends a purely technical/scientific evaluation.’ (Sala et al., 2015, p.314 cited in Kaur & Garg, 2019). However, with more than 200 definitions of sustainable development already in use by 2003, it has proven quite difficult and even contentious to put into practice (Parkin et al., 2003). Despite these difficulties and the lack of consensus, however, the concept of sustainability marched inexorably across multiple dimensions including urban development (Cohen, 2017).

Therefore, the lack of agreement and the absence of a broad definition of the concept of sustainability and sustainable development led to multiple approaches and methods for assessing sustainability in the built environment. But despite all this theoretical and methodological activity, the need for locally-informed and site-specific approaches and tools has not received the attention it deserves, particularly in the case of assessing sustainability in the context of vernacular and traditional built environments. This paper aims to address this gap, proposing an approach for how sustainability and sustainable development can be traced and assessed in vernacular and traditional built forms. In general, to clarify our definitions: vernacular architecture is taken to refer to a building, typology, style or forms, while traditional is taken to refer to a settlement or community which share similar values, history and location.

This paper consists of four sections. The first section discusses the applicability of current assessment tools on vernacular forms and traditional settlements. The second section reviews the theoretical framing of the current assessment tools in order to identify their limitations and shortcomings. Also, this section discusses the basic concept of vernacular and traditional built form and their embedded sustainability principles. The third section offers a conceptual framework and proposed principles and indicators to assess sustainability in the vernacular and traditional built environment. The concluding section discusses the applicability of the proposed framework and where it might be further developed and refined.

2. Applicability of urban sustainability tools to traditional settlements and vernacular form

The lack of theoretical ground and misunderstanding of the concepts of sustainability and sustainable development generate multiple methods and approaches to assess sustainability in the built environment. Despite all the concerns raised, these methods and tools can be utilised on different cases at the same scale: building, neighbourhood or city. Sustainability might be ranked and assessed differently based on the tools applied and enhanced by their alteration. However, most of the current urban sustainability tools are not appropriate to be applied to assessing sustainability in a traditional or vernacular built environment.

The first and fundamental reason for this can be drawn from the nature and philosophy of current assessment tools. Most of these tools have been developed to measure sustainability performance in existing developments or future scenarios, but not in a historical context. Thus, the proposition comes with a default assumption of the contemporary urban structure of a living city of today or a visionary city of tomorrow. Consequently, the methods used, indicators and criteria selected, and data collection techniques would not be applicable to historical or traditional settlements.

Another limitation of the current sustainability assessment tools is that they do not cover cultural and spatial aspects. Some tools such as Pearl (UAE) have included culture as a separated aspect. Also, CASBEE (Japan) added a specific evaluation for vernacular building, but still in a very limited trial. According to Lues et al. (2018), there are two approaches currently predominant when assessing sustainable development in a heritage context. First, there is evaluation by the same instruments used for modern buildings or projects. Second, there is the situation whereby the heritage aspects of a particular evaluation are conceived in very limited terms as the management of cultural heritage. It has been observed that ‘heritage aspects receive limited attention as a single indicator or sub-indicator. Many elements that are essential for an integrated sustainability assessment of specific cases, like cultural heritage sites, are simply overlooked in heritage value-based management’ (Leus & Verhelst, 2018, p. 1).

Therefore, the majority of indicators in these tools do not reflect or capture the realities of a traditional settlement which might be assessed in term of its sustainability *as a built settlement*; for instance, energy and waste management (natural environment), and transportation and infrastructure (built environment) do not exist and have not existed in them in the same way as they do in cities of today. Other indicators such as water consumption and air quality (natural environment), safety and crime rate (social), and job opportunities (economic) seem to be more applicable and valid, but most of the required data is hard to come by, especially in an abandoned settlement, due to the absence of public authorities or of technology needed to generate such data. Moreover, although some of the data would be available in some cases to a certain extent, it would be complicated to set a benchmark or thresholds criteria related to things such as poverty, education, or gender roles.

Sustainability in traditional and vernacular settlements cannot be assessed by indicators like biodiversity and recycling rate, access to public transport, percentage of piped sanitation, cycle lanes, GDP or availability of broadband internet. At the same time, it cannot be simply claimed that a particular settlement is not sustainable due to the absence of these indicators. Sustainability assessment in the traditional built environment needs to be assessed with appropriate methods and approached differently.

3. State of the art

3.1. Urban sustainability assessment

3.1.1. Theoretical framing

In general, it can be noted that the Brundtland definition serves as a decent frame of reference for sustainability as a concept. Consequently, equal consideration of environmental, social and economic aspects circles the concept of sustainable development. Given this framing, this section attempts to discuss some of the sustainable assessment definitions and theoretical propositions which most of the current methods and approaches refer to. However it is beyond the scope of the current paper to trace all current tools and methods or to draw a comprehensive synthesis. We shall limit our discussion to a review of the more influential and salient studies to help delineate the discourse sufficiently to begin to develop a new conceptual framework.

Cohen (2017) argued that guiding principles for urban sustainability assessment cannot be identified in the literature. His review of urban sustainability assessment indicated that most of the assessment tools incorporated indicators or index-oriented frameworks. He stated that ‘grounding urban sustainability assessment in foundational principles of sustainability science was not a common practice at all’ (Cohen, 2017, p. 9). Although literature shows that sustainability dimensions of three pillars plus one (institutional) is the most typical framing of indicator selection, he argued that this may lead to the bias and the selection of convenient data. He called for a principle-based approach to avoid oversimplification and reductionism (Cohen, 2017).

Another powerful argument was brought by Gibson (2009), to the effect that since sustainability is essentially an integrative concept, then sustainability assessment should follow an integrative process, providing frameworks to enhance the decision-making for all physical and non-physical undertakings. He argued that possible advantages of so-called ‘triple bottom approaches’ would be to build expertise in three fields (environment, social, economic), organise data sets collected separately, and distribute the responsibilities among relevant governmental authorities involved (Gibson, 2006). However, he argued that this approach may lead to neglect the interdependence of these factors and deal with them as conflicting rather than complementary factors. He stated that ‘The three pillars approach is often accompanied by an assumption that sustainability is about balancing, which contradicts both the key insights concerning the interdependence of factors and the need for mutually supporting advances on all fronts’. Also, this will encourage trade-offs, which may be necessary but not as first option. (Gibson, 2009, p. 263).

On the other hand, some authors claimed that current sustainability assessments are the ‘next generation’ of environmental impact assessment (EIA) and strategic impact assessment (SEA). These integrated assessment tools intend to assess negative impact of a development on the natural environment. Thus, most of these tools derived from EIA and SEA were extended to integrate social and economic aspects (Pope et al., 2004). Other studies propose a process-oriented approach, rather than commercial rating and label tools, to deliver criteria related to life cycle assessment, or LCA (Vandevyvere, 2013).

Furthermore, some studies argued that since sustainability is a solution-oriented discipline, urban sustainability assessment should be framed around achievable goals and objectives derived from guiding principles. This would allow to select appropriate indicators and track progress towards sustainable development (Cohen, 2017).

Also, an alternative approach has adopted the multi-modal system analysis of Dutch philosopher Herman Dooyereed as a frame of reference for a holistic way to deal with complex problems. These modalities ground things in term of its significance rather than its existence, which has been adopted to assess sustainability in the built environment. These modalities “do not refer to ‘what’, but to ‘how’ the reality manifests itself to the human experience” (Leus & Verhelst, 2018, p. 3).

In the urban planning context, a plurality of studies point out a consensus to include ‘institutional’ as a fourth dimension of sustainable development in urban built environments, in addition to the environmental, social and economic aspects (Sharifi & Murayama, 2015).

According to Vandevyvere (2013), the benefits of aggregated sustainability emerge in the urban scale rather than a single building. He stated that it is ‘at this scale where the full complexity of interplay between factors, such as the planet, people and prosperity, occurs. In this way, the urban fragment establishes an essential link between the micro- and macro-functioning of urban structures’ (Vandevyvere, 2013, p. 36). Also, Turcu (2019) argued that sustainability indicators should focus on process and flow and integrate spatial and temporal aspects due to the complexity and dynamics of urban development. Further suggestions include incorporation of the Human Development Index and Ecological Footprint for assessing sustainability within the neighbourhood population (Gibberd, 2019).

In conclusion, there are many theoretical propositions concerning where urban sustainability assessment derived from and how it should be framed. In general, it can be noted that framing urban sustainability around three pillars - environment, social, economic - is the most typical approach which can be found in the literature. This aligns with the call to include other dimensions such as institutional and spatial aspects in the context of urban planning. However, this approach raised some concerns including interdependence of factors, oversimplification and reductionist. Thus, some studies suggested to frame sustainability assessment around goals and objectives which will lead to a process or goal-oriented assessment. Other studies sought to frame assessments around sustainability values and principles which can result in a principle-based assessment to avoid the concerns raised above.

3.1.2. Limitations and shortcomings

In this section we identify the main limitations and shortcomings of current urban sustainability assessment models. In short, these involve the inconsistency resulting from the absence of a common theoretical ground, and the subsequent development of multiple methodological approaches.

In general, criticism of current assessment methods and tools is mostly related to methods used, the selection of indicators, topic coverage, transparency and complexity issues. Furthermore, some review studies of current assessment tools point out inconsistency in terminologies, weighting systems, benchmarking and certification schemes. Also, a common discussion in the literature about these tools relates to our concern for locality and the incorporation of a site-specific context.

Cohen (2017) argued that weakness of the theoretical framing of current sustainability assessment tools caused indicator selection to be based on availability of data rather than on integrative thinking. A cross evaluation of current urban sustainability assessment shows an absence of core indicators and criteria in some tools, which reflects misconception of sustainability and its implication (Kaur & Garg, 2019). Another general aspect related to current tools is the level of complexity and transparency. Turcu (2019) argued that although the results of these tools can be easily visualised by the public and policy makers, it cannot be a transparent assessment due to the indicator structure and level of information presented in the outcome.

A major deficiency associated with current assessment tools is related to the idea of locality and site-specific context. Most of these tools were established to assess sustainability-specific goals or programs at multiple levels or scales – in a building, development, city or national scale – which renders it problematic when removed from its context, scale or region. Sharifi et al. (2015) argued in relation to this that identical developments might be rated differently due to inconsistent scale benchmarking of the tools used. Feleki et al. (2018) suggested that it is meaningless to use indicator values of a city as a reference for another city with different conditions. This led to disagreement whether standardised-global sustainability assessment should be developed or more flexible ones which could integrate more context-specific aspects. Sharifi et al. (2015) argued that ‘assessment tools may need to be altered to take into account various context specific issues’ (Sharifi & Murayama, 2015, p. 20).

This calls for including context-specific issues in the current assessment tools including natural, spatial and socio-economic aspects. Kaur and Garg (2019) argued that it is vital to include local natural characteristics in the sustainability assessment, such as geography, topography, hydrology and vegetation, beside cultural heritage and visual significance which may vary, especially in regions with different ecological and geo-climatic conditions. However, some natural aspect indicators provided by some tools would be irrelevant in other contexts, such as earthquake resilient criteria (Sharifi & Murayama, 2015).

In the socio-economic aspect, some studies indicate the need to develop local criteria against universal criteria with different thresholds to assess social sustainability. For instance, Feleki et al. (2018) argued that although thresholds should be scientifically determined, local conditions and capacities should also be taken in consideration; an issue like poverty is an example. Also, Sharifi et al. (2015) emphasised the need to use different indicators and benchmarks while evaluating social sustainability at the neighbourhood scale in particular. They argued how the need of privacy may vary, for instance, in one neighbourhood due to background diversity (Sharifi & Murayama, 2015). Feleki et al. (2018) concluded that the reason behind the failure to introduce a representative set of indicators applicable for many cities is that ‘existing approaches have mostly treated cities as social-economic-ecological systems that are internally homogeneous in space’ (Feleki et al., 2018, p. 565).

Moreover, beside the general criticisms of the methodological approaches and the limitation of locality, many issues can be related more directly to urban sustainability assessment tools. This may include terminology used, indicators and criteria selection, and weighting and rating systems. According to Vandevyvere (2013, p. 37), the major difficulty confronting current assessment tools is their ambition towards ‘quantifying the unquantifiable.’ He argued that ‘the complex trade-offs that characterize urban development projects complicate a straightforward translation of a stated sustainability aspect into a value or score, in particular because a wide diversity of quantitative as well as qualitative criteria must be combined into the final judgement.’ He also argued that this tension exists due to the ‘determinative’ and ‘normative’ conditions for environmental sustainability, while a social definition of sustainability (Vandevyvere, 2013). Further, Gibberd (2019) also indicated the subjectivity issue associated with the selection process of indicators and criteria of current assessment tools. Vandevyvere (2013) claimed that even though some of these tools are promoted with robust standards, ‘a closer observation of their methodological basis indicates that many uncertainties and qualitative trade-offs remain embedded in the evaluation process’ (Vandevyvere, 2013, p. 37).

In terms of terminology, a valid argument is brought by Cohen (2017), indicating that inconsistent definition of terms, goals and

objectives can be found across the literature. He stated that ‘what one author considers a criterion, another might treat as an indicator. Likewise, there is much conflation between goals and objectives’ (Cohen, 2017, p. 4). With regards to the spatial dimension, some authors point to the gap in coverage of this aspect in the current assessment tools. According to Feleki et al. (2018), some crucial spatial and cultural heritage aspects were not observed in these tools at all. This includes certain aspects of the urban fabric such as narrow streets, population density, building compactness, as well as open and social places.

Another limitation of current assessment tools is related to imbalance weighting and focus of the dimensions covered. A review study done by Feleki et al. (2018) recorded 284 indicators where 54% respond to the environmental aspect, 32% of indicators address the social aspect and 14% deal with the economical aspect. This emphasis on the environmental aspect (natural/man-made) compared with other aspects (social and economic) has been discussed intensively in various studies (Gibberd, 2019; Kaur & Garg, 2019; Sharifi & Murayama, 2015; Turcu, 2019). This might be due to the original evolution of the sustainable development concept where the environment factors have much influence. Also, it could be related to the type of data and its availability in the environmental fields compared to other aspects. At any rate, evaluation procedures for quantitative data would be more convenient and easily used when compared with qualitative data, which often requires a certain level of expertise in these fields.

The conclusion that can be drawn here is that no existing tools or set of indicators can be globally accepted as combining a sound and original theoretical background with robust data collection or analysis. According to Dong et al. (2016), ‘no single assessment method can provide perfect evaluation for one city up-to-date due to the complex urban nature, addressing different needs of economic, environmental and social perspectives’ (cited in Feleki et al., 2018, p. 563,). Also, the work of Lynch et al. (2011) concludes that the insufficiency of current sustainability assessment, although it attempts to cover multiple dimensions, is due to the absence of ‘globally accepted perception of sustainability’ (cited in Feleki et al., 2018, p. 564). This conclusion is supported across a number of studies (Ciegis et al., 2009; Turcu, 2019). However, as a qualifier, Gibson (2009) argued that uncertainty should be appreciated as a part of the sustainability concept. He mentioned that ‘the essence of the concept, and the key to its implementation, is clearly centred on appreciation of links and integration of the relevant considerations’ (Gibson, 2006, p. 262).

3.2. Vernacular forms and traditional settlements

3.2.1. Background

In the last twenty years, vernacular architecture typology has emerged in the discourse of cultural heritage as well as sustainability and sustainable development (Olukoya & Atanda, 2020). According to Stubbs (2004), the historic building, town and landscape gained its value as heritage today because it presents the values and beliefs of people in the past: ‘heritage is a selective part of the past which is only partially interpreted for present-day consumption’ (Stubbs, 2004, p. 287). Therefore, the loss of vernacular architecture is equal to the loss of traditional knowledge, local identities, collective memories, crafts and technology, lessons which are all underlined in the sustainable development context (Olukoya & Atanda, 2020).

In architecture, however, the interest in vernacular and traditional building began earlier, and although it became implicated in issues of sustainability the original impulse to notice these things was more often about style, aesthetics and regional identity.

According to Oliver (1969), vernacular means ‘the language or dialect of a country or region’ as it has ‘metaphoric appropriateness’ when applied to ‘building idiom’. However, he argued that ‘Even so, the assumption that vernacular architecture implies that which is indigenous to the country and not borrowed, or learned from, is still open to argument’ (Oliver, 1969, p. 11).

Rudofsky (1964) requested architects and architectural historians trace ‘nonpedigreed architecture’ instead of grand public architecture made by professional architects – the latter of which represents a negligible fraction of the world’s historical building stock. He extended the term by referring to ‘communal architecture’, defined as ‘a communal art, not produced by a few intellectuals or specialists but by the spontaneous and continuing activity of a whole people with a common heritage, acting under a community of experience’ (Rudofsky, 1964, p. 7).

In the same context, Fathy (1973) argued that ‘every people that has produced architecture has evolved its own favourite forms, as peculiar to that people as its language, its dress, or its folklore’ (Fathy, 1973). In terms of tradition, he defines it as ‘the social analogy of personal habit, [which] in art has the same effect, of releasing the artist from distracting and inessential decisions so that he can give his whole attention to the vital ones’ (Fathy, 1973, p. 24). Also, Frank Lloyd Wright praised ‘folk buildings,’ which were produced by people in response to their need and environment, and are highly worth studying compared to other historical buildings (Oliver, 1969, p. 16).

Many other architects and historians have praised the embedded qualities of vernacular architecture and traditional settlements, as well as exploring ways to update them for the present-day. And this discourse is particularly strong in nations like Japan that have witnessed an almost convulsive switch from traditional to modernist and back again to traditional values. Consequently, it is argued that there are many architectural and spatial qualities that can be found in vernacular form and the traditional built environment; however, we focus here on those aspects relevant to the concept of sustainability and sustainable development.

3.2.2. Embedded sustainability principles?

As mentioned, sustainability as a terminology did not exist explicitly in the early discourse of vernacular architecture and traditional built form. However, similar terms were often used to indicate the same concept. These terms were often used in more romantic and philosophical ways. Some terms tend to be repeated, such as ‘honesty,’ ‘truth’ and ‘respect’ in response to the use of local materials or in relation to constructional properties and limitations; ‘wisdom’ in relation to the way a settlement integrates with its environment and resources or the application of craft techniques; ‘rightness,’ ‘fitness,’ ‘appropriateness’ and ‘naturalness’ describing moral judgments about the benefits of tradition and the lifestyles associated with it; ‘economic’ indicating an efficient use of local and natural resources; and ‘rootedness’ and ‘connection’ indicating an authentic relation to the land, its history and cultural values. These are some recurring

words in the historical dialogue frequently used as loose, pre-emptive synonyms of what we call sustainability today (Richards, 2012).

Most of the research subsequently investigating vernacular architecture discusses the thermal properties in the materials, building type, and layout in relation to microclimatic condition. Some research indicates how vernacular architecture is fitted into the surrounding landscape in response to geographical and environmental conditions. Furthermore, some computer based modelling studying vernacular architecture demonstrated lower carbon footprint and energy consumption and more thermally comfortable buildings by employing different technology, materials and building techniques with mechanical means (Olukoya & Atanda, 2020).

According to Alsayyad et al. (2011), there are four sustainability principles of vernacular tradition. These include ‘materials and site appropriateness,’ where vernacular materials are produced locally and used efficiently in relation to their surrounding environment; ‘climatic responsive,’ wherein vernacular forms and materials are by default responsive to climatic condition; ‘socio-cultural advantages,’ involving the idea that building process strengthens social bonds and lowers cost; and finally ‘adaptability,’ the assumption borne out by long histories of usage that vernacular architecture is remarkably flexible and expandable (Alsayyad & Arboleda, 2011).

Vernacular architecture and traditional settlements can offer many sustainability lessons. Some of these principles can be easily noted, such as building materials and integration with surrounding environment. Other sustainable principles are embodied in the planning and construction process, as with low-impact construction techniques and the use of natural resources. Also, there are many sustainable practices locally-oriented in relation to how people live and interact as communities, which requires in-depth ethnographic understanding and further analysis to evaluate its impact on sustainability as a concept. But in general, the typical sustainability principles which can be found in vernacular architecture and traditional built environments can be categorised into three: the environmental dimension (including natural and built environment), the social and cultural dimension, and the economic dimension.

From the environmental perspective, the ecological friendliness and passive technology rooted in vernacular architecture provide knowledge and values suitable to be applied in contemporary practices (Olukoya & Atanda, 2020). According to Alsayyad et al. (2011), the environment was one of the main aspects of Rudofsky's approach. He praises ‘the climatic advantages of underground houses in Tungkwang, China; the cool narrow alleys in Zanzibar; the interior courts in Marrakesh; and the coolness and warmth in the covered streets of Benabarre, Spain, Gubbio, Italy and the Kharga oasis in the Libyan Desert’ (cited in Alsayyad & Arboleda, 2011, p. 137). Further, Alexander argues that traditional builders not only understood the importance of avoiding any damage to nature, but also sought to enhance the natural landscape (Alsayyad & Arboleda, 2011).

From a social perspective, people in a traditional settlement are collectively involved in planning, creation and decisions related to vernacular architecture. The capacity of people to turn mud, stone and wood into houses, mosques and churches in an organic way addresses cultural identity in their locality (Olukoya & Atanda, 2020). Further, another group of studies argues that vernacular architecture can provide lessons on cultural sustainability, indicating that ‘it encourages the re-establishment of the anthropological and social particularity of a specific locality.’ Thus, it provides a testimony to the capacity of human adaptability towards their environment resources and limitations (Olukoya & Atanda, 2020, p. 3). Also, traditional building techniques and local crafts can have a positive impact on social as well as economic sustainability. They represent a local identity and values which can be noticeably preserved over generations. Also, this requires a high degree of public participation and knowledge exchange which often lead to the strengthening of social bonds and enhances the sense of place for the locals in their traditional settlement.

From an economic perspective, traditional societies have been successful at maintaining equilibrium between population, environment and resources. Since most vernacular buildings are self or community-built, they demand strong bonds in the community and cost less because they depend on available materials and local labour in a communal way (Alsayyad & Arboleda, 2011). This process satisfies community needs and encourages them to be self-sufficient by sustaining production and optimising local materials. Thus, some studies indicate that vernacular architecture shows a great deal of efficiency in the management of natural resources, especially scarce resources such as water and wood in arid environments (Olukoya & Atanda, 2020).

In conclusion, the discussion of sustainability assessment in the urban context highlights some of the main limitations and shortcomings relative to this context. Moreover, in vernacular and traditional settlements, most of the current urban sustainability assessment methods also proved to be inapplicable due to various limitations. The traditional built environment already has embedded sustainability principles which need an appropriate approach for assessment. In the next section, an attempt is made to develop an alternative assessment framework which employs core sustainability principles in order to identify sustainable qualities in vernacular settlements.

4. Framing sustainability assessment of vernacular and traditional built environments

4.1. Theoretical basis

For the purposes of our alternative model, some clearer definitions of the terms sustainability and sustainable development should be elaborated in order to frame a sound theoretical basis. This is a crucial step to provide a common understanding of sustainability in order to develop a method to assess sustainable development involving key principles associated with core indicators.

For our purposes, sustainability can be defined as ‘an endeavour to bring society within the Earth's planetary boundaries while lifting the global population above a basic standard of living’ (Cohen, 2017, p. 2). Within this frame, Rodwell, (2003) defined sustainability in term of conservation as ‘the wise use of resources to ensure their continuity of supply, minimum intervention to fabric and cultural identity (physical, social, economic, artistic); and constructive evolution as opposed to destructive revolution’ (cited in Stubbs, 2004, p. 286).

The proposed model accepts the following facts and qualifiers as its basis: a level of uncertainty is associated with the concept of sustainability, as mentioned by Gibson, (2006); there are ‘determinative’ and ‘normative’ conditions of environmental and social science, as discussed by Vandevyvere (2013); and there is a required degree of subjectivity involved in the selection process of key indicators, as mentioned by Gibber (2019). In addition, the proposed model realises the limitation of the integrative approach of three

pillars. Thus, it attempts to find an intersection and linkage based on key embedded principles through which different sustainability aspects can be assessed. However, these embedded principles, which are derived from vernacular and traditional forms, should also be open to being related to different pillars in accordance with the topic assessed.

In the methodological context, the current sustainability assessment tools can be divided into integrated assessment, objective-led assessment, multi-criteria or indicator-led assessment, and principle-based assessment (Pope et al., 2004). The principle-based assessment is more appropriate for sustainability assessment of vernacular architecture and traditional built forms. This approach intends to frame assessment around sustainability values and principles rather than categorised indicators. This will ensure integrative assessment and avoid oversimplification and reductionist approaches criticised in the literature (Cohen, 2017). It will also allow the development of appropriate principles and indicators for the traditional built environment derived originally from sustainability concepts which can be found in traditional settlements themselves, as compared with other assessment methodologies which might not be applicable in a historical context as discussed earlier.

Therefore, beyond historical documentation, the new assessment framework would allow for comparisons between different traditional settlements in terms of sustainability in order to trace sustainable principles which can inform current planning practice. The model proposed can be used by researchers and planners aiming to re-apply indigenous sustainable principles while developing certain traditional sites instead of the attempt to impose international methods and tools which may not be considerate towards the local cultural and natural context.

Finally, the proposed method follows some of the concluding advice and recommendations of forgoing studies. It sees sustainability as process rather than an end-product, as theorised by Stubbs (2004), while taking into account the calls to include temporal aspects of timescale along with spatial and cultural dimensions in the assessment process (Turcu, 2019). In addition to the essential request to develop more context-specific assessment tools at different urban scales discussed intensively in the literature, the proposed framework allows for more integration of local considerations and requirements. Additional indicators, moreover, can be integrated into the proposed framework in order to better fit the particular scale and developmental stage of the settlement at hand.

With the theoretical principles selected and justified, we move now to the elaboration of the evaluative framework itself.

4.2. Building the conceptual model

Most of the limitations and shortcomings regarding current urban sustainability assessment tools can be related to three problems: deficiency in analytical tools, inadequate coverage of site-specific context, and the ignoring of timescale. Conflicting issues including coverage, weighting, rating, benchmarks and thresholds are caused through the default settings and applications of the tools themselves. Also, there are problems related to developing assessment tools coverage of local conditions and context or site-specific context at different macro-micro levels, as most tools have been developed to be applied only to one scale: building, neighbourhood, city, national or global. In addition, the absence of time as a factor in the assessment process further highlighted the insufficiency of current tools and their indicators in relation to historic and heritage contexts, as well as their limited ability to measure the dynamics of urban context and indirect impact over the longer term (See Fig. 1,

Therefore, the proposed framework attempts to assess sustainability in the vernacular architecture and traditional built form by allocating relevant aspects to appropriate sustainability dimensions, scales and times. Its claim is that in order to assess sustainability in the traditional built environment, the need is to assess the process, the product, and the praxis. The process, referring to the past aspect, should be assessed in terms of sustainability. This is to answer the question of how this product (i.e., building, district, or town) has been

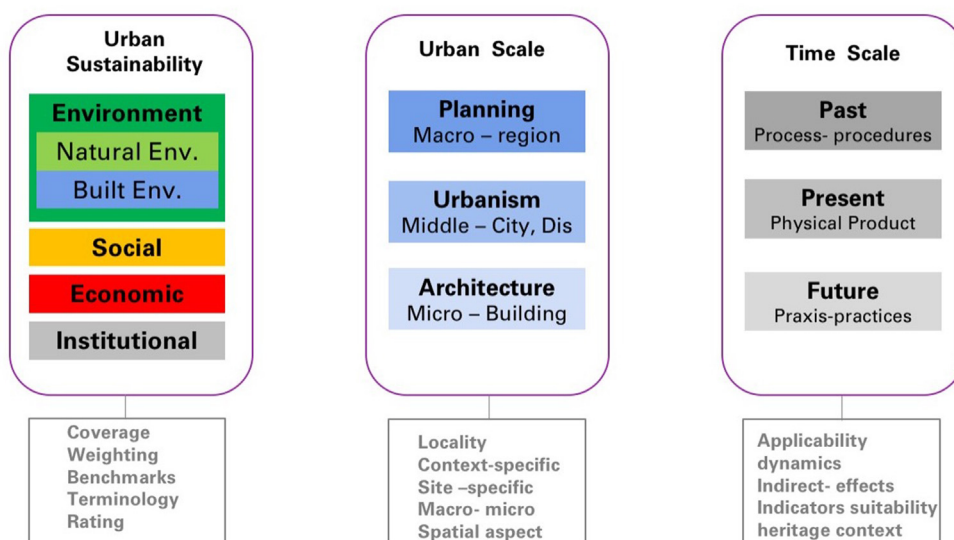


Fig. 1. Current Sustainability assessment limitations categories.

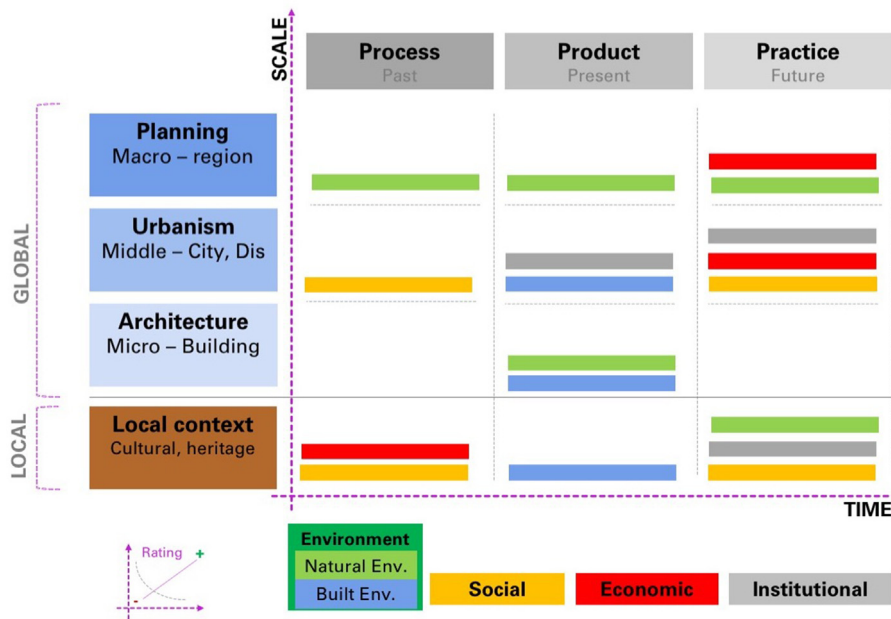


Fig. 2. Conceptual model for sustainability assessment in traditional built environments.

developed and in which way that could affect its sustainability, whether positively or negatively. Next, the assessment would focus on the product itself. Here is where issues like land use, urban form, infrastructure and architectural style would be main topics in the assessment. Also, this model extends the assessment to include how this product operates and functions in relation to sustainability. In this sense, all human activities (environmental, social economic and institutional aspects) will be assessed under this category. For instance, energy, water consumption and waste management fit in the environmental dimension, while governance systems and public participation, equity and job opportunity fit in the socio-economic aspect.

In other words, the proposed framework sees vernacular architecture and the traditional built environment as *process, product and practices simultaneously*, in which the sustainability dimension will be assessed separately based on the appropriate scale and time. Thus, sustainable processes and sustainable practices can be distinguished and evaluated accordingly, and not merely the sustainable product, which most of the current tools focus on assessing to the detriment of the other two factors (see Fig. 2).

In addition, the proposed model integrates local context which can be traced and assessed at different levels according to key sustainability dimensions. Further, the proposed model can identify and arrange priorities and advantages of different aspects on overall sustainability. The higher the level of urban scale and time scale, the more influential indicators or principles there will be. For instance, a sustainable neighbourhood is always better than a sustainable building, a sustainable city is more important than a sustainable neighbourhood, and so on. Also, it can be argued that sustainable processes and practices would more important than sustainable products. This is due to the indirect long-term impact on sustainability compared to the direct impact of a product itself: surely it is always better to build and use a building in a sustainable way rather than have a certified sustainable building.

4.3. Principles/indicators selection

Determining and measuring indicators is at the heart of sustainability assessment (Cohen, 2017). According to Leus et al. (2018), a comprehensive vision is crucial in the creation of a set of indicators: 'indicators describe complex phenomena in a (quasi-)quantitative way by simplifying them in such a way that communication is possible with specific user groups' (Leus & Verhelst, 2018, p. 4). Thus, indicators should be clear and measurable reflections of the priorities of the native urban environment (Kaur & Garg, 2019).

Cohen (2017) suggested that it may be beneficial to frame generic criteria and indicators around a common set of guiding principles which scholars can set goals and objectives around. This principle-based approach was promoted by a number of studies as an alternative to the triple bottom line (TBL) approach. Pope et al. (2004) reinforced Gibson's argument that 'principles-based approach emphasize interconnections and interdependencies between pillar areas rather than promoting conflicts and trade-offs', which avoided the limitations associated with the TBL approach (Pope et al., 2004, p. 610).

Therefore, an assessment of sustainability should take into account the main characteristics of the specific location, the normative nature of sustainability, variations in perception and the dynamics of an urban environment (Sharifi & Murayama, 2015). Also, indicators should be simple, comprehensive and measurable with data available that reflects the triple line of sustainability (Feleki et al., 2018). Ciegis et al. (2009) also added that indicators should be developed along with a measuring unit, a source of data, survey and analysis methods, and criteria for evaluation. In this case, the level of complexity of interrelationships would be reduced to make an assessment easier (Ciegis et al., 2009).

In a more heritage-based context, Leus et al. (2018) argue that indicator selection depends on pragmatic factors such as scale and heritage typology, and subjective factors related to subjective attributes, as defined by Clark et al., such as ‘legitimacy, credibility and salience’. In this sense, salience would refer to the type and scale of the heritage, and its long term effect on sustainability. Credibility refers to the feasibility and availability of the data collected. Legitimacy relates to the ‘scientific validity,’ the level of acceptance of the indicators for experts and stakeholders. They stated that ‘creating a set of indicators is a methodological compromise between local relevance, practical feasibility, availability of data, and theoretical justification’ (Leus & Verhelst, 2018, p. 5).

This paper argues that the proposed framework and guiding principles would be applicable to the assessment of any traditional and vernacular built form. Also, local variation in traditional settlements can be traced following the same approach. Adding more principles will follow a simple procedure: the principle should be relevant to sustainability as a core concept (meeting human needs now and in the future), and then it should be assigned to the appropriate scale and time. The main advantages of this approach compared to current tools is that it starts initially with sustainable principles, then it assesses to what extent they have been achieved in the targeted settlement. Most of the proposed principles have been intensively discussed in the vernacular sustainability discourse (Alsayyad & Arboleda, 2011; Hărmănescu & Enache, 2016; Olukoya & Atanda, 2020; Paridah et al., 2016; Pollalis & N, 2019).

The following principles and indicators aim to assess sustainability in the vernacular and traditional built form in terms of the following aspects: adaptability, durability, efficiency, compactness, connectivity, engagement and involvement, identity, innovation and creativity, interdependence and self-sufficiency

Adaptability: This principle should assess the extent to which the traditional built form was responsive to natural aspects, including climate, topography, hydrology and soil. For a micro-climatic aspect, thermal comfort can be measured to find out the variation in temperature by using local building materials. In the topographical aspect, an analysis can show the total amount of cut and fill that was needed to establish the settlement. In terms of sustainability, minimum intervention would always be recommended. Also, it might involve simply finding out how a targeted settlement could avoid natural drainage lines and valuable agriculture soil. This will result in a positive impact on sustainability overall.

Durability: The principle aims to assess the reliability and resilience of building materials; the building age and maintenance required; its craftsmanship and the quality of local products. From a social aspect, this principle may assess the durability of social relationships. For instance, issues such as social structure (family and tribal communities), and the durability of the governing system can be assessed by this principle as well.

Efficiency: This principle is one of the major sustainability principles that can be identified in a traditional settlement. This core concept derives from the ‘wise use’ and ‘optimal alternative’ concepts. The efficiency principle aims to assess the consumption of natural aspects, such as energy, water, waste management and natural resource management in a general sense. Also, by the same principle, different aspects of a man-made environment can be assessed, like efficiency of land use planning and agricultural land. Further, it can also be extended to assess the efficiency of different aspects, such as the social, institutional and economic dimensions.

Compactness: This principle is more appropriate to be used on traditional settlements with vernacular forms. This principle aims to assess the degree of compactness and density of a specific urban environment with the assumption of positive impact.

Connectivity: This principle aims to assess accessibility and connectivity of urban form, street networks, open space, mobility and walkability. It also attempts to assess transportation patterns in order to evaluate its impact on environment and wellbeing. This principle can be mainly applied to the built environment however it could be extended to assess connectivity in natural or social dimensions if applicable.

Engagement: This principle is more related to social aspects, aiming to assess the degree of public participation and involvement in the decision-making process. Also, this can be applied to assess any communal efforts, which often take place in the building process, craft and the preparation of materials, or in agricultural practices. In a general sense, this principle assumes that more engagement would result in a more sustainable society.

Identity: This principle mainly aims to cover cultural aspects related to indicators such as sense of space, locality and local values and principles. Also, it could be extended to the built environment where building type and urban form can be explicitly distinguished to belong to a specific culture or region.

Innovation: The main purpose of this principle is to trace creativity in local practices and solutions which influence the overall sense of sustainability. This principle should cover different sustainability dimensions. From the environmental aspect, it could be related to tradition-based natural resource management systems or rain harvesting techniques. In the built environment, topics such as building materials and construction techniques can be assessed under this indicator. Also, innovation can be employed in the social field, where local customs and rituals may have an influence on the overall sustainability.

Self-sufficiency: This principle is one of the main characteristics of a traditional settlement. It aims to assess the level of interdependence of a specific region or society, and mainly covers aspects related to the economic and trade dimension. Topics such as market order, product diversity, income level and employment can be assessed in this principle.

Security: This principle in general is commonly used in the social dimension to measure issues related to safety and security. However, in this context it can be extended to assess environmental aspects such as (natural) hazard resilience, man-made environment aspects such as building safety, or economic aspects such as livelihood security.

Next table is showing proposed principles and indicators along with related dimensions covered. Also, these dimensions are associated with main category and sub-category indicating the main topics for assessment. Further, every topic is identified in terms of scale (planning, urban, architecture) as well as in terms of stage (process, product, practice) (See Fig. 3).

Fig. 3. Sustainability principles assessment in the traditional and vernacular forms.

5. Discussion and conclusion

5.1. Limitation and future research directions

The conclusion that can be drawn here is that the absence of a clear definition of sustainability and sustainable development has led to a distorted theoretical basis from which most of the current tools are derived. These tools and instruments have relative advantages and limitations. In a historical context, the assessment of sustainability should follow a different approach, employing principles and indicators derived from and suitable for vernacular architecture and traditional built environments. In the traditional built environment, these principles were not optional choices but more like a way of life, borne out of necessity. Thus, the influence of environmental factors can be traced in the traditional built forms. Nowadays, however, the impact of the globally-sourced built environment on the natural environment is the main issue.

The proposed conceptual model can be set as a framework to assess sustainability in the traditional built environment. The selection process of appropriate principles and indicators can be a crucial exercise to help understand the complexity of sustainability and sustainable development. Also, aligning principles and indicators in accordance with the core sustainability pillars within definite temporal and scale horizons would reveal its potential implications for sustainability overall. The proposed indicators reflect embedded sustainable principles rather than sustainable performance. For instance, more adaptability, efficiency, engagement and other indicators mentioned above would eventually lead to more sustainability in general and sustainable development in particular. Therefore, the necessity to determine thresholds or benchmarks would not be relevant at this stage. However, every principle may require further qualitative and quantitative analysis employing computer modelling, spatial and ecological analysis as well as an in-depth understanding of local conditions.

Furthermore, the proposed model and principles allows indicators to be assessed as a matrix, i.e.: the same indicators can be assessed in response to relevant principles. For instance, an indicator such as building materials can be assessed in term of its adaptability, durability and innovation. Also, an indicator like (natural) hazards can be assessed by principles such as adaptability and security. Therefore, assessment of the same indicators by different sustainability principles can identify their indirect impacts across other sustainability dimensions.

The main advantages of this approach compared to current tools is that it starts initially with sustainability principles which can be found in traditional settlements with vernacular forms, then it assesses to what extent they have been achieved. This assessment is not limited to the physical product, but also it takes into account how this product has been developed over time and operates as well. Further, local variations in traditional settlements can be traced following the same approach. Despite the fact that the proposed assessment is principle-based, assessed aspects can be categorised under common sustainability dimensions (environment, social, economic) and institutional aspects as well. However, there are some limitations that must be acknowledged in this conceptual model and its proposed sustainability principles. The common criticism of the principle-based approach may refer to the level of subjectivity and transparency associated with it. In this case, a minimum level of expertise might be required in two fields – sustainability and vernacular architecture – in order that an assessor might derive appropriate principles that meet sustainability goals and objectives and which can also be found in the traditional built forms of the locality.

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