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A critical review of environmental assessment tools for sustainable urban design

Raed Fawzi Mohammed Ameen [a,b,*], Monjur Mourshed [a], Haijiang Li [a]

[a] BRE Centre of Sustainable Construction, School of Engineering, The Parade, Cardiff University, Cardiff CF24 3AA, United Kingdom
[b] Department of Civil Engineering, College of Engineering, University of Karbala, Iraq

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ABSTRACT

Cities are responsible for the depletion of natural resources and agricultural lands, and 70% of global CO_2 emissions. There are significant risks to cities from the impacts of climate change in addition to existing vulnerabilities, primarily because of rapid urbanization. Urban design and development are generally considered as the instrument to shape the future of the city and they determine the pattern of a city's resource usage and resilience to change, from climate or otherwise. Cities are inherently dynamic and require the participation and engagement of their diverse stakeholders for the effective management of change, which enables wider stakeholder involvement and buy-in at various stages of the development process. Sustainability assessment of urban design and development is increasingly being seen as indispensable for informed decision-making. A sustainability assessment tool also acts as a driver for the uptake of sustainable pathways by recognizing excellence through their rating system and by creating a market demand for sustainable products and processes. This research reviews six widely used sustainability assessment tools for urban design and development: BREEAM Communities, LEED-ND, CASBEE-UD, SBTool^{PT}–UP, Pearl Community Rating System (PCRS) and GSAS/QSAS, to identify, compare and contrast the aim, structure, assessment methodology, scoring, weighting and suitability for application in different geographical contexts. Strengths and weaknesses of each tool are critically discussed. The study highlights the disparity in local and international contexts for global sustainability assessment tools. Despite their similarities in aim on environmental aspects, differences exist in the relative importance and share of mandatory vs optional indicators in both environmental and social dimensions. PCRS and GSAS/QSAS are new incarnations, but have widely varying shares of mandatory indicators, at 45.4% and 11.36% respectively, compared to 30% in BREEAM Community. Considerations of economic and cultural aspects are only marginal in the reviewed sustainability assessment tools. However, the newly developed sustainability assessment tools such as GSAS/QSAS and PCRS diverge from their predecessors in their consideration of cultural aspects.

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* Corresponding author at: 14-17 The Parade, Cardiff University, Cardiff CF24 3AA, United Kingdom.
E-mail addresses: MohammedAmeenRF@cardiff.ac.uk, raedf.ameen@yahoo.com (R.F.M. Ameen), MourshedM@cardiff.ac.uk (M. Mourshed), LiH@cardiff.ac.uk (H. Li).

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1. Introduction

Due to rapid urbanization, more than 50% of the world's population now live in cities (Mele, 2014; UN, 2014) and by the year 2050 the figure will increase to 69% of the global population (Shen et al., 2011; Komeily and Srinivasan, 2015) as shown in Fig. 1. Existing cities are responsible for the depletion of natural resources and agricultural lands, as well as contributes to more than 70% of global CO_2 emissions (FAO, 2011). Cities of all sizes are drivers of economic growth for their respective regions and countries. They continue to influence the demand for natural resources and energy derived from fossil fuels. The intrinsic inertia in global energy infrastructures implies that the dependency on fossil fuels is set to rise in the short term, before the policies for phase-out start to have a real impact. The majority of the increase in energy demand is estimated to come from the emerging economies, particularly India, China and the Middle East (IEA, 2013), coinciding with increasing urbanization rates and population densities in developing countries. Fig. 2 illustrates the trend in urbanization in developing countries, projected to rise from 46% in 2010 to 63% in 2050, with corresponding increases in population density, which is expected to double over the next three decades (Huang, 2010) as shown in Fig. 3. Urbanization and population density are suggested as the key determinants that will shape the future of 21st century cities (Suzuki et al., 2010). There is an urgent need to find effective solutions for new and existing urban areas to mitigate the impacts of climate change, and to achieve a balance between various dimensions of sustainability (Siemens, 2012; Sharifi and Murayama, 2015).

1.1. Need for urban sustainability

Since its inception, sustainability has primarily been an ecological concept (Drexhage and Murphy, 2010). However, during the course of its evolution, the scope of urban sustainable development has widened to incorporate economic and social dimensions, primarily due to the increasing body of knowledge on the impact of urban form (e.g. density, land-use, urban layouts) on a range of sustainability indicators (Cooper and Boyko, 2010), as well as to address societal urban practices linked with sustainability dimensions that result in undesirable urban trends (Basiago, 1998).

The impact of built cultural heritage on the social wellbeing of different population groups living within increasingly cosmopolitan towns and cities has also been recognized as an important dimension of sustainability (Tweed and Sutherland, 2007), bringing the constituent dimensions to four: environmental, economic, social and cultural.

The dimensions of urban sustainability are characterized by a large number of indicators. Xing et al. (2007) identified over 600 relevant indicators of urban sustainability. Similar conclusions have been reached by Zhou et al. (2012) to build a framework comprising 141 urban indicators for sustainability assessment of Chinese cities. In addition to the challenges of having to consider the large number of indicators for urban sustainability, the inter-dependence of the indicators brings about further challenges for implementation, in particular when the increase in performance in one indicator results in a corresponding decrease in performance in another. The method of reconciliation of inter-dependent indicators from different dimensions is, therefore, the key in achieving urban sustainability. As a result, the need for a comprehensive and integrated framework for urban sustainability assessment has been emphasized by researchers, as opposed to the stand-alone considerations of the influence of the cities' variables on urban sustainability and its constituent dimensions (Adinyira et al., 2007; Ameen et al., 2014; Castanheira and Braganca, 2014).

The building of sustainability assessment tools has been launched and used over two decades globally and characterized to assess sustainability for building components such as energy, water, waste, and infrastructure (Bragança et al., 2010). Despite its importance and role in environmental assessment, the sustainability assessment process for buildings without the environments that they are contained in, doesn't represent an inclusive option.