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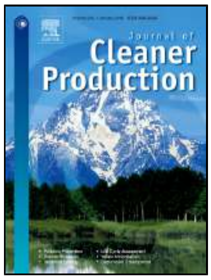

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Urban Sustainability Assessment Tools: A Review

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ABSTRACT

This paper presents a comprehensive review of literature on most widely used urban sustainability assessment tools. The aim of this paper is to understand the similarities and differences in existing urban sustainability assessment tools and identify the gaps so as to find out whether these are capable of and suitable for addressing multiple issues of urban sustainability in multiple contexts, including settlements in diverse geo-climatic and ecologically sensitive regions such as the Himalayan hill regions of India. Qualitative Content Analysis (QCA) is employed in this study to identify various themes/categories associated with various dimensions of sustainability. A total of 2594 articles were selected, of which 105 have been analysed in detail. The research reviews six most widely used urban sustainability assessment tools i.e., Building Research Establishment Environmental Assessment Method (BREEAM)for Communities, Comprehensive Assessment System for Built Environment Efficiency (CASBEE) for Urban Development, Green Building Index (GBI)for Township, Leadership in Energy and Environmental Design (LEED) for Neighbourhood Development that are used in other countries, and Indian Green Building Council (IGBC)for Green Townships and Green Rating for Integrated Habitat Assessment (GRIHA) for Large Development which are used in India. Analysis of these assessment tools reveals that most of them view sustainability from different perspectives by laying more emphasis on some aspects like infrastructure and resource management while ignoring others like cultural, business and innovation. The findings of the analysis highlight that certain aspects are given more importance in all the urban sustainability assessment tools reviewed and certain other aspects are given much lower or no consideration in all tools reflecting an incomprehensive understanding of urban sustainability on one hand; most tools reviewed do not address all context-specific aspects on the other. Further, it is observed that these tools are unable to address the complex relationships among various criteria and categories and each criterion is assessed in isolation irrespective of the fact that it can influence or be influenced by other criteria.

Keywords: sustainable urban development; sustainability assessment tools; criteria; analysis

1. Introduction

Sustainable urban development is essential for protecting the natural environment as well as the well-being of people and the society at large, as inappropriate urban planning and development practices have the potential to adversely affect the surrounding environment (Pushplata, 2010; Bai et al., 2012). In some cases, these have adversely affected the rainfall, temperature, (Liu and Diamond, 2005; Shao et al., 2006) quality of air, water and soil in the area (Zhou et al., 2004; Gonzalez et al., 2005). However, it is viewed at from different and narrow perspectives, depending upon the role played by the professionals and the agencies involved in the process of planning, design, and implementation of urban development (Fisher and Newig, 2016). This incomprehensive understanding of urban sustainability results in lack of integrated solutions and coordinated actions which are required for addressing such a complex issue, necessitating a holistic understanding of sustainability in the context of urban areas (Pushplata, 2010). Though, the need for sustainability of urban development has been recognized for quite some time now, the current trends of urban development, consequent upon prevalent planning and design practices dictated by economic and demographic considerations (Kumar and Pushplata, 2013), not only result in the high consumption of non-renewable natural resources (energy)but also create large amount of waste (Poon, 2007), high levels of pollution and result in urban heat islands (Galanis, 2017), reflecting their inappropriateness. Even most of the current practices related to a sustainable urban development focus primarily on generation and optimization of energy; waste management; water management; and public transportation ignoring area/region specific aspects of natural environment and socio-cultural. Also, urban development projects like Smart Cities Mission under the Government of India (GoI) emphasize more on the economic development, providing infrastructure services, making urban cities more compact and livable with the utilization of advanced technologies such as Information and Communication Technology (ICT as a tool) for achieving sustainability (Mission Statement and Guidelines - Smart Cities, 2015), ignoring concerns towards the conservation and protection of natural environment which is an important dimension of sustainable development (Randhawa and Kumar, 2017;Praharaj et al., 2017). However, it is necessary to understand sustainability in a holistic sense for ensuring sustainable urban development, which requires proper understanding of concepts, approaches methods, tools and techniques used for the evaluation of the sustainability of urban development.

1.1. Dimensions of Sustainability – Concepts and Approaches

Till 1970's, development of an area and/or a society focused primarily on economic growth, though the need to consider the natural environment in planning, design and development has been emphasized since 1960's in the form of Ecological Planning and Architecture by Ian McHarg's in his famous book 'Design with Nature' (McHarg, 1969). The link between environmental issues and urban development was highlighted in the late 1960s and 1970s with the birth of environmental movement and debates about the "Limits to Growth" (Meadows, 1982) and "Greening the Economy" (Pearce et al., 1989). The need for a new development model which could account the equitable distribution of resources and increase the quality of life in the long term was felt in the late 70's. Thereafter, the "World Commission on Environment and Development" (WCED) presented the idea of sustainable development (SD) in 1987 in the Brundtland report "Our Common Future" which defined SD as "the development that meet the needs of the present without compromising the ability of the future generations to meet their own needs", emphasizing on "three pillars of sustainability" i.e. Environmental, Economic, and Equity (WCED, 1987, p.16). In 1995, Commission on Sustainable Development (CSD) identified four dimensions of sustainable development as Political-Institutional, Natural, Economic and Social (Littig and Griessler, 2005; Burford et al., 2013; UNESCO, 2010). Further, Spagenberg (2002) also highlighted institutional dimension as the one which has the capacity to encourage the linkage between alternative dimensions and complement them (Wijngaarden, 2001; Spagenberg, 2002; O'Connor, 2006). Valentin and Spangenberg (2000, p.382) define institutional sustainability as "human interaction and the rules by which they are guided, i.e., to the institutions of the society" (Valentin and Spangenberg, 2000; Pfahl, 2005). Thereafter, UNESCO in 2001 and Canadian International Development Authority (CIDA) mentioned the incorporation of culture as one of the sustainable development dimensions and introduced Cultural Diversity as one of the sustainability dimension (Beaulieu et al., 1994; Rotmans and de Vries, 1997; Nurse, 2006) to address the problems associated with community identity and conservation of traditions and to develop native belief system and customary values of various communities (Todd and Geissler, 1999; Sev, 2011).

"A number of urban sustainability frameworks such as "smart, efficient, green and socially just" have attempted to conceptualize urban sustainability in various, and sometimes very distinct, ways and offer different access roads to the topic of urban sustainability" (Journals.elsevier.com., 2017, pp.1). Smart growth/development is understood differently in different countries (Kolbadi et al., 2015). For example, principles of smart growth, as announced by the Smart Growth Network in context of American cities in 1996, include mixed land uses, compact design, walkable neighbourhoods, preservation of open spaces, agriculture land, and critical environmental areas, creating a sense of place and encourage community and stakeholder's collaboration (Smart Growth Network, 2006; Yang, 2009; Raparthi, 2015). Whereas, the Concept of Smart Cities developed in China since around 2008 when "underlying technologies enabled new approaches to collaborative solutions for urban challenges based on extensive data collection" (Smart Cities in China, pp.2) focus on "infrastructure interlinked by software" (Andrews, 2017). The objective of the Smart Cities Mission of the Government of India (GoI) "is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions" (Mission Statement and Guidelines - Smart Cities, 2015, pp.5). The concept of "*efficient"* refers to technologically driven approaches with low/zero impact achieving resource efficiency, including energy, water, waste management; use of materials, renewable and non-renewable resources (Akadiri et al., 2012; Zaman and Lehmann, 2011). The concept of "*Just"* refers to 'right to the city' is the foundation of social sustainability (Friedmann, 2000). In the book 'Just City', Susan S. Fainstein developed three principles of urban justice of "*diversity, democracy, and equity*" and recommended that such principles should be considered mindfully as a first evaluative criterion in planning practices and policies (Fainstein, 2010). *"Just"* focuses on social structures (affordable housing, health, and well-being, provision of adequate work, necessary social provisions and governance) enabling equal distribution of an environmental asset and encouraging participation of underrepresented groups in decision making with social inclusiveness and cohesion for all (Mitchell et al. 1995, p. 107; Dyllick and Rost, 2017). Whereas *"Green"* concept represents the environmental sustainability that emphasizes certain concepts that promote the efficient use and protection of natural systems of human and other species (Carley et al., 2011) and ensuring high quality of life in the long term. Green also refers to certain policy topics, together with activities and technology related to the movement of people and goods (public transportation system, non-motorised transport (NMT), alternative modes) (Tolley, 2003); the location (climate impacts-heat island effect, flooding), design (energy efficient technologies – solar photovoltaic panels) (Chel and Kaushik, 2017), construction (recycling of material), maintenance (retrofits), and dismantling of buildings; waste management and recycling (Ng et al., 2017); pollution (air, water, noise, light) prevention, treatment; energy production and consumption (renewable energy, efficient lighting, smart metering, monitoring); management of natural resources including air, water, land, forest, agriculture, ecosystems, etc. and other green services (Hammer et al., 2011). Most of the approaches to the sustainability of urban development aim to address urban environmental problems, which vary in their impact and intensity across the range of different spatial scales: micro (household), community, urban, national and global (Bartone, 1990).

2. State of the Art: Review of Urban Sustainability Assessment Tools

"Sustainability assessment (SA) is a complex appraisal method. It is 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). It is also defined as a methodology "that can help decision-makers and policy-makers decide what actions they should take and should not take in an attempt to make society more sustainable" (Devuyst, 2001, p.9). A global survey of urban sustainability rating tools defines it as "a standalone procedure offered publicly to national or international markets" (Crit.com, 2014, p.1).

The current urban sustainability assessment rating tools were initiated in 2004 with the introduction of the CEEQUAL (UK), CHINA EcoCITY, China EcoGarden, Enterprise, Green Neighbourhood rating tool. Two years later this was followed by CASBEE (Japan) and EnviroDevelopment (Australia) in 2006. The rating systems in different countries are largely based on the earlier building rating systems i.e. BREEAM (Netherland), LEED (Emirates) and Green Star (South Africa). BREEAM Communities, CASBEE-UD, GBI Township, LEED-ND have been globally developed for analysis of Built

Environment. India developed its first assessment tool for large-scale township projects by IGBC Green Township rating system in 2010 and another tool in 2015 on GRIHA-LD (Fig. 1).

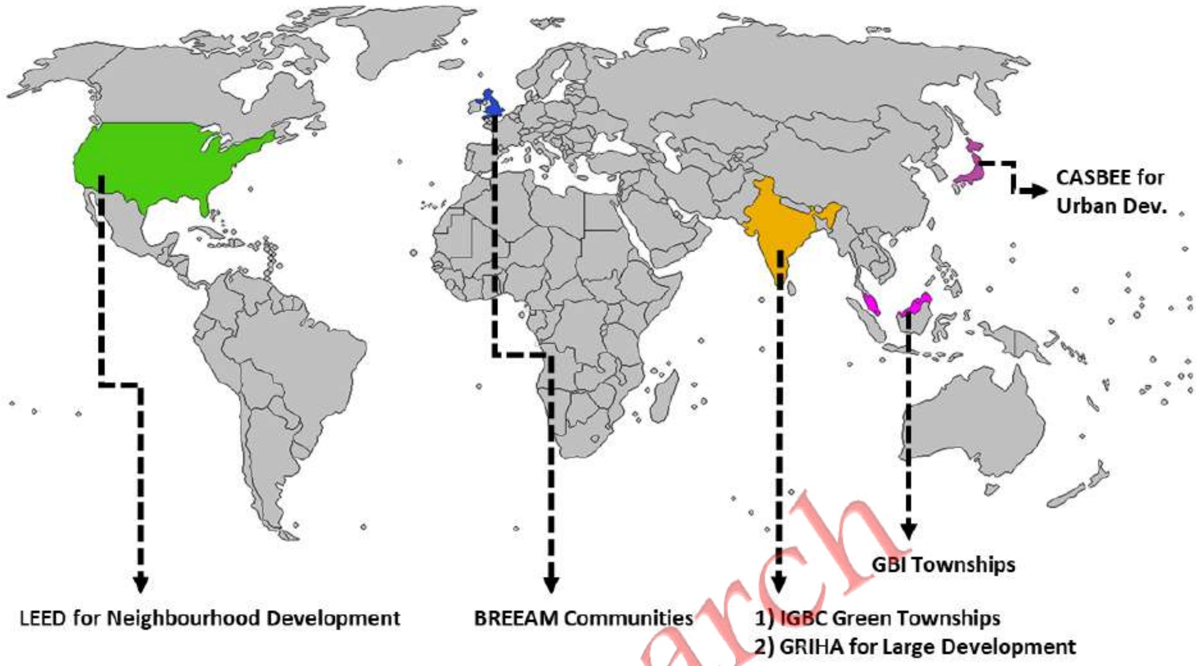

Fig. 1. Selected six urban sustainability assessment tool's geographical locations.

Sustainability is assessed on quantitative and qualitative indicators at different spatial scales from building to neighbourhood to an entire city/urban level – ranging from choice of material, analysing the energy and indoor air quality analysis as individual aspects to whole building assessment, and then to site selection and planning, transportation planning, community development and social well-being, governance and innovation at city/urban scale sustainability assessment in order to achieve sustainability for future generations. The neighbourhood/urban rating systems such as LEED-ND in US, CASBEE-UD in Japan and BREEAM-Communities in Europe, IGBC Green Townships and GRIHA-LD provide "a more balanced assessment between environmental, social and economic dimensions" (Deng and Prasad, 2010) as compared to the building level rating systems which focus only on environmental aspect pertaining to site (Retzlaff, 2008). According to Haapio and Viitaniemi, 2008, the prevailing building environmental assessment methods and tools neither be underestimated nor be considered the only possibility for sustainability assessment (Haapio and Viitaniemi, 2008); one must widen the viewpoint as the requirements for building sustainability assessment tools have increased and nowadays it is not enough to evaluate building components or the building separately (Berardi, 2011; Haapio, 2012),but built environment, neighbourhoods, landscapes & parks, transportation & infrastructure, special purposes-coastal etc. should also be considered simultaneously for the sustainability assessments based on geographical and topical focus (Crit. com, 2014).

Typical rating tools/systems include a list of items/criteria organized into themes/major categories, such as, site (location, linkage, planning, sustainability), resources (energy, water, material), infrastructure, waste management, transportation, land use planning, social & economic well-being, and innovation (design, technology) to evaluate the sustainability of development. Sustainability assessment in most of the rating systems is done on a 100 or more-point system, with equal or differential weighting approach and some use the percentage of the score, being different for different rating systems. The decision/judgement of which category and criteria should be included in a system and qualitative approach of assigning weights are subjectively based that lead to a lack of objectivity (Retzlaff, 2008). These systems are very diverse in terms of development history, strategy choices, assessment structure, assessment criteria and local benchmarks. Some comparative studies are found in the literature which reflects the effectiveness and applicability of these systems (Fowler and Raunch, 2006; Nguyena and Altana, 2011; Wu Deng, 2011; Happio, 2012). In order to understand the similarities and differences within the sustainability assessment tools in different geological context, six most widely used urban sustainability assessment tools, namely, BREEAM Communities, CASBEE-UD, GBI Township, LEED-ND, IGBC Green Township and GRIHA-LD are analysed in detail so as to identify the gaps in the existing assessment tools.

2.1. BREEAM Communities

BREEAM is the first environmental certification system for building designs, launched in 1990 in UK. It was initially developed for the assessment of buildings only but now has a specific scheme for neighbourhoods also and called BREEAM Communities (Bonham-carter, 2010). It provides a chance for planners and developers to point out the project's "environmental, social, and economic benefits to the local people at the planning and design stage of the development process" and focuses on mitigating the impact of development within the built environment (BREEAM, 2012).

The criteria to be assessed are categorized as "*Governance*; *Social and Economic Wellbeing*; *Transport and Movement*; *Land use and Ecology*; *Resources and Energy;* and *Innovation"*, of which social and economic well-being have been divided into three sub-categories i.e. Social and Economic Wellbeing for local economy; Environmental conditions; Social Well-being (Table 1). These are further divided into minor categories that are assessed using six scales rating based on the percentage of the score and categories valued on one to three points. The category Transportation and Mobility is emphasized the most, followed by Land use, Ecology, Resource and Energy, Well-Being, Economy, Governance, and Innovation is considered least significant.

2.2. CASBEE-UD (for urban development)

"Comprehensive Assessment System for Building Environmental Efficiency" (CASBEE) – the precursor to CASBEE-UD, covering housing, building and urban scales was developed in 2004 by the Japanese government, industry and academia (Sev, 2011), whereas CASBEE for Urban Development (CASBEE-UD) was developed in 2006 and focuses on the assessment of urban areas (block/zone-scale projects) together with Building scale assessment, excluding the interiors of the buildings (CASBEE, 2007). In CASBEE-UD, assessment criteria are divided into two – QUD ("Environmental Quality of Urban Development") within the site boundary and LUD ("Environment Load of Urban Development") on the spaces beyond the site boundary. Each of these is further divided into three major categories namely environmental, social and economy which further comprise of two/ three medium-level categories that are further divided into two/ three small categories. For example, QUD (outdoor environment on site) is divided into three major categories i.e. *Environment, Social* and *Economy,* the middle categories of which are– resource, nature and artefact (building); impartiality/fairness, safety/security and amenity; and traffic/urban structure, growth potential and efficiency/rationality respectively. Likewise, major themes of LUD (off-site environment) include "CO_2 emissions from traffic sector, building sector and absorption in green sector" (Table 1). These are graded on a five-scale rating based on achieved points in which each category is assigned equal weightage though the points of sub-categories vary (CASBEE for Urban Development, 2014).

2.3. GBI Township

Green Building Index (GBI) Township tool developed by GBI in Malaysia in 2011, is based on the principles of balancing the consumption of energy and water; respect towards the surrounding environment and native ecological systems; planning and designing for the benefit of the community; creating well-connected areas with different modes of transportation; use of resources having lower impact on the environment and human well-being; and creating business and employment opportunities along with the adoption of various innovative system solutions. The rating tool covers six core categories divided into minor categories, graded using point system on a four-scale rating. The core categories are "*Climate, Energy, Water* (CEW); *Environment and Ecology* (EEC); *Community Planning and Development* (CPD), *Transportation and Connectivity* (TRC) and *Business and Innovation"* (Table 1). In GBI Township, the criteria are rated differently – some (Green Transport Masterplan) of them are awarded eight points, GBI Certified Building and Innovation (six points) and others such as "Land Reuse, Flood Management & Avoidance, Wetland & Water body Conservation, Agricultural Land Preserve, Hill Slope Development, Proximity to Existing Infrastructure, Services Infrastructure Provision, Light Pollution, Compact Development, Community Diversity, Affordable Housing, Availability & Frequency Of Public Transport, Facilities of Public Transport, Alternative Transport Options, Pedestrian Networks, Low Impact Materials, Regional Material, Construction Waste Management, Site Sedimentation & Pollution Control And GBI Facilitator" are awarded only one point (GBI, 2011).

2.4. LEED-ND (for neighbourhood development)

LEED-ND integrates the ideas of "smart growth, urbanism and green building models" to create a rating system with an emphasis on land use and environmental concerns for a variety of development projects. The rating system's pilot version was first launched by the "U.S. Green Building Council"

(USGBC) in 2007, the latest version, in 2009 for Neighbourhood Development. LEED-ND emphasizes the "Site selection, design and construction elements that bring buildings and infrastructure together into a neighbourhood and importance is given in relating the neighbourhood to its landscape as well as its local and regional context" (LEED, 2011). In LEED-LD, there are three main categories ("Smart Location & Linkage, Neighbourhood Pattern & Design and Green Infrastructure and Buildings") and two additional categories ("Innovative & Design Process and Regional Priority") which are further divided into sub-categories. Green infrastructure and Buildings is the most significant category as shown in Table 1. The criteria of evaluation are based on differential weighting and values awarded to each category varies from one to ten points.

2.5. IGBC Green Townships

IGBC ("Indian Green Building Council") Green Townships rating system permits the designer to use green ideas, to reduce environmental impacts that are measurable. The rating system is planned to address the issues of sprawl, car reliance, social and environmental disconnect by the incorporation of necessary development aspects like "Environmental planning, Land Use planning, Resources management, Community development at each sector level" (IGBC, 2010). In IGBC Green Township, there are five main categories such as "Site Selection & Planning (SSP), Land Use Planning (LP), Transportation Planning (TP), Infrastructure Resource Management (IRM), Innovation in Design & Technology (IDT)" with further division into 40 minor categories, as shown in Table 1. Infrastructure Resource Management is the most significant category that has been given the maximum points, almost double than the rest of the categories. In IGBC, points are awarded in the multiplication of two (two being the least and 16 being maximum points awarded). According to IGBC (2010), It is mandatory to include a minimum 25% of residential development out of the total built-up area of the township.

2.6. GRIHA-LD (for large development)

"Green Rating for Integrated Habitat Assessment" (GRIHA) is India's National Rating System. In 2015, GRIHA-LD (Large Development) was developed by "The Energy and Resources Institute" (TERI) in coordination with the "Ministry of New and Renewable Energy" (MNRE) Govt. of India, for the evaluation of environmental impacts of large-scale developments like Green Campuses, Townships, and Special Economic Zones. Draft guidelines have been prepared in various contexts that are applicable to projects having built up area larger than or up to of 1,50,000 sq. m. with a total site area larger than or up to 50 hectares. GRIHA-LD include one indicative category ("carrying capacity and carbon footprint: site sufficiency – energy, water, organic solid waste treatment") and six main categories ("site planning, energy, water and wastewater, solid waste management, transport, social") (Table 1). In this rating scheme, resource efficiency (categories related to energy, water and waste) is given the maximum emphasis. Infrastructure management, mobility, and social well-being are given equal weightage.

Table 1

Characteristic of Selected Urban Sustainability Tools

Tools Name	Categories/Theme	No. of Items/Criteria	Weight Coefficient	Performance Rating Scale
CASBEE-UD (CASBEE, 2014)	Environment: Resource	4	3	Excellent = 60% Very Good = 30 -59% Good = 20-29% Fairly Poor = 10-19% Poor >10%
	Environment: Nature (greenary& biodiversity)	4	3	
	Environment: Artifact (building)	1	3	
	Society: Impartiality/Fairness	2	3	
	Society: Safety/Security	4	3	
	Society: Amenity	4	3	
	Economy: Traffic/Urban Structure	4	3	
	Economy: Growth potential	3	3	
	Economy: Efficiency/Rationality	4	3	
	CO_2 Emissions at Traffic sector	1	-	
	CO_2 Emissions at Building sector	1	-	
	CO_2 Emissions at Green sector	1	-	
	2 (12)	33	3	
BREEAM communities (BREEAM Communities, 2012)	Governance	4	9.3	Outstanding = 85% Excellent = 70-84% Very good = 55 - 69% Good = 40 - 54% Pass = 25 - 39%
	Innovation	1	0	
	Social and economic wellbeing-Local economy	2	42.7	
	Social and economic wellbeing - Environmental conditions	6		
	Social and economic wellbeing - Social wellbeing	9		
	Transport and movement	7	13.8	
	Land use and ecology	6	21.6	
	Resources and energy	6	12.6	
	6	41	100	
GBI Township (GBI 2011)	Climate, Energy, Water (CEW)	6	20	Platinum ≥ 86 points Gold = 76 - 85 points Silver=66 - 75 points Certified = 50 - 65 points
	Environment & Ecology (EEC)	11	15	
	Community Planning & Development (CPD)	11	26	
	Transportation & Connectivity (TRC)	6	14	
	Buildings & Resources (BDR)	8	15	
	Business & Innovation (BSI)	3	10	
	6	45	100	
LEED-ND (USGBC, 2011)	Neighbourhood Pattern and Design	14 (P5, C9)	28	Platinum = 80% Gold = 60-79% Silver = 50 - 59% Certified = 40 -49%
	Smart Location and Linkage	18 (P3, C15)	41	
	Green Infrastructure and Buildings	21 (P4, C17)	31	
	Innovation & Design Process	2 (C2)	6	
	Regional Priority	1 (C1)	4	
	5	56 (P12, C44)	110	
IGBC Green Township (IGBC 2010)	Site Selection & Planning (SSP)	9 (MR3, C6)	40	Certified = 100 - 119 (Best Practices) Silver = 120 - 139 (Outstanding Performance) Gold 140 - 159 (National Excellence) Platinum = 160 - 200 (Global Leadership)
	Land Use Planning (LP)	8 (MR3, C5)	44	
	Transportation Planning (TP)	9 (MR2, C5)	30	
	Infrastructure Resource Management (IRM)	11 (MR2, C9)	70	
	Innovation in Design & Technology (IDT)	5 (C5)	16	
	5	40 (MR10, C30)	200	
GRIHA-LD (GRIHA-LD 2015)	Site Sufficiency - Energy	2 (M1, O1)	18	1 star = 25 – 40 2 star = 41 – 55 3 star = 56 – 70 4 star = 71 – 85 5 star = Above 85
	Site Sufficiency - Water	2 (M1, O1)	23	
	Site Sufficiency - Organic solid waste treatment	1 (O1)	12	
	Site Planning	7 (M3, O4)	8	
	Energy	5 (M2, O3)	9	
	Water and waste water	6 (M2, O4)	12	
	Solid waste management	4 (M1, O3)	6	
	Transport	6 (M1, O5)	6	
	Social	4 (M1, O3)	6	
	7	37 (M12, O25)	100	

Note: environmental social economic

Based on the review of concepts, approaches and urban sustainability assessment tools above, the need for proper and in-depth understanding of the impact of development on natural environment (resources, climate), society (health and well-being of people, equity), and urban areas as "engines of growth in developing economies" is considered essential for developing a broader perspective of urban sustainability, addressing the problems and issues of urban sustainability, and suggesting potential solutions on one hand (Yan et al., 2018). Comprehensive understanding of the tools and techniques for integrated assessment of the sustainability of urban development is essential for developing more appropriate ones that can be helpful in creating and monitoring of sustainable urban development and making existing areas more sustainable on the other hand (Deakin et al., 2001, Brandon and Lombardy, 2011).The degree of emphasis given to different aspects of urban sustainability varies in different urban sustainability assessment tools that are in use, wherein some aspects are given higher significance in all the tools and techniques, while some are considered only in one or two. It has also been observed that, in addition to revising weighting points and benchmarks of the existing tools with different aspects, it needs to be assured that local requirements are met, in terms of the incorporation of all the context-specific aspects (Gibson et al., 2006; Sharifi and Murayama, 2013). For instance, the significance of site-specific and spatial natural environmental aspects/characteristics such as, slope stability – geographic structure, lithology, topography, hydrology, vegetation, seismicity (Sidle et al., 1986); environment and ecology, microclimate, proneness to geological hazards (cloudburst, landslide, earthquake, soil slump, ground subsidence, mud/snow avalanches), proximity to amenities and facilities, accessibility to infrastructure, cultural heritage and visual significance, vary considerably in different areas, including settlements in diverse geo-climatic and ecologically sensitive regions such as the Himalayan hill region of India (American Society of Planning Officials, 1968; BIS, 1995; Pushplata 2000). Likewise, context-specific aspects that are crucial for the sustainability of urban development in other environmentally sensitive areas like wetlands, coastal areas, areas prone to particular natural hazards, also need to be considered in the assessment of sustainability of urban development, hence need to be incorporated in sustainability assessment tools.

Though considerable research has been done on specific aspects of sustainability, but a very little attempt has been made by the academicians and researchers to identify the peculiar aspects of sustainability in environmentally sensitive hill areas. Integrated Site Suitability Index for determining the suitability of areas for urban development incorporating criteria specific to hill context, Design methodology and urban design matrix and guidelines for hill towns are formulated by Pushplata (Pushplata, 2000). However, the assessment tool proposed in the study was limited at area level and it highlighted the need to validate/evaluate the proposed tool at city level by conducting empirical studies for the evaluation of their performance in environmentally sensitive areas so as to find out whether the same or similar tool could be used as an urban sustainability assessment tool. The paper aims to understand the similarities and differences in existing urban sustainability tools and identify the gaps so as to find out whether these are capable of and suitable for addressing the issues of urban sustainability in Indian hill regions.

3. Methodology

To achieve the above-stated aim, current urban sustainability approaches and assessment tools are reviewed based on the study of relevant documents, books, journal papers, websites and manuals on the sustainable urban development and urban sustainability assessment. After doing a search for literature, the Qualitative Content Analysis (QCA) (Haapanen and Tapio, 2016; Moldavska and Welo, 2017; Park and Cai, 2017) is employed to identify various themes/categories associated with various dimensions of sustainability, that is, environmental, economic, social, cultural, political, technological and institutional, which are then evaluated by drawing an inventory of common criteria of various dimensions of sustainability. Further, similarities and differences in the selected assessment tools and the gaps are identified.

The process of literature selection started with the use of Google's general search engine followed by Web of Science and Academic Search Premier to capture the additional sources. A total of 2594 records were identified, of which 307 duplicates were removed from the collected data. The searched data screened for the review was restricted to peer-reviewed articles; practitioner-based assessment protocols/systems/manuals that are most frequently used such as CASBEE-UD, BREEAM Communities, GBI Township, LEED-ND, IGBC Green Township and GRIHA-LD. This resulted in the selection of relevant articles/studies (268 out of 2287) for further systematic review, each of these read in depth for a Qualitative Content Analysis. These are assessed further for eligibility to include those studies which have used similar frameworks to develop a new methodological framework for sustainability assessment, later used to conduct context-specific empirical studies. At last 105 references were included into Qualitative Content Analysis. The systematic literature review (Okoli and Schabram, 2010; Booth et al., 2012; Nawaz and Koc, 2018) done for the content analysis and the extraction of useful data/studies is shown using the PRISMA (Moher et al., 2009) flow diagram in Fig. 2.

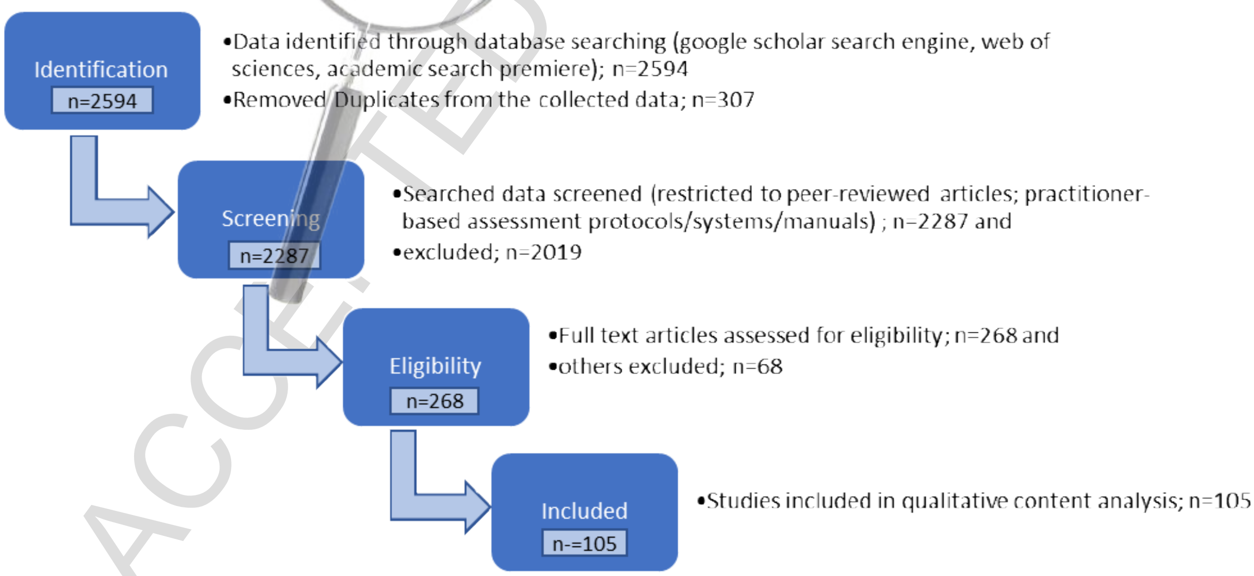

Fig. 2. PRISMA flow diagram of systematic literature search and extraction of data/studies for review.

Further analysis was done by formulation of matrices to examine the categories and indicators covered in the selected tools and literature that have considered similar aspects. One matrix of each of the five dimensions of sustainability is prepared, showing categories and their criteria that have been incorporated in the selected urban sustainability assessment tools. Another matrix containing categories/themes, number of indicators, their credits/points, and weightage scores of indicators in the categories were formulated so as to understand the significance given to each category in different assessment tools.

4. Discussion and Results

Following two sections discuss the process of identification of common criteria and indicator and their relative importance given in different sustainability assessment tools.

4.1. Criteria and Indicators List Selection

"Sustainable urban development indicators should be clear, workable, measurable and reflect the priorities and objectives of the native urban environment" (Ameen, 2015, pp. 118; Behzadfar and Abdi, 2013). These indicators are crucial in the decision-making process throughout the urban development projects for being sustainable (Wedding & Crawford-Brown, 2007). Levett highlighted the various difficulties being faced in determining the standard number, type of indicators and their applications (Levett, 1998).

Review of criteria, indicators and sub-indicators of the selected six sustainability assessment tools reveal 41 main/primary indicators and 252 sub-indicators (34 pre-requisite/mandatory sub-indicators); whereas, United Nations Division for Sustainable Development proposes fifty-eight indicators, representing varied categories and sub-categories in four different dimensions (environmental, social, economic and institutional) of sustainable development (UN DSD 2004).Sustainability indicators for development are often discussed in three or four dimensions, however alternative samples of indicator categorizations also exist. Portney (2003) presents five categories of indicators: "resources (ecological, environmental & natural); economic performance & equity; ethical considerations; socio-cultural issues; political governmental functions" (Portney, 2003). For the implementation of Habitat Agenda, UN HABITAT (2004) encourages the development of quantitative and qualitative indicator. The agenda developed 23 key indicators and additionally assembled a large database of indicators consisting of 90 quantitative indicators and 35 qualitative indicators to measure the urban sustainability of cities around the world (UN HABITAT, 1998). Though higher significance has been given to quantitative indicators, databases are available only for approximately half of the listed quantitative indicators (Zegras et al., 2004). Ignorance of some of the issues due to non-availability of valid and reliable indicators leads to a skewed understanding of aspects (Hodge et al.,1999). Therefore, it is vital to consider all the important issues pertaining to specific urban areas.

The indicators of selected sustainability assessment tools emphasize the interrelation and interconnection of various dimensions of sustainability. Two out of the six assessment tools exhibit overlap in sustainability dimensions and their indicators to serve diverse functions simultaneously, e.g., Neighbourhood patterns & Design and Green Infrastructure in LEED-ND; Social & Economic Well-being in BREEAM Communities. There are three out of six assessment tools where there is no overlap of indicators within same dimensions. Example of these non-overlapping indicators can be 'environmental conditions: land use & ecology; resources & energy in BREEAM Co.', 'environment: resource, nature (greenery & biodiversity), artefacts (buildings) in CASBEE-UD' and 'climate, energy & water (CEW), environmental & ecology (EEC) in GBI Township'.

Pillars/dimensions identified through the Qualitative Content Analysis and mention the number of times each was used in the studies as summarised in Table 2, depict that most (34) of the reviewed papers/articles mention traditional pillars of sustainability for the methodological framework of urban sustainability assessment. Out of the reviewed articles, 13 articles included three pillars with the addition of one or two other dimensions such as cultural and institutional for good governance. In some papers, an integrative dimension has also appeared (i.e. socio-economic, socio-cultural, and environmental-economic).

Table 2

Pillars of sustainability: Dimensions identified in the literature review.

Dimensions	Spatial Scale	No. of times in the paper's reviewed
Environmental	land-use, building, estate, neighbourhood, district, or city scale	39
Social	land-use, building, estate, neighbourhood, district, or city scale	34
Economic	land-use, building, estate, neighbourhood, district, or city scale	34
Cultural	Building, Urban Centres and City	8
Institutional	Neighbourhood and city level	7
Mobility and Accessibility	Neighbourhood, Urban Corridors and City	6
Infrastructure and Transportation	Neighbourhood, Urban Corridors and City	4
Governance	Neighbourhood and city level	4
Crime/Safety	Neighbourhood and city level	4
Demographics	Neighbourhood and city level	3
Integrative	Building to Neighbourhoods	3
Energy and resource efficiency	Neighbourhoods and building	3
Land Use and Urban form	Urban Neighbourhoods to City	2
Heritage	Neighbourhood and city level	1
Technological	City	1
Physical	Neighbourhood	1
Architecture and Urban Design	Neighbourhood	1
Urban Planning	City	1
Urban Structure	Neighbourhood	1
Political	City	1
Livability	Neighbourhood to City	1
Research and development	City	1
Territorial	City	1
Quality of life	Neighbourhood to City	1
International outreach	City	1
Human capital	City	1

Multiple authors cite institutional as an important sustainability dimension to be incorporated to the three pillars of sustainability (Sharifi and Murayama, 2013; Valentin and Spangenberg, 2000, Parris and Kates, 2003; Wijngaarden, 2001). According to Sharifi and Murayama (2013, p.77), "the institutional dimension is not only the interactions between the government and non-government organizations involved in the decision making, but also a set of norms, laws, and regulations governing these interactions". For Spangenberg (2002), "institutional dimension has ability to facilitate the linkages between other dimensions and complement them" (Spagenberg, 2002; O'Connor, 2006). In addition, several studies attempt to add culture as the additional dimension of sustainability to focus on important issues of community identity and preservation of traditions in a specific region (Tweed and Sutherland, 2007; ADUPC, 2010). Therefore, in this paper cultural and institutional dimensions as an additional pillar is considered along with the existing three core dimensions (pillars) for a comprehensive assessment of urban sustainability.

Aspects assessed under different categories for five dimensions of sustainability has been listed in Fig.3, after reviewing indicators suggested by international and national agencies, and by referring varied research articles and papers related to five dimensions of urban sustainability for the assessment of sustainable urban development. There are 23 themes/categories under five urban sustainability dimensions (Environmental, Social, Economic, Cultural and Institutional) that occurs in all the selected global/international and national level indicators in one form or the other. Environmental dimension consists of categories of atmosphere/climate, environmental and ecology, land use and green infrastructure, resources and energy, water and wastewater, natural hazards, solid waste management, buildings and resources, material management; whereas Social dimension includes categories of social and health wellbeing, urban layout/pattern and design, transportation and connectivity, amenity, safety/security, comfort in outdoor areas, innovation, governance; Economic dimension includes categories of economic impact, economic structure; Cultural dimension have local community cultural and heritage, visual aesthetic sensitivity (Tweed and Sutherland, 2007); and Institutional dimension includes categories of institutional framework, institutional capacity. This listing of categories and their indicators can be further used to develop a framework for the assessment of sustainable urban development at the local level by adding indicators of local importance to take care of the concerns of different regions/areas.

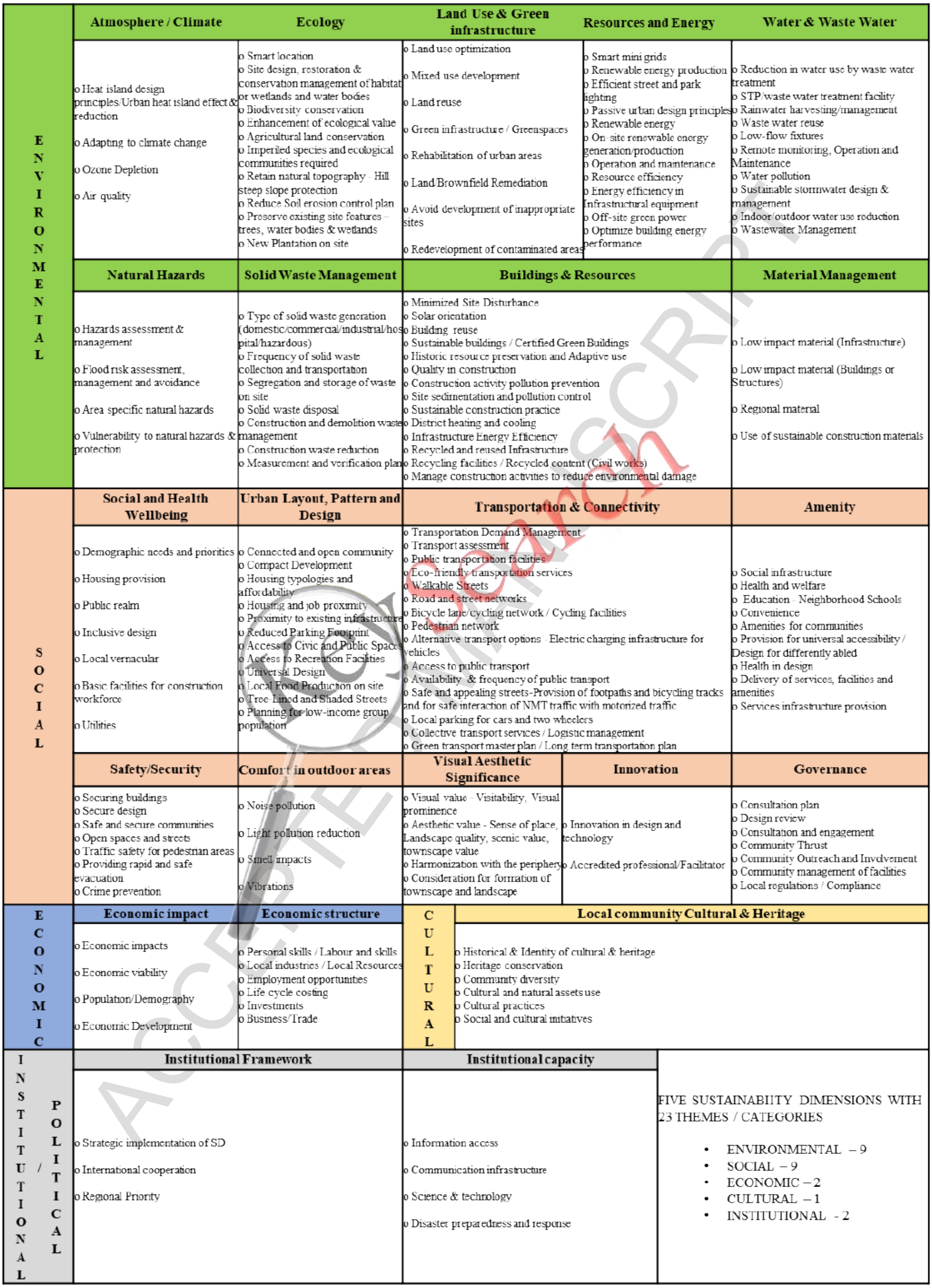

Fig. 3. Various aspects covered in selected urban sustainability assessment tools for different dimensions of Sustainable Development.

Similarities and differences between the selected urban sustainability tools are discussed in detail in the following section, for better understanding that can lead to the development of a more holistic and integrated urban sustainability assessment tool.

4.2. Analysis of Categories and Criteria/Indicators

Categories/themes, number of indicators under each category/theme and their credits/points incorporated by the six urban sustainability assessment tools selected have been analysed further in Table 3. Since credits/points assigned to indicators in each category, as well as the total credits/points for each dimension in the selected tools vary from 1.0 in GRIHA-LD to 200 in IGBC Green Township, the credits/points assigned to indicators under each category were converted to weighted score (%) (similar to what is given in BREEAM Communities) in order to understand the relative significance of indicators under each category in different tools.

Comparative analysis (Table 3) reveals that the number of indicators assigned to a category in the urban sustainability assessment tools are not directly proportional to their significance (weightage). For instance, while in the LEED-ND assessment tool 50% of the total number of indicators are related to the environmental dimension, the points assigned to these sets of indicators sum up to only 41.8% of the total points. Likewise,47.7% of the total number of indicators are related to the social dimension, whereas the points assigned to these sets of indicators sum up to 54.5% of the total points. Further, different emphasis has been given to different indicators in different tools as indicated in Table 3. All the tools (except BREEAM Communities and CASBEE-UD) assign more significance to *Green Infrastructure and Resource Management* (includes resources and energy, water, waste, and building). GBI Township places more emphasis on *Infrastructure and Resource Management* with 17 criteria out of total 45 criteria. Likewise, GRIHA-LD also places more emphasis on category related to *Resource Efficiency* (energy, water, and solid waste water) with 15 criteria and 87.80% weightage out of total 25 indicators/criteria and in LEED-ND, there are 16 criteria out of total of 44 criteria for *Green Infrastructure and Buildings*.

Social aspects (justice, fairness and equity) including equal accessibility to the resources and facilities; equal distribution of monetary resources; housing for all; equal platform for all to participate in the decision making process (Holden, 2006; Munier, 2011; Rexhepi et al., 2018); safety for all, reducing social inequalities has been fairly distributed in terms of "social, economic and environmental" conditions in case of BREEAM Communities as the main category under Social & Economic Well-being, Community Planning & Development in GBI Township, and Social in GRIHA-LD. However, CASBEE-UD, IGBC Green Townships and GRIHA-LD have a few criteria related to social and economic well-being but these issues are not being addressed adequately (Sharifi A. et. al., 2012). All tools except LEED-ND and GRIHA-LD have significance for social aspects and economic aspects. BREEAM Communities gives more emphasis on *Social and Economic Well-being* issues with 21criteria, 57 maximum credit and 41.10% weightage for social aspects and 2 criteria, 5 maximum credit and 14.80% weightage for economic aspects out of a total of 41indicators/criteria and 126 credits. Likewise, LEED-ND places more emphasis on *social aspects* with 21indicators/criteria and 54.50% weightage out of total 44 indicators/criteria and 110 credits/points and makes it the most significant category. Whereas, GRIHA-LD, have more focus on social well-being aspects with 8 criteria out of total 33 for social and no mention of economic aspects.

Site Selection and Planning is considered in the tools, but often it is included in other categories except in IGBC Green Township and GRIHA-LD, where it is included as the main category and covers, cover a number of issues, including location – job and housing proximity; land reuse – redevelopment of contaminated areas, infill, and Brownfield sites for reducing pressure on land use; conserve greenfield sites; storm water management; management of construction activities and existing site features. For instance, criteria related to *Site Selection and Planning* category are included as: *Smart Location & Linkage* (including location, Brownfield remediation, steep slope protection, site design, floodplain avoidance, conservation of water body)*, Neighbourhood Pattern & Design* (compact development, mixed-use neighbourhoods) and *Green Infrastructure and Buildings* (Construction activity pollution prevention, heat island reduction)in LEED-ND; *Social & Economic Well-being* (Flood risk management & assessment, microclimate) in BREEAM Communities; Climate, energy & water (Heat Island Design Principles), and *Environmental & Ecology* ("Land Reuse, Flood Management and Avoidance, Hill Slope Development, Storm Water Design and Management"), *Community Planning & Design* (Compact Development); *Building & Resources* ("Site sedimentation and pollution control")in GBI Township. Criteria for *Site Selection* and *Planning* are given high priority in LEED-ND (7 indicators – 17.7% weightage) and GBI Township (9 indicators – 13% weightage), and this is because of the fact that sprawl is more severe concern in the US as compared to other countries and its dependency on energy and natural resources has caused various concerns for American planners. BREEAM gives much less emphasis to the aspects related to *Site Selection and Planning* (1 criterion – 2.7% weightage).

Transportation & Connectivity is mentioned as the main category in BREEAM Communities, GBI Townships, IGBC Green Townships and GRIHA-LD and as a subcategory in LEED-ND (Neighbourhood Pattern and Design) and CASBEE-UD (Traffic Urban structure). CASBEE-UD has considered transportation as the least significant criteria with 2 criteria, 0.5 maximum credit and 5.3% weightage out of a total of 33 indicators/criteria and 9 credits compared to other urban sustainability tools.

Governance is given high priority in BREEAM Communities, CASBEE-UD and GBI Townships, and very less emphasis in LEED-ND with 1 indicator, 2 credits and 1.82% weightage out of a total of 44 indicators/criteria and 110 credits, and not given any importance in IGBC Green Townships and GRIHA-LD.

Analysis indicates that the factors associated with business and innovation, finances and economy have not been given much attention among the selected tools. GRIHA-LD and CASBEE-UD do not include *Business &Innovation* category. However, Innovation is considered the "core element of all sustainability strategies, improves the adaptability, flexibility and tool's capability of incremental improvement" (Sharifi, 2013, p. 94). Due to innovation's significance, BREEAM Communities, GBI Township, LEED-ND and IGBC Green Townships award points for innovative concepts. In IGBC Green Townships, four credits out of a total of 200 credits are given to those projects that employ a certified professional as a project member and twelve credits are given for Innovation.

Considering all the tools, *Infrastructure Resource management* is the most significant category. *Environment*, *Ecology,* and *Transportation* are also important (Ali and Nsairat, 2009). There are a number of categories which are given less emphasis than the others, including site selection and planning, social well-being, business, innovation and governance.

Besides, the results indicate that there is no single, best method for assessing the sustainability of urban developments. Diverse types of criteria and methods were used for assessment across the selected sustainability assessment tools. Regarding the criteria used for assessment, our cross evaluations revealed that some major criteria missed out in each of the selected sustainability assessment tools. It is worth mentioning, however, that we do not suggest that all these criteria should be considered. The final decision about which criteria to use should be made in consultation with the relevant stakeholders.

Also, evaluation has been performed on the aspects important for sustainability of urban development in hills based on relevant literature against the selected urban sustainability assessment tools (Table 4). Specific aspects which are crucial for urban sustainability in environmentally sensitive hill areas relate to Slope Stability, Environment and Ecology, Climate and Energy, Mobility, Visual Resource and Built Environment, which have been identified as six categories. These six main categories have been further subdivided into criteria such as Slope Stability, that include area gradient/topography, geologic structure and lithology, relative relief, land use and land cover, hydrology, and the geological hazard (Sidle et al., 1986; BIS, 1998); Environment and Ecology, that include water resources, natural drainage pattern, storm water management, vegetation/tree cover, urban agriculture and erosion; Climate and Energy, that include solar orientation, exposure to cold winds, rainfall, snowfall, skylight/daylight factors; Visual Resources including scenic views and vistas, visual character and quality, harmony with the surroundings, lighting or glare; Mobility including accessibility (transport & movement), connectivity, distance to public transit, proximity to cycling network, walkability, parking, electric charging infrastructure for vehicles; and Built Environment, that include compact development, land use mix and diversity (proximity to basic amenities and existing development), housing provision, infrastructure resource management, history and culture (cultural heritage resources), security/safety, quality of place.

529 **Table 3**

530 Common categories and their indicators included in urban sustainability assessment tools.

Dimensions	Categories / Themes	BREEAM Communities			CASBEE - UD			GBI Township			IGBC-Green Townships			LEED-ND			GRIHA-LD		
		No. of Indicators	Credits	Weighted Score (%)	No. of Indicators	Credits / Weight	Weighted Score (%)	No. of Indicators	Credits	Weighted Score (%)	No. of Indicators	Credits / Points	Weighted Score (%)	No. of Indicators	Credits / Points	Weighted Score (%)	No. of Indicators	Credits / Weight	Weighted Score (%)
ENVIRONMENTAL	Atmosphere / Climate	3	7	7.2	3	-	4.4	1	4	4	1	8	4.0	1	1	0.9	X	X	X
	Environment & Ecology	3	9	8.5	4	1.00	10.6	5	8	8.0	5	32	16.0	5	14	12.7	2	0.03	3.0
	Resources and Energy	2	15	6.8	2	0.50	5.3	3	8	8.0	3	36	18.0	3	5	4.5	4	0.27	27.0
	Material Management	1	6	2.7	X	X	X	3	3	3.0	X	X	X	X	X	X	1	0.021	2.1
	Solid Waste Management	X	X	X	X	X	X	1	1	1.0	3	16	8.0	1	1	0.9	3	0.159	15.9
	Water & Waste Water	3	7	4.9	2	0.50	5.3	3	10	10.0	3	18	9.0	4	9	8.2	6	0.386	38.6
	Buildings & Resources	2	8	6.8	3	1.50	15.9	5	13	13.0	1	12	6.0	7	14	12.7	1	0.012	1.2
	Natural Hazards	2	5	3.6	2	0.33	3.5	1	1	1.0	X	X	X	X	X	X	X	X	X
	Land Use & Green infrastructure	2	7	3.9	2	0.50	5.3	2	4	4.0	1	10	5.0	1	2	1.8	X	X	X
Sum Total of Environmental		**18**	**64**	**44.4**	**18**	**4.33**	**50.4**	**24**	**52**	**52.0**	**17**	**132**	**66.0**	**22**	**46**	**41.8**	**17**	**0.878**	**87.8**
SOCIAL	Social and Health Wellbeing	6	13	11.7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Urban Layout, Pattern and Design	X	X	X	X	X	X	3	3	3.0	1	8	4.0	10	28	25.5	1	0.012	1.2
	Transportation & Connectivity	7	16	14.7	2	0.50	5.3	6	14	14.0	5	30	15.0	5	21	19.1	5	0.06	6.0
	Amenity	1	7	2.7	2	0.50	5.3	4	9	9.0	X	X	X	2	2	1.8	2	0.048	4.8
	Safety/Security	X	X	X	2	0.67	7.1	1	2	2.0	X	X	X	X	X	X	X	X	X
	Comfort in outdoor areas	2	6	2.7	X	X	X	1	1	1.0	X	X	X	1	1	0.9	X	X	X
	Visual Aesthetic Significance	X	X	X	1	0.25	2.7	X	X	X	X	X	X	X	X	X	X	X	X
	Governance	4	8	9.3	2	1.00	10.6	2	8	8.0	X	X	X	1	2	1.8	X	X	X
	Innovation	1	7	X	X	X	X	2	7	7.0	5	16	8.0	2	6	5.5	X	X	X
Sum Total of Social		**21**	**57**	**41.1**	**9**	**2.92**	**31.0**	**19**	**44**	**44.0**	**11**	**54**	**27.0**	**21**	**60**	**54.5**	**8**	**0.12**	**12.0**
ECONOMIC	Economic impact	1	2	8.9	3	1.00	10.6	X	X	X	X	X	X	X	X	X	X	X	X
	Economic structure	1	3	5.9	X	X	X	1	3	3.0	1	8	4.0	X	X	X	X	X	X
Sum Total of Economic		**2**	**5**	**14.8**	**3**	**1.00**	**10.6**	**1**	**3**	**3.0**	**1**	**8**	**4.0**	**0**	**0**	**0**	**0**	**0**	**0**
CULTURAL	Local community Cultural & Heritage	X	X	X	1	0.25	2.7	1	1	1.0	1	6	3.0	X	X	X	X	X	X
Sum Total of Cultural		**0**	**0**	**0**	**1**	**0.25**	**2.7**	**1**	**1**	**1**	**1**	**6**	**3**	**0**	**0**	**0**	**0**	**0**	**0**
INSTITUTIONAL	Institutional Framework	X	X	X	X	X	X	X	X	X	X	X	X	1	4	3.6	X	X	X
	Institutional capacity	X	X	X	2	0.50	5.3	X	X	X	X	X	X	X	X	X	X	X	X
Sum Total of Institutional		**0**	**0**	**0**	**2**	**0.50**	**5.3**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**3.60**	**0**	**0**	**0**
TOTAL		**41**	**126**	**100**	**33**	**9**	**100**	**45**	**100**	**100**	**30**	**200**	**100**	**44**	**110**	**100**	**25**	**1**	**100**

Table 4

Consideration of the context-specific indicators in the selected tools.

Category	Criteria	BREEAM Communities	CASBEE - UD	GBI Township	IGBC Green Townships	LEED-ND	GRIHA-LD
Hill stability	Area gradient / Topography	○	●	●	●	●	●
	Lithology / Soil Properties	◐	○	◐	○	○	○
	Structure	●	○	○	○	○	○
	Relative relief	○	○	○	○	○	○
	Land use and landcover	●	●	●	○	●	○
	Hydrology	○	○	○	○	○	○
	Geological Hazard	◐	●	◐	○	◐	○
Environment and Ecology	Water resources	◐	◐	◐	●	●	●
	Natural drainage pattern	●	○	●	○	◐	●
	Storm Water Management	●	●	●	●	●	●
	Vegetation / Tree cover	●	●	●	●	●	●
	Urban Agriculture	●	○	●	●	●	●
	Erosion	◐	○	●	●	●	●
Climate and Energy	Solar Orientation	●	○	○	○	●	○
	Exposure to cold winds	●	○	○	○	◐	◐
	Rainfall and Humidity	◐	○	○	○	◐	○
	Snowfall	○	○	○	○	○	○
	Skylight/Daylight factor	●	○	○	○	◐	○
Visual Resources	Scenic Views & Vistas	○	○	○	○	○	○
	Visual Character & Quality	◐	●	○	○	○	○
	Harmony with the Surrounding	○	●	○	○	○	○
	Light or Glare	●	●	●	○	●	○
Mobility	Accessibility	●	●	●	●	●	●
Built Environment	Compact Development	◐	○	●	●	●	○
	Land Use Mix and Diversity	●	●	●	●	●	○
	Housing Provision	●	○	●	●	●	●
	Infrastructure Resource Management	●	●	●	●	●	●
	History and Culture	○	●	○	●	●	○
	Security/Safety	◐	●	◐	○	○	○
	Quality of place	●	●	●	○	●	○
TOTAL	30	15●, 8◐	14●, 1◐	14●, 4◐	12●	16●, 5◐	10●, 1◐

Note: Does meet criteria (●), Partially meet criteria (◐), Does not meet criteria (○).

Analysis shows that all assessment tools investigated cover intensively three assessment category (Environment and Ecology, Mobility and Built Environment) and partially cover the other. For example, stormwater management, vegetation/tree cover, infrastructure resource management are considered by all the tools. Criteria related to Hill Stability are given some emphasis in BREEAM Communities and GBI Townships. Likewise, Climate and Energy are given some significance in BREEAM Communities and LEED-ND. CASBEE-UD encourage the Visual Resources impact on developments to the natural setting that respects existing landforms. However, these are mentioned in general context and not in specific context/s – hills or any other environmentally sensitive areas. Each of which require context-specific aspects to be considered in urban sustainability assessment tools and accordingly incorporated in urban sustainability assessment tools and thereby assigning due weightages that can help in creating and monitoring sustainable urban development.

5. Conclusion and Recommendations

Urban sustainability assessment tools are useful and essential means for creating and monitoring sustainable urban development. These also reflect our understanding of urban sustainability, which is often viewed from different perspectives, depending largely upon the domain the professionals, agencies and researchers are working in. The main shortcomings of the existing, conventional approaches to urban sustainability is that these covers only limited or few specific aspects of sustainability, ignoring others, thereby reflecting incomprehensive understanding of the interrelations and interdependencies of one or more dimensions of sustainability, lack of a holistic vision and integrated approach (Brandon and Lombardy, 2011). This is also reflected in the urban sustainability assessment tools studied. In spite of the need to incorporate additional dimensions of sustainability other than environmental, social and economic like cultural and institutional, these have either not been included in majority of the tools or wherever included these are given less weightage.

Review of the urban sustainability assessment tools adopted in different countries reflect the significance given to various dimensions of sustainability as well as the aspects that are not covered or given less importance. For example, Varying emphasis has been given to different aspects of sustainability in different tools. All the tools, except BREEAM Communities, have given much more emphasis on *Infrastructure and Resource Management* (energy, water, waste, and building) category and assigned higher weightage. Moreover, only a few of them have provision for assessing *Social and Economic Well-being* issues, such as, *Community Involvement*. *Transportation & Connectivity* is another significant category in BREEAM Communities, GBI Townships, IGBC Green Townships and GRIHA-LD and as a sub category in LEED-ND, whereas CASBEE-UD has considered transportation as less significant criteria compared to other urban sustainability tools. Analysis indicates that the issues related to *Business & Innovation, Finances & Economy* have not been given much attention among the selected tools. Though, BREEAM Communities, GBI Township, LEED-ND and IGBC Green Townships award few points for innovative concepts, GRIHA-LD stands out for not including *Business &Innovation* as a category or criteria. Further, according to the literature reviewed, not even a single framework/tool has succeeded in establishing the complex relationships among various criteria/categories and each criterion is assessed in isolation irrespective of the fact that it can influence or be influenced by the other criteria" (Sharifi A. et.al, 2012). For example, use of pedestrian and bicycle networks though influence the *Well-being* also, are counted only as a category for *Sustainable Mobility*.

Though all the tools reviewed have included some criteria for Site Selection, Location & Land reuse, but the category/ies under which these are included are given less weightage. Also, specific aspects of site planning and development in environmentally sensitive areas, which are crucial for urban sustainability, are not incorporated. Lack of a comprehensive list of indicators for sustainable urban development makes it difficult to assess urban sustainability in varying contexts especially those that are highly sensitive, having fragile ecology and lower threshold limits/carrying capacities like Himalayan hill regions of India. For example, aspects of stability of hill slopes, topography, vegetation, hydrology, slope aspect, climate and visual significance in hill areas that are crucial for sustainability of development in hill areas, do not find specific mention in any of the assessment tools. Likewise, some other aspects crucial for sustainability in other environmentally sensitive areas like wetlands, coastal areas, areas prone to particular natural hazards, also need to be considered in these assessment tools. Hence, a comprehensive list of indicators and range of weigtages varying according to contexts, are recommended, that can lead to development of a context-specific sustainability assessment tool/framework and methods to monitor the development in environmentally sensitive areas and enable planners, designers and developers to consider all the aspects of urban sustainability in a holistic manner. This study can be helpful in developing new urban sustainability assessment tools and/or modifying the existing tools to make these more comprehensive, reflecting better/more holistic understanding of sustainability. These along with development of assessment tools that take care of context-specific concerns can lead to urban development being more sustainable and a sustainable world at large.

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