Sustainability Indicators for Vernacular Architecture in India

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Abstract

Vernacular architecture has evolved with time, establishing a connection between people and their natural surroundings. This is one of the essential elements of sustainable design too. Sustainable development helps to determine appropriate solutions to the physical, cultural, environmental, and economic development of various settlements with limited resources. In this paper, indicators of sustainability have been developed to measure the level of sustainability of any building, or settlement, which can be applied to vernacular settlements too. The paper discusses the indicators to measure sustainability of vernacular structures and settlements, under the three pillars of sustainability: environmental, social and economic. The review is based on the need for sustainability assessments and indicators as applicable to vernacular architecture of India.

Keywords: India, Sustainability Indicators, Vernacular Architecture.

Introduction

Time has been a witness to the changing climate, culture, as well as the social and economic aspects of people and their environments. Vernacular Architecture has always been a way of building locally in adaptation to cultural, social and the micro-climate of a particular region. It has evolved along time, with the introduction of better equipment and skills of the local craftsmen. Vernacular Architecture is not fixed and adapts constantly with the changing culture and immediate surroundings. Native to a region, it gives rise to sustainability of a community and their environment. With the changing approach of the built environment, there exists a need to understand the status of sustainability of vernacular (Rapoport, 1969; Oliver, 1989, 1997; Dayaratne,2018).

As said, sustainability is an integral part of vernacular architecture, having evolved over time with the local materials and technologies, while creating a coherent relationship between Man and his surroundings. Sustainability improves quality of life by integrating the environment, and social and economic aspects of any built environment, thus becoming a part of both tangible and intangible cultural identities (Taha, 2005).

The intention of this paper is to identify the potential indices for the evaluation of sustainability of vernacular architecture. It does so by examining published material—literature and documentary research—as a methodology. The indices are framed under the three pillars of sustainability: economic, social and environment. A study of selected sustainable features and practices adopted in vernacular architecture have been employed to ascertain sustainability of vernacular architecture of India. By doing so, the paper tests the validity of the indices while divulging some of the sustainable characteristics of vernacular settlements in India.

Vernacular Architecture

Vernacular Architecture is a conscious sense of belonging to Man's immediate environment and surroundings. It governs and advocates the social and cultural aspects of inhabitants; beginning with the reach of material and technology to the people of a region. Vernacular has been defined as an act of spontaneous, indigenous, rural and mostly anonymously built structures: initially featured as non-pedigree architecture (Rapoport,1969;Dayaratne, 2008). Bernard Rudofsky in 1964 introduced indigenous architecture through his exhibition titled 'Architecture without Architects: A short introduction to Non-pedigreed architecture', promoting it as a debatable phenomenon amongst various disciplines such as anthropology, social sciences, engineering, art and architecture (Rapoport, 1969).

In the 19th century, 'vernacular' focused on traditions and folkloristic culture, which was initiated by the cultural flux of the industrial revolution (Upton, 1983;Martin, 1971). The Arts and Crafts movement (1880-1910) created a renewed focus on traditional ways of building, as it brought back the artistic value to the built environment (Vellinga, 2006). Early studies in vernacular began with the focus on the built forms, materials and styles of buildings. Vernacular houses are heritage handed down to generations, but they are not fixed. They have changed with reforms in traditions and values of the residents (Oliver, 1989).

Vernacular architecture can thus be termed as the traditional buildings built with the knowledge of the indigenous people having passed down through generations, using the materials and craftsmanship available locally, in response to the local climate, and economic and social norms of the region. The most significant is that vernacular architecture is a response to the environmental context, built by ordinary people of a locality, having knowledge of their culture and surroundings (Oliver, 1997; Lawrence, 1987).

Sustainability

In recent years, the consciousness for the environment has led to a concern about issues such as global warming, replenishing of limited resources, pollution of air and water, increase in waste production and growth of population and globalization. These concerns have called for a move towards sustainability as an everyday practice (Salman, et al., 2016).

Our Common Future, 1987, coined the term 'sustainable development'. This was the Brutland report to the World Commission created by the United Nations. It defined sustainability as, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (1987). The Earth Charter added environment protection, social responsibility and economic practice, to the definition of sustainable development. Sustainability is a holistic approach, which considers the environment, as well as social and economic parameters, which are also its three pillars.

Various researches have established objectives with respect to the environment for sustainable development. They are to propagate the protection, conservation and preservation of Nature; to establish culture and ethics in the society through appropriate rules and regulations; to establish and promote use of renewable resources and to maintain a healthy environment for humans and ecology. These objectives of sustainability towards the environment have been reflected in varied fields of design and architecture (Kim & Rigdon, 1998;Dizdaroglu, 2017;Loo & Mahdavinejad, 2017).

Sustainable Architecture

Buildings designed with a perspective of environment, involving energy efficient methods, built to the social aspects and prevailing economic conditions can be termed as sustainable architecture (Poveda, 2009;Kim & Rigdon, 1998). Sustainable buildings, which integrate the three pillars of sustainability have many issues to consider in the designing and execution of a building. In terms of energy consumption–the minimum use of embodied energy must be promoted to reduce the consumption during construction vis-à-vis the use of alternative renewable energy, which shall be promoted through design. The efficient approach to environment involves the longevity and performance of the material, in terms of the ease in application and use, health and comfort, non-

hazardous to the environment and the occupants. Sustainability does not involve only the external environment but also the environment in the interior of the building. The quality of air outside the building is polluted and carries matter, which could be harmful to an occupant; thus, efficient designs concerning the health and safety of the occupants need to be achieved to fulfil and justify sustainability (Kim & Rigdon, 1998;Oxley, 2006).

Environmental sustainability adheres to water as a resource element. Potable water must be easily accessible to the people, and recycling measures to minimize waste must be adapted to achieve efficient use of water energy in the buildings. A building must be designed to incorporate waste management facilities, and apply recycling terms wherever applicable (Oxley, 2006;Salman, et al., 2016). Social and economic sustainability are driven by the context and individual's limitations (Bureš & Rácz, 2017).

Objectives of sustainable architecture have been to design the buildings/units with a number of aspects in mind; utilize minimum energy; adhere to the local and environmental regulations in the design process; apply knowledge and technology to enhance the building life cycle without hindering the environment; use non-renewable resources. The building should be connected with the socio-cultural aspects promoting socio-cultural sustainability and ensure safety and security derived (Loo & Mahdavinejad, 2017; Dayaratne, 2008;Kim & Rigdon, 1998).

Sustainability and Vernacular Architecture

Vernacular architecture has developed through time, by traditional knowledge of builders and local craftsmen being passed down from generation to generation ensuring the buildings respond to the outdoor environments. Traditional design principles are based on function of a space, optimum use of energy, human comfort, aesthetics, and economic viability while understanding and adapting to the local climate and culture (Foruzanmehr & Nicol, 2008). They were built on sustainability principles, with the use of limited resources either due to the availability of material and skill or due to economic factors. In most cases, traditional design principles have provided rational solutions to harsh climatic conditions and human needs (Lathiya, 2017).

Sustainable development helps determine appropriate solutions to the physical, cultural, environmental and economic developments of various settlements with limited resources. Vernacular architecture enacts the core of sustainability, as it is built from local materials using indigenous practices, producing minimum waste. Vernacular Architecture is an expression of culture and its significance at the local and regional territory at the same time.

The concept of sustainability in architecture relates to understanding and analyzing of the built structure with the human activities and the surrounding environment. The principles of sustainable architecture are as follows:

- Optimum use of various energy resources must be promoted from the pre-construction phase to the operation and maintenance of the building, by employing renewable energy resources.
- The building must be designed to utilize maximum natural geographical terrain, and be adaptable to the local climatic conditions, with minimum use of energy.
- Use of local, renewable and recyclable materials, which can be easily maintained should be promoted for construction
- Design should inherit the lifestyles of the dwellers by providing spaces which respond to their social, cultural and religious needs.
- Design should respond coherently to the site and its surroundings.
- The built space should allow a healthy and comfortable living environment to its dwellers while safeguarding the environment and its natural surroundings.

(Loo & Mahdavinejad, 2017;Foruzanmehr & Nicol, 2008;Mayer, 2008;Singh, et al., 2009;Akadiri, et al., 2012;Biranvand, 2011)

Vernacular architecture was built to respond to human needs by adapting and learning from the environment; the concept of sustainability was adapted in various forms, construction practices and materials. There can be a relationship between various aspects of vernacular architecture and sustainability. Dayaratne (2018) lists some of these:

- Vernacular built environments provide human comfort naturally, as it is built in response to the local climate.
- Vernacular buildings are an outcome of the cultural beliefs of the people; not just at individual level but also at the settlement and regional levels.
- Vernacular strategies tackle the natural geographic conditions and environmental resources, in a manner that they are least modified.
- Vernacular architecture responds to the lifestyles of the dwellers, promoting a sustainable and holistic living environment by also nurturing the communities.
- The techniques and technologies of vernacular have evolved through time with cohesive changes and developments in the natural and cultural environment, thereby promoting sustainability.

Need to Study Sustainability in Vernacular Architecture

The degree of transformation of vernacular varies from one region to another. These transformations need to be identified and analyzed as expressions of the emerging technologies, hybrid economies and social structures. They deals not only with the evolution of house forms and change of materials and construction technologies but also affects the living patterns, culture, and traditions of a place. New houses built are sometimes void of the older traditions, but the study of transformations may lead to terming them as "new vernacular" (Hoseini, Berardi & Dahlan, 2014). In the changing scenario, it is important to examine sustainability, efficiency, and affordability (Savyasaachi, 2019).

Methods to study Sustainability in Vernacular Architecture

Vernacular architecture is a source to simple sustainable solutions with significant environment-friendly features such as providing human comfort using low energy techniques, use of locally available materials and resources and integral approaches to form and orientation. Thus, it has strong ties to culture and social traditions in harmony with the climate, built forms and people (Dili, et al., 2010; Darus, et al., 2009).

In the past, understanding of sustainability of buildings has evolved around technical issues such as materials, building components, construction technologies and energy related optimization. More recently however, non-technical issues such as economic, social and cultural aspects have been taken into consideration for sustainability assessment of buildings (Darus, et al., 2009).

Sustainability rating systems are effective means to assess the sustainability of a building. A rating system is a key tool to evaluate and compare sustainability indices of a building. A syatem provides a systematic framework for specifying performance criteria, thereby providing a measured and accurate move towards sustainable forms of design, construction and building operations (Elisa Campbell Consulting, 2006).

The research discussed below are based not only on vernacular architecture, but studies based on sustainability rating for existing buildings, rural structures and heritage structures.

No	Year	Aim	Parameters	Rating Systems	Outcome	Source
1	2015	Sustainable rating systems for built heritage, and identification of parameters for environment assessment of Heritage buildings.	1. Site and geographic location 2. Urban setting and Linkage 3. Water efficiency 4. Energy and resources 5. Envelope and Fabric 6. Indoor environmental Quality	1. LEED – NC 2. LEED – ND	Identified categories of LEED applicable to heritage buildings in the United states.	(Shetabi, 2015)

2	2013	The study makes a situation analysis of rural development in poor areas of china. Establish a framework for environmental building assessment for rural areas.	1. Land & resources conservation 2. Waste management 3. Pollution control 4. Food self- reliance 5. Water self- reliance 6. Housing self- reliance 7. Safety and security 8. Health and well being 9. Energy self- reliance 10. Economic self- reliance 11. Sustainable landscaping 12. Sustainable agriculture 13. Culture & context 14. Inclusiveness & participation 15. Education and Information	1. CASBEE for home (Detached House) 2. ESGB for residential building 3. SBAT 4. LEED – ND	A framework was developed from the various rating systems and structured as Rural Built Environment Sustainability Assessment System	(Wan, 2013)
3	2014	Description of the new rating system GBC Historic Building for assessing the historic value of heritage buildings, introduced to improve buildings sustainability without compromising the cultural value.	1. Historic value 2. Sustainable Sites 3. Water Efficiency 4. Energy & Atmosphere 5. Material & resources 6. Indoor Environmental Quality (IAQ)	1. LEED – NC 2. GBC Historic Building		(Boarin, Guglielmino and Zuppiroli, 2014)
4	2017	To extract the main implications to building design by doing a comparative analysis the environmental impact of buildings in recent years by the various existing rating systems.	1. Energy 2. Indoor Environmental Quality 3. Innovation 3. Management 4. Material and resources 5. Pollution and waste 6. Resistance against natural disaster	1. DGNB 2. HEQ 3. CASBEE 4. LEED v4 home design and construction 5. LEED v4 Interior Design and Construction 6. LEED v4 Operation and maintenance	The analysis reviewed that all rating systems were suitable for new and existing buildings.	(Bernardi, et al., 2017)
5	2008	The paper on sustainability rating systems around the world focuses on the similarities and differences between the four rating systems and look into the environmental and cultural factors that impact the rating system development.	1. Site selection 2. Water 3. energy 4. Material & resources 5. Indoor Air Quality 6. Project Management	1. LEED 2.2 2. LEED 3.0 3. BREEAM 4. Green Star 5. Green Globes	All five rating systems surveyed in this paper show variations in their point system which reflect their geographic and cultural singularity, yet there are few variations to allow for climate or cultural differences within each specific system.	(Say and Wood, 2008)

6	2017	To analyze sustainable rating tools in respect to communities in order to understand the challenges that apply to developing nations in achieving sustainability at neighborhood level.	1. Cultural aspects such as building design and historical influences. 2. Food systems and Food control infrastructure 3. Agriculture and farming 4. Growing populations and shortage of skilled human resources 5. Government regulations 6. health 7. Energy supply systems 8. Water shortage and draughts 9. Diverse climatic conditions 10. Natural resources use and management 11. Drainage disposal and rainwater harvesting system 12. Transportation infrastructure 13. Economic aspects	1. LEED – NC 2. BREEAM 3. CSBEE 4. Green Star Communities		

Table 1: Various parameters, objectives and rating systems adapted to analyze sustainability of existing buildings or built heritage structures.

The various methods discussed in the paper are used to form a framework for evaluating sustainability of vernacular settlements and buildings. The rating system has been developed using existing frameworks and making a comprehensive data of applicable parameters in the context.

Sustainability Indicators for vernacular structures

Indicators are variables that describe a specific characteristic of a system. Indicators are developed as a set, and utilized either independently or together. The indicators can be measured as an individual component with appropriate weightage as per the system it elaborates. Indicators are quantitative measures of the factors they illustrate (Mayer, 2008). Analyses and measurement of indicators in sustainability can lead to:

- Formulate a framework for measuring and evaluating sustainability.
- Make a record of the existing policies and plans leading to the production of an environment.
- Achieve multiple goals in adapting planning approaches.
- Monitor successive progress of a matter of concern.
- Collaborate the work of different nations and define a broader perspective.
- Strengthen the efforts of all parties involved.
- Provide a data base of information for decision makers related to environment and development

(Dizdaroglu, 2017;Bureš & Rácz, 2017).

Sustainable indicators proposed for a building are initially divided in to the three pillars of environment, social and economic factors. There are different indicators under each of the pillars defined as per the context of the study. For vernacular architecture, the framework will vary in the methods and strategies of evaluation compared to other buildings.

The main objectives of the indicators are to establish the measure of sustainability in the three categories: environment, social and economic. The major objectives under environment, social and economic are: resource conservation, Design for human adaptation and cost efficiency. The framework of indicators for measuring sustainability can be evaluated as mentioned in table 2 (Loo & Mahdavinejad, 2017; Dayaratne, 2018; Rapoport, 1969; Rathore, et al., 2018; Sarangi, 2017; Oliver, 1989; Oliver, 2010; Biranvand, 2011).

The environmental indicators serve the major objective of resource conservation under which land conservation, material conservation, climate responsiveness and water conservation are sub objectives to be fulfilled to achieve environmental sustainability. The indicators under land conservation are elaborated under, site selection and planning. The strategies and details of these are; land use: to promote adaptive reuse if there is any existing building on the site; to develop the project on brownfield or non-cultivatable land. Access to site: measuring the accessibility to the existing road network; accessibility to the nearest public transport, accessibility to the basic infrastructure and amenities, proximity to basic services such as schools, open areas, clinics. Site Planning: retention of existing trees on the site; adhering to the natural slope and contour of the site; retention of any other element of environmental importance.

Material conservation indicators are elaborated under, building materials and resources, the various strategies and details of these are: availability and initial cost: use of recyclable materials. Cost in use: the frequency of maintenance of material; the life span of the material; ease in repair of material; ease in regular cleaning. Waste management and recovery cost: use of materials along with waste; disposal of waste in appropriate manner. Technique: use of local craftsmanship, skills and labor.

Climate responsive indicators are elaborated under, energy for heating and cooling, the various strategies and details of these are, energy efficiency: providing sufficient green areas on the site; health and comfort: provide efficient door to window opening ratio; materials used must improve the thermal comfort; filtration of air to provide better indoor air quality. Water conservation indicators are elaborated under, rainwater harvesting, the various strategies of this can be use of rainwater harvesting techniques.

For social sustainability, the indicators can be elaborated under, inclusive design. The various strategies of this are: design for all; the design should be accessible to all (Universal Design). Design as per the cultural norms: the design must adhere to the cultural practices. Social status: the design distinguishes the social hierarchy. For measuring sustainability of aesthetics under social indicator are elaborated as social features: any aesthetical or specific features.

For economic sustainability, the indicators can be elaborated under benefits to stakeholders, life cost efficiency, and indirect economy impact. These can be further elaborated, under benefits to stakeholders providing employment opportunities: use of local craftsman; use of local labor. Local market: use of locally available materials and tools. Under life cost efficiency leading to maintenance cost: cost of building to cost of maintenance. Under the indirect economy impact leading to crafts: use of local crafts for building elements and details.

	Objectives		**Indicator**	**Strategies**	**Method of study**
Environmental Indicators	**Resource Conservation**	**Land Conservation**	Site selection and planning	Land Use	Existing land use
					Natural vegetation
					Soil condition
					Pasture land
				Access to site	Orientation
					Road transport
					Basic amenities
					Safety and security
					Existing services
				Site Planning	Topography
					Drainage Profile
					Disaster prone area

		Material Conservation	Building Material and resources	Availability and initial cost	Traditional materials
					Material proximity
				Cost in Use	Maintenance
					Sustainability
				Waste management and recovery cost	Recycle/ Reuse
				Technique	Workmanship
		Climate responsive	Energy for heating/ cooling	Energy efficiency	Source pf electricity
					Electricity usage
					Use of daylight
					Mechanical use of energy
					Use of passive methods
				Health and comfort	Illumination
					Temperature
					Humidity
					Air change
		Water Conservation	Rainwater Harvesting		Water source
					Water usage
					Water recycle
Social Indicators			Inclusive Design	Design for all	
				Design as per the cultural norms	
				Social status	
			Aesthetics	Social features	
Economic indicators			Benefits to stakeholders	Employment opportunities	
				Local market	
			Life cost efficiency	Maintenance cost	
			Indirect economy impact	Crafts	

Table 2: Framework for sustainability in vernacular architecture
Source: Authors

Conclusions

Sustainable development is an encompassment of its three pillars – environment, social and economic. Although the three are equally important in the measurement of sustainability, the major responsibility falls on the environmental aspect of sustainability. The environmental indicator includes a cohesive development with respect to the land, material, climate and water. It is based on the consumption of energy for the entire process from setting of site, and procurement of materials to the operation and maintenance. The social indicators are based on the relation of the dwellers with their units and their cultural practices. Economic indicators are based on the individual and its community where it seeks to benefit collectively.

In terms of vernacular architecture, the measures of sustainability are reserved to few indicators as the nature of vernacular is to be local and in context with the socio-cultural and economic terms of the region and individual respectively. As seen in the Indian context, the nature of these indicators will vary in different regions as the emphasis on different aspects will be highlighted. The need for establishing these indicators is to evaluate the sustainability of the vernacular built environment in today's context, with the change in the natural surrounding are the vernacular buildings able to perform with sustainability or are forced to transform.

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