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Evaluation of LEED Requirements for Site Properties in Developing Country-Specific Certification

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Abstract

Construction activities are strongly affected by the properties of the site. Site conditions direct the investment decision and development approach. Leadership in Energy and Environmental Design (LEED), the most widely used certification system around the world, covers site properties with two sections, i.e., Location and Transportation, and Sustainable Sites. These two sections in LEED v4 NC add up to 42 points, which corresponds to approximately 33.3% of the total points that a building can receive. Issues such as neighborhood development location, sensitive land protection, high priority site, surrounding density and diverse uses, access to quality transit, bicycle facilities, reduced parking footprint, and green vehicles that are treated in the Location and Transportation section have different priorities and implications in developing countries. Similarly, issues such as pollution prevention, site assessment, site development - protect or restore habitat, open space, rainwater management, heat island reduction, and light pollution reduction that are treated in the Sustainable Sites section are based largely on local practices and standards, and therefore offer different challenges. In this study, these two sections of LEED v4 NC are assessed relative to practices in developing countries. A comparative review of the topics is performed by means of a thorough literature survey. It is expected that the outcome of the study will provide guidance to professionals in selected developing countries towards improvement of the existing state and practices.

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1. Introduction

Construction and the many resources it uses have a considerable effect on the environment. Besides the construction process itself, the operation and maintenance of buildings also have significant impact on the environment. The “green building” concept was developed in the 1970s as a response to the need for energy efficiency and sustainability in construction [1-3]. There is agreement among researchers that sustainable design aims to minimize or eliminate the negative impacts on the environment, natural resources and nonrenewable energy sources [3].

Construction projects are one-time endeavors performed on a piece of land, and thus are strongly interrelated with the site. Also, it is estimated that the transportation channels used to carry resources to a construction site cover thirty to forty percent of the surface area of cities [4]. In addition, infrastructure that carries water, sewage, electricity, and data is an important part of the construction activity and the built environment, and has a sizeable effect on the environment. Rowings and Walker [5] state that, of the energy used for the construction of a building, 28.5% is consumed during the pre-construction phase, 36.8% during the construction phase, and 34.7% during the post-construction phase. Considering the fact that every phase requires the availability of land, the transportation of resources, and infrastructure for basic utilities, the location and characteristics of the site on which the building is placed has an important impact on the efficient use of existing resources [6].

The LEED certification system is the most preferred green building certification system in the world, and has been developed in the U.S. by the U.S. Green Building Council [7, 8]. The LEED certification system heavily relies on U.S. codes, standards and regulations, which limit its applicability and success in other countries [3, 7, 9]. In this study, LEED-mandated Location and Transportation, and Sustainable Sites requirements are reviewed with respect to local conditions in the U.S., India and Abu Dhabi. The review is performed based on LEED v4 NC, LEED-India NC, and ESTIDAMA PBRs. The status of the codes, standards, and regulations in the U.S., India and Abu Dhabi are investigated by reviewing the relevant literature about current studies in these countries. Finally, suggestions are made for an easier implementation of LEED requirements in developing countries.

2. Applicability of LEED Location and Transportation and Sustainable Sites Requirements in Developing Countries

Developed countries, supported by their consistent and well regulated industries, have introduced and implemented their own green building guidelines and certification systems since the 1990s [8]. BREEAM in the U.K., CASBEE in Japan, GREENSTAR in Australia, and LEED in the U.S. are such certification systems that rely on the standards in use in the respective countries. Although LEED’s credibility and popularity makes it preferable by professionals around the world, the success of its application in different countries is limited by the local conditions and requirements in the subject countries [3].

LEED’s latest version v4 has been published in July 2014 [10]. Updating the previous version (LEED 2009), LEED v4 handles site related properties in two credit categories, i.e., Location and Transportation, and Sustainable Sites. The Location and Transportation category adds up to 32 points for new construction (NC) out of 126 points, which is the highest score that can be achieved. On the other hand, the Sustainable Sites category has a total of 10 points for NC. The Location and Transportation category emphasizes the building’s relationship with its close proximity and infrastructure. However, the Sustainable Sites category points out to the building’s direct effects to the site and close environment. USGBC has not used prerequisite/credit numbering in LEED v4. The numbers added to credit names in parenthesis in this paper are proposed for easy following and are based on the order of listing in the LEED Reference Guide.

2.1. India

LEED-India NC, which is an adaptation of a previous version of LEED to India’s local conditions and requirements, has been introduced by the Indian Green Building Council in January 2007 [11, 12]. In LEED-India NC, site-related issues are assessed in the Sustainable Sites category. The subject category focuses on natural

habitat, transportation, stormwater, heat island effect, light pollution, and pollution caused by construction processes. It rewards a total of 13 points of the 69 points achievable.

Although some of the credits in the Sustainable Sites category of LEED-India NC directly cover the topics of some credits in LEED v4, some credits only partially meet the definitions of the credits. For instance, SS Credit 3. Brownfield Redevelopment matches one of the LT Credit (3) High Priority Site's three options, i.e., Option 3. Brownfield Remediation. The other two options (i.e., Option 1. Historic District and Option 2. Priority Designation) are not met by LEED-India NC's Credit 3.

LT Credit (1) - LEED for Neighborhood Development Location, SS Credit (1) - Site Assessment, and SS Credit (3) - Open Space do not have any counterparts in LEED-India NC. Actually, SS Credit (1) - Site Assessment was not present in the previous version (LEED 2009 NC). It is one of the new credits that were introduced in the new version, LEED v4 NC. This may explain the absence of this credit in LEED-India NC that was based on an earlier version of LEED.

In LEED-India NC, the only credit that refers to local standards is SS Prerequisite 1. Erosion & Sedimentation Control. This prerequisite refers to the National Building Code of India (NBC) Part 10, Section 1, Chapter 4 - Protection of Landscape during Construction. The remaining credits refer to U.S. standards such as ASHRAE, IESNA, and ASTM.

The subject categories in LEED v4 NC sum up to 42 points, which corresponds to approximately 33.3% of the total points that a building can receive. However in LEED-India NC assigns approximately 19% of the total points to the Sustainable Sites category.

2.2. Abu Dhabi

Abu Dhabi, being the largest emirate of the UAE, lies on dry desert. Because of that she has the highest water consumption per capita, and the majority of the energy consumption is caused by desalination of water [13]. Consequently, Abu Dhabi places a special emphasis on sustainability. ESTIDAMA PBRs is the rating system implemented by the Abu Dhabi Urban Planning Council, for the assessment of new buildings [14]. It was introduced in April 2010. The rating system has been developed by experts based on U.S. standards such as ASHRAE, IESNA, and ASTM as well as CIBSE (U.K.) and ISO standards, and EU directives [3]. It also refers to local regulations and has been announced in September 2010 as mandatory for all new buildings in Abu Dhabi [15]. Since the Abu Dhabi Quality and Conformity Council was established only as late as in 2009, the quality and quantity of standards needed for the implementation of a rating system are not sufficient [16].

The prerequisites and credits in subject categories in LEED v4 NC, Location and Transportation, and Sustainable Sites are met by requirements and credits cited in four different categories in PBRs, which include Livable Buildings: Outdoors, Natural Systems, Integrated Development Process, and Precious Water. The sum of the points assigned to these four categories is 82, out of 180 points that is achievable by a new building, which accounts for 46% of the total points. However, the credits that meet the counterpart credits in LEED v4 NC amount to only 27 points, which is 15% of the total points. The explanation for this is that PBRs puts emphasis on Precious Water (approximately 24%) and Resourceful Energy (approximately 24%) categories because of Abu Dhabi's geographical priorities.

As seen in Table 1, two of the credits in LEED v4 NC are not met by any credits in ESTIDAMA PBRs. These credits are LT Credit (4) - Surrounding Density and Diverse Uses, and LT Credit (7) - Reduced Parking Footprint. Eight of the 14 requirements and credits (i.e., NS-R1: Natural Systems Assessment, NS-2: Remediation of Contaminated Land, LBo-R3: Outdoor Thermal Comfort Strategy, LBo-6: Public Transport, LBo-7: Bicycle Facilities, LBo-10: Light Pollution Reduction, IDP3: Construction Environmental Management, PW-4: Stormwater Management) refer to local codes and regulations.

Table 1. Comparison of LEED 2009 NC, LEED India NC, and Abu Dhabi ESTIDAMA PBRs on the basis of Location and Transportation and Sustainable Sites categories

| LEED v4 NC | | | LEED India NC | | | ESTIDAMA PBRs: Design & Cons., V. 1.0 | | |
|---|------|--|---|-----|---------------------------------------|---|-----|------------------------------|
| Location and Transportation, and Sustainable Sites categories | | | Sustainable Sites | | | Livable Buildings: Outdoors, Natural Systems, Integrated Development Process, and Precious Water categories | | |
| Prerequisites - Credit No. | Po. | Referenced Standards | Prerequisites - Credit No. | Po. | Referenced Standards | Requisites - Credit No. | Po. | Referenced Standards |
| LT Credit (1)- LEED for Neighborhood Development Location | 8-16 | N/A | - | - | - | LBo-2: Pearl Rated Communities | 1 | N/A |
| LT Credit (2)- Sensitive Land Protection | 1 | U.S. Department of Agriculture, United States Code of Federal Regulations Title 7, Volume 6, Parts 400 to 699, Section 657.5 | SS Credit 1. Site Selection | 1 | N/A | NS-1: Reuse of Land | 2 | N/A |
| | | U.S. Fish and Wildlife Service, List of Threatened and Endangered Species | | | | | | |
| | | NatureServe Heritage Program, GH, G1, and G2 species and ecological communities | | | | | | |
| | | FEMA Flood Zone Designations | | | | | | |
| LT Credit (3)- High Priority Site | 1-2 | U.S. Environmental Protection Agency, National Priority List | SS Credit 3. Brownfield Redevelopment | 1 | N/A | NS-2: Remediation of Contaminated Land | 2 | Environment Agency Abu Dhabi |
| | | U.S. Housing and Urban Development, Federal Empowerment Zone, Federal Enterprise Community, and Federal Renewal Community | | | | | | |
| | | U.S. Department of Treasury, Community Development Financial Institutions Fund | | | | | | |
| | | U.S. Department of Housing and Urban Development, Qualified Census Tracts and Difficult Development Areas | | | | | | |
| LT Credit (4)- Surrounding Density and Diverse Uses | 1-5 | N/A | SS Credit 2. Development Density & Community Connectivity | 1 | N/A Regulated by LEED India NC itself | - | - | - |

| | | | | | | | | |
|---|-----|---|--|-----|---|---|---|--|
| LT Credit (5)- Access to Quality Transit | 1-5 | N/A | SS Credit 4. Alternative Transportation | 1-3 | N/A Regulated by LEED India NC itself | LBo-6: Public Transport | 3 | Surface Transport Masterplan, Abu Dhabi Department of Transport, April 2009 |
| LT Credit (6)- Bicycle Facilities | 1 | N/A | - | - | - | LBo-7: Bicycle Facilities | 2 | Abu Dhabi Urban Planning Council's Development Code Abu Dhabi Urban Planning Council's <i>Urban Street Design Manual</i> , 2010 |
| LT Credit (7)- Reduced Parking Footprint | 1 | Institute of Transportation Engineers, Transportation Planning Handbook, 3rd edition, Tables 18-2 through 18-4 | - | - | - | - | - | - |
| LT Credit (8)- Green Vehicles | 1 | American Council for an Energy Efficient Economy (ACEEE) Green Book | - | - | - | LBo-8: Preferred Car Parking Spaces | 1 | N/A |
| | | Society of Automotive Engineers, SAE Surface Vehicle Recommended Practice J1772, SAE Electric Vehicle Conductive Charge Coupler | | | | | | |
| | | International Electrotechnical Commission 62196 | | | | | | |
| SS Prerequisite- Construction Activity Pollution Prevention | - | Environmental Protection Agency (EPA) Construction General Permit (CGP) | SS Prerequisite 1. Erosion & Sedimentation Control | - | National Building Code of India (NBC) Part 10, section 1, chapter 4 - Protection of Landscape during Construction | IDP3: Construction Environmental Management | 2 | Environment Agency Abu Dhabi's EAD's Construction Environmental Management Plan Technical Guidance Document |
| | | | | | | | | ISO 14001 Environmental Management Standard: 2004 |
| | | | | | | | | Abu Dhabi Emirate Environment, Health and Safety Management System (EHSMS) |
| SS Credit (1) - Site Assessment | 1 | Natural Resources Conservation Service, Soils | - | - | - | NS-R1: Natural Systems Assessment | - | Abu Dhabi Urban Planning Council (Development Review and Design Process, and Coastal Development Guidelines) |
| | | TR-55 initial water storage capacity | | | | | | |
| | | Environment Agency Abu Dhabi (Environmental Impact Assessment (EIA) and Preliminary Environmental Review (PER) guidelines) | | | | | | |
| Union for Conservation of Nature, IUCN | | | | | | | | |
| SS Credit (2) - Site Development - Protect or Restore Habitat | 1-2 | U.S. EPA ecoregions | SS Credit 5. Reduced Site Disturbance | 1 | N/A Regulated by LEED India NC itself | NS-4: Habitat Creation & Restoration | 6 | N/A |
| | | Land Trust Alliance accreditation | | | | | | |
| | | Natural Resources Conservation Service, web soil survey | | | | | | |
| | | Sustainable Sites Initiative (SITES™) | | | | | | |

| | | | | | | | | |
|---|-----------|--|---|-----------|--|--|-----------|--|
| SS Credit (3) - Open Space | 1 | N/A | - | - | - | LBo-5: Private Outdoor Space | 1 | N/A |
| SS Credit (4) - Rainwater Management | 2-3 | U.S. EPA Technical Guidance on Implementing the Rainwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act | SS Credit 6.1. Stormwater Design, Quantity Control | 1 | N/A | PW-4: Stormwater Management | 4 | Environment Agency Abu Dhabi |
| | | | SS Credit 6.2. Stormwater Design, Quality Control | 1 | N/A Regulated by LEED India NC itself | | | CSIRO Urban Stormwater Best Practice Environmental Management Guidelines (2006) |
| SS Credit (5) - Heat Island Reduction | 1-2 | ASTM Standards E903 and E892 | SS Credit 7.1. Heat Island Effect, Non-Roof | 1 | N/A Regulated by LEED India NC itself | LBo-R3: Outdoor Thermal Comfort Strategy | - | ASTM E1980 - 01 Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces |
| | | | | | | | | ASTM E1918-06, Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field |
| | | | | | | | | ASTM C1549-09, Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer |
| | | ASTM E 903 | ASTM E 408-71 (2008), Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques | | | | | |
| | | ASTM E 1918 | ASTM C1371-04a, Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emisometers | | | | | |
| | | ASTM C 1549 | Abu Dhabi Urban Street Design Manual | | | | | |
| | | ASTM E 408 | Community facilities requirements, Urban Planning Council | | | | | |
| | | ASTM C 1371 | LBo-1: Improved Outdoor Thermal Comfort | 2 | N/A | | | |
| SS Credit (6) - Light Pollution Reduction | 1 | Illuminating Engineering Society and International Dark Sky Association (IES/IDA) Model Lighting Ordinance User Guide and IESTM-15-11, Addendum A | SS Credit 8. Light Pollution Reduction | 1 | ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting Section | LBo-10: Light Pollution Reduction | 1 | International Energy Conservation Code (IECC) 2009 |
| | | | | | IESNA RP-33 | | | IESNA RP-33-99 |
| Total Points | 42 | | Total Points | 11 | | Total Points | 27 | |

3. Conclusion

Sustainable construction aims to create a system that consists of natural and built environments that function in harmony and present equal economic opportunities [17]. From the architect's point of view, the whole process needs to be planned to the last detail. It should include the design and the choosing of the systems and details, site usage and excavation, materials supply and construction, disposal of construction waste and control of contamination caused by the construction activities, operation and maintenance of the facility, and finally demolition of the building [6].

The lack of standards developed for local needs is the issue that weakens the success of implementing green building certification systems. The Sustainable Sites Category of LEED-India NC refers to only one local standard. For the efficiency of sustainable practices, especially in implementing the Sustainable Sites Category of LEED-India NC, there is an urgent need for standards that are adequate for local conditions in India [3, 12]. On the other hand, the Emirates Authority for Standardization and Metrology (ESMA) was established by the United Arab Emirates in 2001 [18]. However, the Abu Dhabi Quality and Conformity Council was founded as late as in 2009 [16]. Because of this, the number of standards introduced by the Abu Dhabi Quality and Conformity Council is not sufficient for the application of a green building rating system. In the absence of an adequate number of local standards, both LEED-India NC and ESTIDAMA PBRS refer to ASTM and ANSI/ASHRAE/IESNA standards. ESTIDAMA PBRS also refers to CIBSE standards. While LEED-India NC refers to only one local code, ESTIDAMA PBRS refers to multiple local codes, as well as manuals and standards, but still not enough for easy implementation of green practices [19].

Being managed by a monarch and all the governmental entities reporting to him, Abu Dhabi's development has a centralized character. Thus the city planning, transportation, environment and related issues are managed in coordination. As a result, Abu Dhabi follows a sustainable city approach, whereas LEED introduces methods for single buildings pursuing certification.

Because ESTIDAMA PBRS is an advanced adaptation of LEED 2009 NC [20], it has established the credit LBo-2: Pearl Rated Communities to promote the development of sustainable communities. USGBC has added LT Credit (1) - LEED for Neighborhood Development Location to LEED v4 NC, which was not present in LEED 2009 NC. It is assumed that USGBC has added this credit to satisfy critics about the lack of emphasis on sustainable communities. The number of points assigned by USGBC to this credit emphasizes the importance of this credit.

Regarding the evaluation process of sensitive land, there are multiple codes regulating the protection of land, water bodies and species in the U.S., whereas there is a lack of regulations in India and Abu Dhabi. For example, in addition to the limited information provided by Abu Dhabi's Environment Agency, Abu Dhabi refers to ASTM standards and evaluation methods used in the U.K.

A different approach is used in the U.S., in India and in Abu Dhabi in dealing with heat island, which has an important effect on the urban environment. While LEED-India refers to a number of ASTM standards, LEED v4 NC refers to only one ASTM standard but also to a standard introduced by a professional organization. ESTIDAMA PBRS on the other hand, refers to multiple ASTM standards as well as the local urban regulations in Abu Dhabi. A different approach can also be observed for the credit pursuing light pollution reduction in these countries.

Since LEED-India has been developed with LEED 2009 NC used as a basis, the references to standards are similar in these two certification systems [9]. Although ESTIDAMA PBRS is a more developed adaptation of LEED 2009 NC, it also refers to the same standards in addition to U.K. standards and local regulations. However, LEED v4 NC has moved a step further by adding references to more specific standards introduced by professional organizations, such as the Institute of Transportation Engineers, ACEEE, SAE, SITES, and IES.

The highly complicated structure and relatively long process of construction projects requires the involvement of numerous parties such as investors, designers, consultants, construction managers, contractors, material suppliers and local authorities. The need for effective standards that emphasize local requirements and priorities demand the contribution of all of these parties as well as policymakers, building users, and educators/academics to the standard development process. This study points to the problems encountered in the creation and establishment of green building rating systems in developing countries, and helps decision-makers to develop efficient systems or improve existing ones.

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