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Comparative Analysis of LEED-NCv3.0 with LEED-NCv2.2

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ABSTRACT

Energy crisis and environmental awareness in the society has forced the construction industry to rethink the current design and construction practices, and adopt more sustainable approaches. To build sustainable environment and achieve optimum comfort, the construction industry utilizes various sustainability rating systems. Among the available rating systems, Leadership in Energy and Environmental Design (LEED) has emerged as one of the most adopted in United States. Since the initial launch in 1998, LEED has evolved over the years. This study presents a comparative analysis of the requirements for the credits/ prerequisites and measurement approach of the most recent LEED v3.0 in respect to the preceding LEED v2.2. Results indicate that requirements for majority of the credits have remained unchanged in LEED v3.0. A shift toward system based approach in LEED v3.0 was noticed in comparison to the preceding version. Finally, some recommendations have been offered for future version of LEED.

INTRODUCTION

The energy crisis in the 1970s acted as a catalyst for the movement of sustainable building design and construction. As a corollary of the energy crisis and concurrent environmental awareness in the society, the construction industry initiated the sustainable design and construction movement (Nicholson, 2004). Sustainable practices bring many potential benefits to the society, environment, and economy. To guide and evaluate the design and construction of various types of facilities in the United States, building evaluation criteria have been established both at the national

level such as Leadership in Energy and Environmental Design (LEED), and regional level such as Earthcraft (Tinker and Burt, 2004).

Developed by the United States Green Building Council (USGBC), LEED is a green building rating system for benchmarking design, construction, and operation of various buildings types. The rating system is in the form of a third-party voluntary certification program targeted towards improving performance of buildings based on energy savings, water efficiency, reduction of carbon dioxide emission, improved indoor environmental quality, and optimum usage of resources (Retzlaff, 2008). Since its initial launch in 1998 (LEED NC v1.0), LEED has evolved over the years. The most recent version (LEED v3.0) consists of nine different rating systems for new construction, core and shell development, schools, new construction and major renovations for retail, healthcare, commercial interiors for retail, operations and maintenance of existing buildings, neighborhood development, and homes (UNEP, 2010). In the past, there has been considerable debate in the sustainable community to gauge the appropriateness, the structure and the weighted measurement approach adopted by the LEED rating system. Sometimes, it is also noticed that adopting LEED may actually be limiting the efforts to achieve sustainability. For example, designers may use materials or opt for design choices that garner a LEED point, even though those may not be appropriate for that particular location and climate. The initial versions of LEED were claimed not to be climate and facility specific, although newer versions claim to address these weakness, emphasizing on performance (Preston, 2011).

With the positive approach towards propagating sustainability, it is the prime responsibility of the practitioners and academicians related to construction industry to ensure that sustainable design and construction is not just a passing fade. The construction industry needs improvisation and constant search for better holistic sustainable solutions (system-based), which in most of the cases are appropriate for a given facility. One of the many ways of enhancing sustainability is by emphasizing the flexibility of data exchange amongst various stakeholders associated in a given project (Krygiel and Nies 2008). Furthermore, according to Frankel and Turner (2008) the success of implementation of system-based measurement approach can be achieved by including credits that measure energy use in completed facilities. Thus, it is essential to find out the changing trends in the measurement system incorporated in LEED v3.0. This will further pave ways to factors that can be introduced in the future versions of LEED.

GOAL & OBJECTIVES

The goal of this study was to identify the changing trends incorporated in the most recent version of LEED (LEED v3.0) rating system when compared to the preceding version (LEED v2.2). The specific objectives were as follows:

1. To identify the proportion of the credits/prerequisites whose requirements have remained unchanged in the LEED v3.0 in comparison to the preceding version

2. To identify whether the requirements for achieving the credits/prerequisites in LEED v3.0 have become more demanding/less demanding in comparison to the preceding version
3. To identify whether the changes in requirements for achieving the credits/prerequisites in LEED v3.0 reflect the characteristics of being either prescriptive/performance/system-based measurement approach in comparison to the preceding version
4. To provide recommendations for the future versions of LEED

METHOD

Based on literature review, the authors realized that the LEED rating system must be designed to adopt system-based measurement approaches, in order to address overall sustainability of projects under various scenarios. One of the major goals of the study was to identify if any such transformation occurred when the LEED version was upgraded from Version 2.2 to 3.0. The overall research process for the study consisted of the following steps:

1. Operationalizing the terms – ‘prescriptive based technologies’, ‘performance based technologies’, and ‘system based technologies’
2. Comparing the requirements for individual credit/prerequisite within LEED v2.2 to the corresponding credit/prerequisite within LEED v3.0
3. Identifying the requirements that have changed in LEED v3.0 in comparison to the preceding version
4. Analyzing the changes in the current version as more demanding/less demanding and prescriptive/performance/system based technologies
5. Validating the analysis with the help of experts from the design/construction industry and academics
6. Providing recommendations for future versions based on the analysis of the requirement to achieve the credit/prerequisite

Prescriptive/Performance/System-based Measurement Approach

Prescriptive Measurement System (PMS) approach helps to achieve certain desired levels of output from a facility by recommending certain technologies/systems over others. Sexton and Barrett (2005) posited that in PMS approach, the facility components are described, specified, and procured, thereby resulting in components within a facility that have an implicit set of attributes. Similar optimization of facilities would likely result in negative impacts from a whole systems standpoint. According to Siddiqui et al. (2009) that would overwhelm the benefits realized, as the whole notion of sustainability of a facility is so much context driven. For this study, the author defines PMS as follows.

“PMS is a component of past experiences, recommended, described or specified by explicitly mandating use of certain technologies or strategies in the LEED manual, in order to realize certain implicit set of attributes or objectives set for the facility.”

Hence, to sum it up for this study, fixed parameters must be fulfilled for achieving the credit and the design team has to follow those recommendations to earn the particular credit.

Siddiqui et al. (2009) stated that performance-based approach to measure sustainability addresses shortcomings, to a certain extent of prescriptive measurement. In this process, the limitations are identified, and goals are set so that the outcomes can be of the desired level. EPA defines Performance Based Measurement System (PBMS) as a set of processes wherein the data needs, mandates, or limitations of a program or project are specified, and serve as criteria for selecting appropriate methods to meet those needs in a cost-effective manner (USEPA, 2011). Similarly, Neely et. al (2005) defines the measurement system as the set of metrics used to quantify the efficiency and effectiveness of actions. Hence, it implies that the measurement system specifies what objectives need to be accomplished and leaves it to the designer to choose any form of material to accomplish it. This system is often perceived as a shift from traditional prescriptive approach. For this study, the authors defined PBMS as follows:

“PBMS is a criteria that specifies level of performance required for certain components of the facility and it is up to the designer to use their innovativeness or follow one of the many criteria published in regulations, permits, or work plans in regard to the project, where they individually or in combination of various building components, are able to satisfy the desired level of performance.”

In context of this study, if there is more than one method of achieving the credit and it is up to the design team to select method that would satisfy the needs of the particular facility; it has been referred to as performance based measurement criteria.

One step ahead of PMS is System Based Measurement (SBM). When a facility is composed of various networks of interconnected systems it is noticed that any change or modification applied on a single system would modify or reflect energy savings for the entire system within the loop (Bossel, 2001). Thus, for this study, the authors have defined System-based Measurement as follows.

“SBM is defined as a comprehensive set of performance indicators for measuring the facility’s sustainability from a holistic perspective. A system based measurement consists of various strategies and technologies which work in tandem with each other in such a way that any change within a single system will result in change of productivity of the system as a whole.”

Thus, it must be noted that adopting a system-based measurement approach within the LEED rating system would be the first step towards solving problems posing hindrance to the successful application of sustainability. In this study, the LEED v3.0 was compared to LEED v2.2 to gauge the trend in change of measurement system. The analysis will pave for solutions that can be adapted for future LEED versions.

Once the definitions were developed, two industry experts and two academic experts reviewed those in order to ascertain the validity of the terms. Feedbacks from the experts were incorporated to finalize the definitions. Upon finalizing the definitions for each of the system types, the authors evaluated the requirements for each of the credit/prerequisite in LEED v3.0 and compared those with the

corresponding credit/prerequisite of LEED v2.2. For instance, in case of Water Efficiency credit 3.0 (water use reduction) LEED v3.0 has recommended a reduction of 30% (LEED v3.0 p.203) in comparison to 20% as recommended by LEED v2.2. This change in the requirement was classified by the authors as “more demanding”. On the contrary, there are changes in the requirement for the credit/prerequisite in LEED v3.0, which were found to be less demanding by the authors. The results of the comparison are shown in Table 1 and Table 2.

Further the LEED credit requirements for both versions were analyzed with respect to the definitions operationalized for the prescriptive, performance, and system-based measurement to classify the credit/prerequisite. Two LEED Accredited Professionals (AP) were used to classify the credits of the two versions of LEED based on the definitions of “performance based measurement system”, “prescriptive measurement system”, and “system based measurement system” provided in the paper. It was found that in 92.5% of the time their classifications were same. In other words, the authors wanted to test the inter-coder reliability. The authors have considered 80% as an acceptable percentage of agreement between two coders.

RESULTS

Comparison between LEEDv3.0 & LEEDv2.2: Credits & Prerequisites

Based on the comparison of the requirements for each of the credits of LEED v3.0 in respect to LEED v2.2, it was found that requirements of a vast majority of the credits (75.5%) have remained unchanged. Only 14.3% of the credits in LEED v3.0 have become more demanding, and 8.2% were found to be less demanding in comparison to LEED v2.2 (Table 2). However, LEED v3.0 has included a new credit under the category: ‘regional priority’. Within the categories, requirements for the credits in the category: ‘innovation in design’ has remained completely unchanged in LEED v3.0 from that of LEED v2.2. In terms of prerequisites for LEED v3.0, requirements for half of the prerequisites (50%) were found to be unchanged, while that of 37.5% has become more demanding (Table 3).

Table 1. Summary of modification of credits in LEEDv3.0 from LEEDv2.2

	Credits	More Demanding	Less Demanding	Unchanged
Sustainable Sites	14	2 (14.3%)	1 (7.1%)	11 (87.5%)
Water Efficiency	3	1 (33.3%)	0	2 (66.7%)
Energy & Atmosphere	6	1 (16.7%)	1 (16.7%)	4 (66.7%)
Materials & Resources	8	0	2 (25%)	6 (75%)
Indoor Environmental Quality	15	3 (20%)	0	12 (80%)
Innovation in Design	2	0	0	2 (100%)
Regional Priority	1 (New)	-	-	-
TOTAL	49 (100%)	7 (14.3%)	4 (8.2%)	37 (75.5%)

Table 2: Summary of modification of prerequisites in LEEDv3.0 from LEEDv2.2

	Prerequisite	More Demanding	Less Demanding	Unchanged
Sustainable Sites	1	0 (0%)	0	1 (100%)
Water Efficiency	1 (New)			
Energy & Atmosphere	3	1 (33.3%)	0	2 (66.7%)
Materials & Resources	1	0 (0%)	0	1 (100%)
Indoor Environmental Quality	2	2 (100%)	0	0 (0%)
Innovation in Design	-	-	-	-
Regional Priority	-	-	-	-
TOTAL	8 (100%)	3 (37.5%)	0	4 (50%)

Table 3 illustrates the credit segregation patterns based on improvements made in the measurement criteria between LEED version 2.2 and version 3.0. Each category demonstrates that most of the credits are designed to be performance based. Furthermore, there is an evident shift of trend from either prescriptive to system based, or from performance based to system-based, as indicated in the table with the shaded cells. But, between the versions 2.2 and 3.0 most of the categories demonstrate similar observed trends, except for the category Energy & Atmosphere (EA) and Indoor Environmental Quality (IEQ). A few credits within the EA and IEQ have been improved in the version 3.0; they demonstrate more performance-based characteristics. As a result the percent difference observed between the versions is not more than 22% and 6% respectively for both the credits EA and IAQ. Thus, it is observed that there is still ample scope for recommending the credits as system-based, which in literature has been defined as holistic approach towards sustainability, for future versions of LEED.

Table 3: Summary of changes made in measurement criteria between LEED v2.2 and LEEDv3.0

			Version 2.2			Version 3.0		
			Prescrip- ive	Perform- ance	System- based	Prescrip- ive	Perform- ance	System- based
Sustainable Sites		26 Pts.						
Prereq 1	Construction Activity Pollution Prevention	Required		√			√	
Credit 1	Site Selection	1				√		
Credit 2	Development Density & Community Connectivity	5		√			√	
Credit 3	Brownfield Redevelopment	1				√		
Credit 4.1	Alternative Transportation - Public Transportation Access	6		√			√	
Credit 4.2	Alternative Transportation - Bicycle Storage & Changing Rooms	1				√		
Credit 4.3	Alternative Transportation - Low-Emitting and Fuel-Efficient Vehicles	3		√			√	
Credit 4.4	Alternative Transportation - Parking Capacity	2		√			√	
Credit 5.1	Site Development - Protect or Restore Habitat	1		√			√	

Credit 5.2	Site Development - Maximize Open Space	1		√	√		√	√
Credit 6.1	Stormwater Design - Quantity Control	1		√	√		√	√
Credit 6.2	Stormwater Design - Quality Control	1		√	√		√	√
Credit 7.1	Heat Island Effect –Nonroof	1		√	√		√	√
Credit 7.2	Heat Island Effect – Roof	1		√	√		√	√
Credit 8	Light Pollution Reduction	1		√			√	
Water Efficiency		10 Pts.						
Prereq 1	Water Use Reduction	Required	Credit not introduced in v. 2.2				√	√
Credit 1	Water Efficient Landscaping	2 to 4		√	√		√	√
Credit 2	Innovative Wastewater Technologies	2		√	√		√	√
Credit 3	Water Use Reduction	2 to 4		√	√		√	√
Energy & Atmosphere		35 Pts						
Prereq 1	Fundamental Commissioning of the Building Energy Systems	Required	√				√	
Prereq 2	Minimum Energy Performance	Required		√			√	
Prereq 3	Fundamental Refrigerant Management	Required		√			√	
Credit 1	Optimize Energy Performance	1 to 19	√	√			√	√
Credit 2	On-Site Renewable Energy	1 to 7		√			√	
Credit 3	Enhanced Commissioning	2			√			√
Credit 4	Enhanced Refrigerant Management	2		√			√	
Credit 5	Measurement & Verification	3	√				√	
Credit 6	Green Power	2	√				√	
Materials & Resources		14 Pts						
Prereq 1	Storage & Collection of Recyclables	Required	√				√	
Credit 1.1	Building Reuse, Maintain Existing Walls, Floors & Roof	1 to 3	√				√	
Credit 1.2	Building Reuse, Maintain Interior Nonstructural Elements	1	√				√	
Credit 2	Construction Waste Management	1 to 2	√				√	
Credit 3	Materials Reuse	1 to 2		√			√	
Credit 4	Recycled Content	1 to 2		√			√	
Credit 5	Regional Materials	1 to 2		√			√	
Credit 6	Rapidly Renewable Materials	1	√				√	
Credit 7	Certified Wood	1	√				√	
Indoor Environmental Quality (IEQ)		15 Pts						
Prereq 1	Minimum Indoor Air Quality Performance	Required		√			√	
Prereq 2	Environmental Tobacco Smoke (ETS Control)	Required		√			√	
Credit 1	Outdoor Air Delivery Monitoring	1		√	√		√	√
Credit 2	Increased Ventilation	1		√	√		√	√
Credit 3.1	Construction IAQ Management Plan - During Construction	1	√				√	
Credit 3.2	Construction IAQ Management Plan - Before Occupancy	1	√				√	
Credit 4.1	Low-Emitting Materials - Adhesives & Sealants	1		√			√	
Credit 4.2	Low-Emitting Materials - Paints & Coatings	1		√			√	
Credit 4.3	Low-Emitting Materials - Flooring Systems	1	√				√	
Credit 4.4	Low-Emitting Materials - Composite Wood & Agrifiber Products	1		√			√	
Credit 5	Indoor Chemical & Pollutant Source Control	1					√	
Credit 6.1	Controllability of Systems - Lighting	1					√	√

Credit 6.2	Controllability of Systems - Thermal Comfort	1			√			√
Credit 7.1	Thermal Comfort – Design	1			√			√
Credit 7.2	Thermal Comfort – Verification	1			√			√
Credit 8.1	Daylight & Views - Daylight	1			√			√
Credit 8.2	Daylight & Views - Views	1			√			√

Recommendations for Future Versions of LEED

The essence of this study was to realize how LEED version has gone through a transformation from prescriptive to system-based. It was observed that the shift to system-based was marginal and has possibility that future versions prescribe system-based approach. Based on the analysis of the credit segregation table and the problem identified through literature review, the following suggestions may be useful for developing the future versions of LEED:

- Incorporation of system-based measurement for achieving credits. Based on the comparison of credits/prerequisites, it would be beneficial to apply stringent pre-requisites to help filter out facilities that may be violating certain basic sustainable fundamentals. For example, facilities built on wetlands or green land should not be examined for certification.
- Certain credits that have been widely utilized over the years can be applied to prerequisite section.
- In the section for EA, credits for measurement of energy use can be increased in occupied facilities to comply with the predicted design energy savings. This will confirm if the initial design efficiency measures are effective. Weightage of measurement for certain critical credits can be elevated that are crucial for energy reduction in comparison to few others that may be trivial. For example, the water efficiency credits that can be system-based could weigh more than certain other credits such as having bicycle storage and changing rooms.
- In the section for material and resources, more credits can be introduced for application of intelligent and innovative waste management strategies, both during construction as well as occupancy period.

CONCLUSION

The sustainable design and construction movement is an increasingly important topic in the construction industry forcing the rethinking of past wastefulness. Sustainable construction aims to prevent environmental degradation and improve the stewardship of the resources for future. In order to implement sustainable construction, a number of sustainability rating systems are in place nationally as well as regionally in the United States. Among them, LEED is currently the dominant system in the United States market and is being adapted to multiple markets worldwide. The aim was to identify the trend of changes incorporated in the most recent version of LEED (LEED v3.0) rating system when compared to the preceding version (LEED v2.2). While this analysis is only a starting point for examining the development of LEED rating system, it leads to interesting results. It

was realized that the requirement of majority of the requirements for the credits have remained unchanged in LEED v3.0 in comparison to LEED v2.2 with a few exceptions. Thus, it is evident that the latest version of LEED rating system has incorporated some more demanding and performance and system-based requirements without any radical modifications from the preceding one.

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