

Technical Attributes of LEED Rating System: Green Building Innovation in India

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Abstract

Green buildings as an innovation provide with energy-efficient and environment friendly buildings to society. Green buildings have made slow progression in Indian cities. One of the popular rating systems for commercial buildings in India is Leadership in Energy and Environmental Design (LEED) with significant presence in various metro cities. Using a dataset of LEED-certified buildings in Mumbai the paper presents technical attributes of LEED certification. The green certification underwent different version improvements and all through had seven defined categories under which points or credits can be taken for sustainability. The paper consolidates these seven categories into two major categories based on primary motivation for undertaking green certification. Energy-efficiency and environmental benefits are the primary reasons for undertaking green certification. The paper also concludes that energy-efficiency has been the dominant motivation for certification in Mumbai's office buildings whereas environmental benefits were dominant motivation for certification in Hotel buildings of Mumbai

Keywords: Green Building Innovation, Energy-efficiency, Environmental benefits, LEED rating systems, Commercial buildings

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I. Introduction

India is undergoing a long-term construction boom in its major cities. According to the World Economic Forum [1], India will be the fastest-growing economy in the world, with its cities contributing 70% to its gross domestic product (GDP). It is estimated that the level of construction in India will surpass that of China and USA by the year 2030 [2]. The services sector in Indian cities needs commercial buildings, whereas the cities are facing severe resources challenges, pollution and urban sprawl. The solution lies in the development of environment friendly green-rated buildings; an innovation that can mitigate the resource challenges, high energy

consumption and pollution challenges that our cities face today.

In recent years, the idea of "green" building construction in Indian cities is gaining momentum. As defined by Indian Green Building Council [3], a green building is the one that uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for the occupant as compared to a conventional building. A green building is environmentally responsible throughout the building lifecycle. One of the famous green building rating system in the world is Leadership in Energy and Environmental Design (LEED) rating system, with presence in 165 countries and more than 90,000 building

projects already registered or LEED-certified worldwide [4]. The LEED rating systems came to India in 2001, and the first commercial building certified was CII-Sohrabji Godrej Green Building Centre (CII-Godrej GBC) in Hyderabad [5]. More than 95% of green buildings in India are commercial green buildings and the LEED rating system has major market share in private green commercial buildings of India.

The objective of this research is to find out the technical attributes of the LEED rating system, which as a green building innovation spread to major US coastal cities in 1999. LEED is a scoresheet based rating system where the project gets credit or points for sustainability features incorporated in the building, and finally a rating level and score as a measure of sustainability. The first rated green building in the history of India, CII-Godrej GBC achieved LEED platinum certification with a score of 56 out of 59 points in 2003. From 2003 onwards, this innovation spread slowly to major metro cities, and now India has achieved five billion square feet of green building footprint [6]. This footprint is mostly of commercial buildings where LEED has a reliable brand name and market presence. The paper details the various rating types, versions, rating level, major certification categories present in LEED rating systems. The paper concludes that energy efficiency and environmental benefits are the essential benefits of the LEED rating system. The paper also recommends that green building innovation diffusion and contribution should be studied in major cities of India.

II. Data

The authors analysed the LEED-certified commercial buildings database of India. The green building certified dataset of Mumbai region is the sample considered for understanding the technical attributes of LEED certification. The spread of these green-certified buildings in the Mumbai region is represented in Figure 1. Mumbai region database as of May 2018 has more

than 89 LEED-certified projects out of a total of 156 projects registered so far.

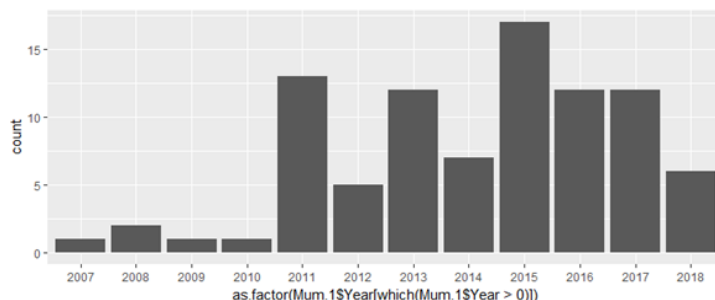


Figure 1: Green Building certification yearly progress in the Mumbai region

The year 2015 has been the best in terms of the number of certification, and there is a healthy increase in the number of registered projects. The first building to be certified in the Mumbai region was B.G. House which was platinum certified in the year 2007.

LEED Versions and types

While looking at Mumbai dataset, we found different LEED versions during different years of certifications. LEED over time has undergone various improvements in its scoresheet and performance measurement, which are presented by different versions. The first building in Mumbai region was certified under Version v1.0 pilot after which Version 2.0 took over. There are a total of seven versions of the LEED rating system so far and as per Figure 2 version v2009 and v2.0 are the most popular versions in the Mumbai region. The current version is LEED v4, and there is new version LEED v4.1 up on the LEED website.

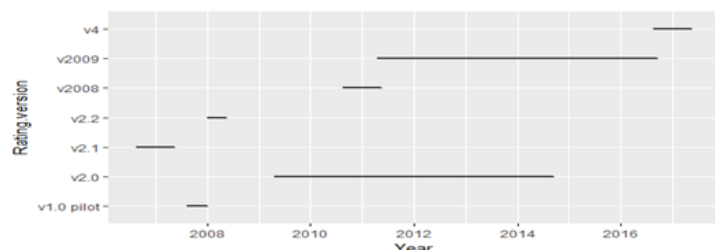


Figure 2: Different LEED version buildings prevalent in Mumbai region

One of the popular rating types is Commercial Interiors certification which is taken by the tenant company for the space it intends to occupy in a given building. In the Mumbai region, 65% of the certified projects are LEED Commercial interiors certification which highlights the awareness and preference of tenants towards occupying green buildings. LEED commercial interiors certification can be taken for a space in any conventional building, or LEED Core or Shell certified building.

The second type is LEED Core and Shell taken by the owner of the building for the common areas, facilities and structure of the building where the tenant has no say. Core and Shell projects are second highest in the Mumbai region in terms of numbers and the highest in terms of square feet area certified. Core and shell buildings do not have any interiors work done and are usually multi-tenanted buildings where the interior work is done by the tenant as per their specifications. The third type of rating system is Existing Building LEED rating system which is taken by the owner or investor in the building. These buildings are conventional buildings which undergo retro fitment or refurbishment to convert to a green building.

The last rating type is LEED New Construction, where the owner undertakes the design and construction of a new green building from scratch. LEED new construction projects may have significant capital expenditure depending on rating level attempted or if more active design strategies are proposed compared to passive design strategies. Commercial buildings have been made for the owner's occupation or for investment purpose where the objective is to lease or sell the building to investor; who further earns rental incomes. Figure 3 shows the certified area that is under each LEED rating type. The certified area is categorised as owner-occupied area and tenant-occupied area. Figure 3 shows that even though Commercial interiors has a maximum number of projects it is the Core and Shell

projects which have the maximum certified area in the Mumbai region. There is the right amount of existing building certified area, but the new construction certified area is less as most new projects constructed are small to medium in size.

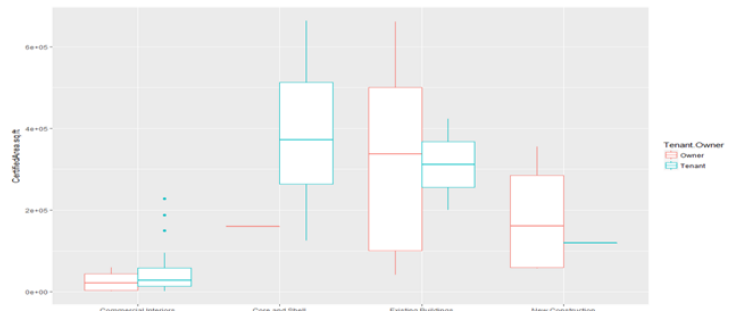


Figure 3: Green certified area in sq.ft present for each LEED rating type in Mumbai region

III. Research Methods

The Mumbai dataset was analysed using statistical software to understand the technical and commercial attributes of the LEED rating system. The LEED scoresheet is first analysed based on earlier literature work done and based on the emphasis and motivation surrounding the development of the LEED rating system. To compare different LEED versions we first had to normalise the different version scores out of a score of 100. The normalised score is represented as LEED Green score and the formula for all the versions is given below.

$$\text{LEEDGreenScore} = \frac{\text{CertificationScoreAchieved}}{\text{MaximumscoreoftheLEEDVersion}} \times 100$$

To further compare Energy score with LEED Green Score we normalised the Energy score also as done with LEED Green Score

$$\text{EnergyefficiencyScore} = \frac{\text{Energy\&Atmosphere(E\&A)categoryscore}}{\text{MaximumscoreofE\&AcategoryinthatVersion}} \times 100$$

We have further used R programming software to draw relevant graphs, and patterns required for our objective. Density plot function is used in R Programming to find the emphasis of Energy and Environmental benefits score in the final score.

The method is visual representation using ggplot functions in R Programming. The next two sections will present the key technical attributes of the LEED rating system; after which the paper presents the findings and concludes the research objective.

Findings and Discussions

LEED Rating system - Major categories and Rating levels

LEED Scoresheet has seven categories under which the credits or points are given. One of the most awarded LEED version in India is v2009 which has a maximum score out of 110 points. These 110 points are distributed in seven categories, and further analysis has classified categories into Major category or Minor category as per below Figure 4

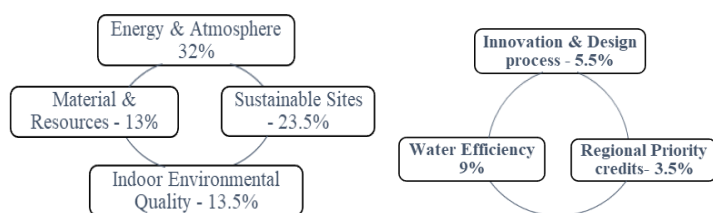


Figure 4: Major category (Left side) and Minor category (Right side)

The major category contributes more than 10% to the maximum score of 110, and minor category contributes less than 10% to the maximum score of the version. As per figure, we find that Energy & Atmosphere category contributes 32% points and is the single biggest category. The points in this category contribute to the energy efficiency of the buildings. The major category also has three more categories, as shown in Figure 3, which contribute to indoor environment as well as outdoor environment where the building located. We can merge these categories into single category of Environmental factor category as per Figure 5.

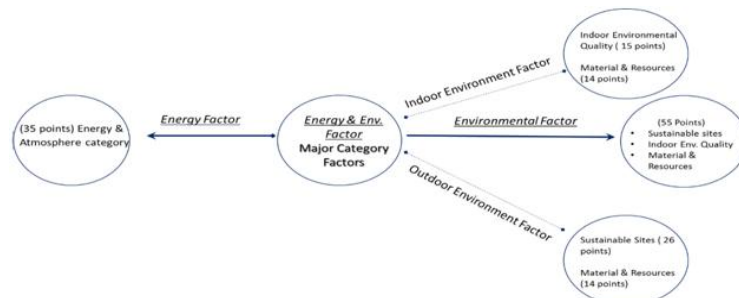


Figure 5: Major category classification - Energy efficiency and Environmental benefits

The environmental factor category points bring benefits to the indoor environment and outdoor environment and can be classified as Environmental benefits category.

Environmental benefits category has 55 points after the merger and Energy & Atmosphere category has 35 points as per LEED v2009 version. The building projects based on the driver for certification will have credits from Energy and Environmental benefits category. If for a building project energy efficiency is more important than environmental benefits, the percentage score of Energy and atmosphere category will be higher than the total percentage score that the project achieves.

The highest rating level in the LEED rating system is Platinum; which is given to a project or building that has achieved 80 points or more in terms of credits in the LEED scoresheet per version v2009. The second-highest rating level is Gold, which is achieved by projects scoring between 60 to 79 points. Silver is the third-highest rating level for project scores between 50 – 59 points; whereas certified level has project scores between 40-49 points. Mumbai region has 61% gold-certified projects, followed by 36% platinum-certified projects. Rest of 3% of projects are either silver or certified

Most of the projects in Mumbai region are higher certified, which is Gold or Platinum rating level. We further conducted statistical analysis for finding the reason for higher certification level achieved by projects in the Mumbai region.

LEED and Energy efficiency scores in the Mumbai region

Energy efficiency and environmental benefits are the major drivers for green certification, which is represented in Figure 5. We want to know that for Mumbai region which of these two benefits have driven buildings more towards green certification. For finding this we compared the LEED green score with Energy score found using formula presented in methods section. Below table shows the range of LEED green score for each rating type.

Table 1: LEED Score range for various certification level achieved by Mumbai projects

Normalized Green Score (\$ GreenScore.100)	Rating Type
36 - 45	Certified
46 - 54	Silver
55 - 72	Gold
73 - 88	Platinum

LEED green score was superimposed on Energy score using density plot function in R Programming represented in Figure 6. There are two peaks in the graphical representation of LEED Green score (Figure 6) the first one for Gold level and the second one for Platinum level.

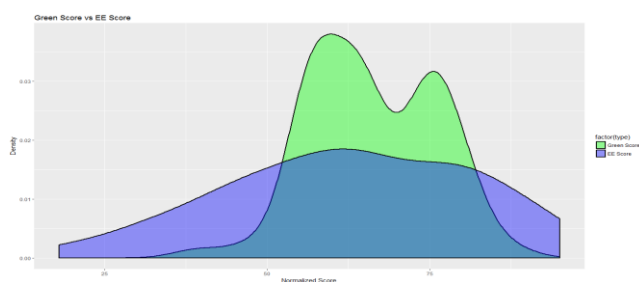


Figure 6: Density plot of LEED Green Score vs Energy score

As we can see from the graph Energy score graph is more spread out and has a higher standard deviation as compared to the LEED Green Score graph. There are few projects where the emphasis is high on energy efficiency and few projects where energy score is low compared to LEED

green score. These projects are mostly green certified for environmental benefits. Looking at the dataset, we found that all Hotels have higher environmental scores compared to energy scores, whereas in office buildings, the emphasis is on energy efficiency. As per Figure 6 the highest normalised score projects are high on the energy score rather than environmental benefits. This justifies the extra capital expenditure done for achieving the highest score as benefits will accrue as energy savings.

IV. Conclusion

The analysis and findings give us energy efficiency and environmental benefits as two essential motivations to go for certification. The paper also presents the vital technical attributes that LEED rating system present. For the Mumbai region we conclude that higher scored projects have more emphasis on Energy efficiency compared to environmental benefits. However it is the hotel projects that we see that environmental benefits are majorly emphasised compared to energy efficiency, which makes sense.

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