

Trend Analysis of LEED Certifications: Insights and Future

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Abstract: As environmental concerns grow, people are becoming more aware of energy efficiency, carbon reduction, and sustainable development. Leadership in Energy and Environmental Design (LEED) certification is currently the most widely recognized building environment assessment method connected to energy and the environment worldwide. This study explores trends for six factors (energy and atmosphere, materials and resources, indoor environmental quality, sustainable sites, water efficiency, and innovation in design) to assess four levels of LEED certification (Platinum, gold, silver, and certified) using 11,209 LEED projects in the United States. The study analyzes trends using scores of percentages of maximum points by certification level, ownership type, space type, and climate zones. With the interest in the Environmental, Social, and Governance (ESG) principle on the rise, this study contributes to a better understanding of the trends and future of LEED certification in the built environment sector.

Key words: LEED, ESG, Green building, Sustainable building, Energy efficiency

1. INTRODUCTION

ESG is an abbreviation for “Environmental, Social, and Governance.” It is a non-financial indicator for sustainability that has gained great interest in recent years. One of the key aspects of ESG management is related to carbon neutrality and energy conversion. Buildings consume a considerable amount of energy and constitute one of the major sources of adverse impacts on the environment [1]. Looking at the industries that affect energy that emits carbon and greenhouse gases, the building and real estate sectors account for about 40% of the world's total energy consumption annually [2]. As a result, building construction, operations, and maintenance have a huge impact on the environment, and many companies are increasingly interested in operating eco-friendly buildings.

Leadership in Energy and Environmental Design (LEED) is the world's most reliable and recognizable building and interior-related eco-friendly certification system developed by the U.S. Green Building Council (USGBC). Many stakeholders in the building sector are employing this certificate to validate the achievement of sustainable development, making LEED a nationally accepted benchmark for the design, construction, and operation of high-performance green buildings [3]. The LEED certification ratings are based on CO₂ reduction, water efficiency, energy savings, and indoor environmental quality. The LEED rating is also based on credit allocation from six categories which include sustainable sites (SS), water efficiency (WE), energy and atmosphere (EA), material and resources (MR), indoor environmental quality (IE), and innovation in design

(ID). To receive each credit, assessors evaluate the performance of the candidate building and award points if certain requirements from the six categories are satisfied. There are different LEED certification levels awarded depending on the number of points obtained by buildings, these being LEED Certified, LEED Silver, LEED Gold, and LEED Platinum [4]. The LEED types are also classified into New Construction (NC), Commercial Interior (CI), Core & Shell (CS), Health Care (HC), and School according to the project type.

This paper explores the level, trend, and application of the relevant points in designing green buildings in the construction industry. Previous studies used a small number of data sets to analyze the scoring characteristics of categories. This paper uses large amounts of data to analyze the overall scoring trend. Understanding the overall trend and target level by analyzing the scoring of each LEED level will be useful for stakeholders with similar goals. It will also be cost effective to determine the target level and target credit of the LEED certificate at the pre-design stage, and optimize the design accordingly.

2. LITERATURE REVIEW

Previous studies report that office buildings with Energy Star or LEED eco-labels obtain rental premium of approximately 3–5% and certified buildings have 5.4% lower operating expenses compared to similar conventional buildings [5][6]. Also, sustainable REITs have improved financial performance by acquiring LEED certificate [7].

In addition to financial indicators, intangibles such as tenant satisfaction and high rental renewal rates were also observed [7]. According to a survey of employees who moved to offices with improved indoor environments, the health and productivity of residents improved [8]. According to a quarter of Fortune 200 conglomerates surveyed in 2015, 82% said they would continue to use LEED for construction buildings over the next three years and 80% agreed that LEED is a point of communicating sustainable efforts to stakeholders [9]. Therefore, eco-certifications such as LEED can be the motivation for creating and fostering a positive corporate image. In addition to the LEED-certified benefits analysis, we reviewed the category score analysis papers. Wu et al. (2016) analyzed 5,340 NC (New Construction) v.2 projects worldwide and found that the ID category was the highest (80.1% of achievable scores) while SS, WE, and EQ categories were in the middle (57.3–68.9%) and EA and MR categories were the lowest (42.6–43.4%) [10].

Pushkar and Verbitsky (2020) studied 920 buildings in 10 U.S. states for NC v.3 (New Construction) where SS, WE, EQ, and IN categories showed moderate performance (56.0–68.3%) while EA (30%) and MR categories showed low levels (41%) [11]. According to Pushkar (2020), the results of the analysis of LEED CI (Commercial Interior), showed the WE and EA categories demonstrated low achievement at all four certification levels [12]. Da Silva and Ruwanpura (2009) studied 42 LEED New Construction (NC) projects in Canada where the highest achievement rates were observed for ID and WE categories and the lowest for EA and MR categories [3]. Pushkar (2020) analyzed the NC v.4 (New Construction) in the U.S, and found that SS and EA were achieved at (low/medium/high/very high) levels for each certification (certified/silver/gold/platinum). In both the SS and EA categories, the consistency across the projects increased with each certification level. Therefore, they concluded that the SS and EA categories were well-designed [13]. Additionally, Shaaban and Neama (2012) studied only the EA category in detail and found that this category for 1,500 buildings of LEED NC 2009 showed similar trends in silver and gold but differed in platinum. In the EA category, investors observe that energy efficiency and field energy are optimized but refrigerant management credits are almost omitted [15]. This paper explores the overall LEED trend (by certification level, climate region, ownership, and space type) using LEED 2009 bulk data from the USGBC website.

3. LEED DATA ANALYSIS

Through this analysis, the target level of certification and the strategies for each category could be identified. To obtain LEED certification, certain scores must be obtained in the EA, IE, SS, MR, WE, and ID categories. We used six categories of score published in USGBC. LEED certification can be obtained in one of the four stages, Certified, Silver, Gold, and Platinum by receiving a certain score. A total of 11,209 LEED 2009 buildings in the U.S. were used to analyze the data by building type (NC type, CI type, CS type, Schools type, HC type) using USGBC online data. Additionally, this paper explores the overall trend (by certification level, climate region, ownership, and space type) for LEED 2009 types. The study also looked at trends for six categories for all LEED types.

Table 1 shows the maximum scores for the six main categories of LEED. Each category's maximum score is different and varies slightly by LEED type. For example, the EA category's maximum score for NC 2009 type is 35, while the EA maximum score for CI 2009 type is 37. By totaling the scores received from all categories, four different certification levels can be achieved: certified (40-49 points), silver (50-59 points), gold (60-79 points), and platinum (above 80).

Table 2. LEED 2009 credits for each category based on different building types

Category \ LEED Type	NC 2009	CI 2009	CS 2009	Schools 2009	HC 2009
EA	35	37	37	33	39
MR	14	14	13	13	16
IE	15	17	12	19	18
SS	26	21	28	24	18
WE	10	11	10	11	9
ID	6	6	6	6	6

Since all six categories have different maximum scores, the “Percent of maximum points (PMP)” scoring method was used [1]. PMP is calculated as the percentage of points obtained from the total number of possible points for each category is used to measure the scoring objectively. As shown in equation 1, “Category max” is the maximum score obtained from a particular category and “Category x” is the score obtained from a particular building [1]. For example, for NC 2009, if a building scored 11 points in the EA category which has a maximum score of 35, the PMP in this category is 31%.

$$PMP(\text{Percent of maximum points}) = \frac{\text{Category}_x}{\text{Category}_{max}} \quad (1)$$

$$\text{ex) } 31\% = \frac{11}{35}$$

As a second step (2), the PMP was normalized because there was a category that scored more than a maximum score. For example, getting 7 points in the ID category where the maximum score is 6 points. Upon receiving additional points, PMP will exceed 100%. Thus, it was a process to set the PMP between 1 – 100%.

$$\text{Normalization} = \frac{PMP \text{ Value} - PMP \text{ Mean}}{PMP \text{ Standard deviation}} \quad (2)$$

4. RESULTS

This study looked at the overall trends of six categories by certification level, climate region, space type, and ownership type. At the certification level, the trends of six categories were analyzed depending on the certification levels (Certified, Silver, Gold and Platinum). ID category had the smallest maximum score and the analysis showed that it seems to be achieved easily as it showed high PMP. The EA category, which has the highest proportions that includes credits like renewable energy, received the highest score rating in the platinum level because it demands more cost and time [14].

The trends of six categories were also analyzed using 8 climate zones. At zone 8, the ID category trend went down while in other zones it maintained the highest scores. Six categories were also analyzed by building space type. The PMP of the residential type spiked especially in the SS category. Additionally, the trends of six categories were analyzed by building ownership. It was expected that the government buildings would be sensitive to environment changes and have high PMP, but the results displayed differently.

4.1. Certification levels

As shown in Table 2, the scoring trends of six categories for each of the four certification levels all showed similar upward trends. However, in the EA category, the PMP in gold level was 48%, whereas the PMP in platinum level sharply increased to 79%. The EA category includes the use of carbon-reducing technology or alternative energy sources such as solar power, wind power, and geothermal heat as renewable energy, which is associated with high technical risk and cost. Therefore, there are costs and technical barriers to consider when compared to other categories. This result align with previous studies. According to Peng, Wu and Yu [15], Receiving platinum level involves a lot of investment and requires capabilities such as recycling or energy savings. Gurgun and Arditi [1] argued that “gold and silver certification applicants prefer not to use the points of on-site renewable energy technology because these technologies require additional large investments.”

In Table 2, MR category was the lowest, only receiving on average 34%, considering all certification levels. Because, 64% of the total data set are NC type, this makes it difficult to score the MR category, which includes credits from reusing materials for buildings [3]. NC type generally does not score high, because most new buildings do not use recycle materials, products, or furnitures. Typically, new construction buildings do not have the option to reuse or integrate old buildings, thus limiting NC type projects from earning points [13].

Table 3. Average Score of PMP

Category Level	EA	MR	IE	SS	WE	ID
Certified	27%	24%	38%	36%	46%	57%
Silver	33%	32%	48%	47%	46%	63%
Gold	48%	36%	55%	55%	51%	78%
Platinum	79%	43%	66%	69%	62%	92%
Average	47%	34%	52%	52%	51%	73%

4.2. Climate

In Figure 1, the ID category, which always scores high in almost all projects, scored the lowest in Zone 8. The WE category scored the highest PMP in Zone8. In this Zone, the WE category is higher than the ID category due to high temperature. In hot regions, Water Efficiency can be interpreted as more important than Innovative Design. The criteria for climate classification are shown in Table 3. Regional issues can be influenced by climatic characteristics [17], so LEED

suggests that categories should be effectively designed to reflect the environment and fit local characteristics.

Table 4. Hardiness zone

Days over 86° F	Climate Zone
0	1
1–7	2
7–14	3
14–30	4
30–45	5
45–60	6
60–90	7
90–120	8

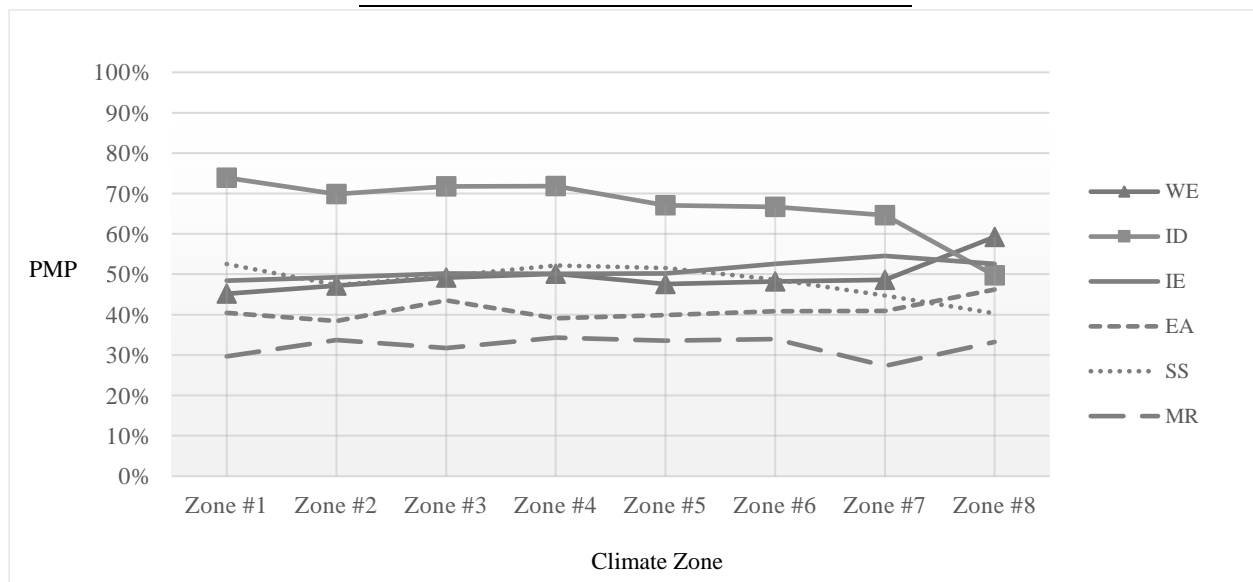


Figure 1. Climate zone

4.3. Space type

The PMPs of six categories were checked by its space type. The trend showed that the ID category always showed a high PMP and the MR category always displayed a low PMP. As shown in Figure 2, the MR category scored, on average about 33%, resulting in a low overall score. It showed a PMP of 69% in Multi-Family Residential and 33% in Warehouse and Distribution. The SS category showed the largest standard deviation. The SS category includes open space equal to 30% of the total site area. Open spaces must be designed for one or more of the following uses: social gathering, gardening, physical activity, or natural habitat that includes elements for human interaction [18]. It also includes the activation of alternative transportation tools such as installing a bicycle depository and appointing land such as to avoid land development harmful to the environment [3]. Thus, the trends for residential spaces where people spend most of the time and for warehouses appeared different.

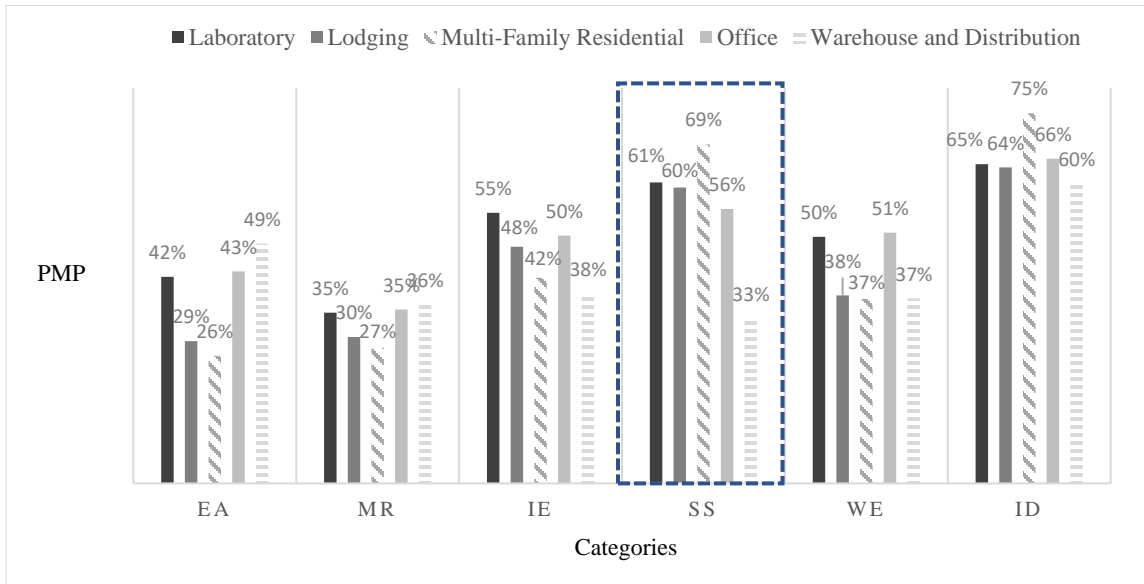


Figure 2. Space type

4.4. Ownership type

The PMPs depending on ownership were checked for 6 categories. The ID category showed a high PMP and the MR category showed a low PMP. It was expected that the government which has to cope rapidly with energy and environment constraints to have a high PMP at all points, but the government rather showed a flat trend. It is similar with the assertion in [19] which analyzed a trend of no signaling from the government agencies at gold and platinum certifications as it might be seen as spending tax money for public buildings.

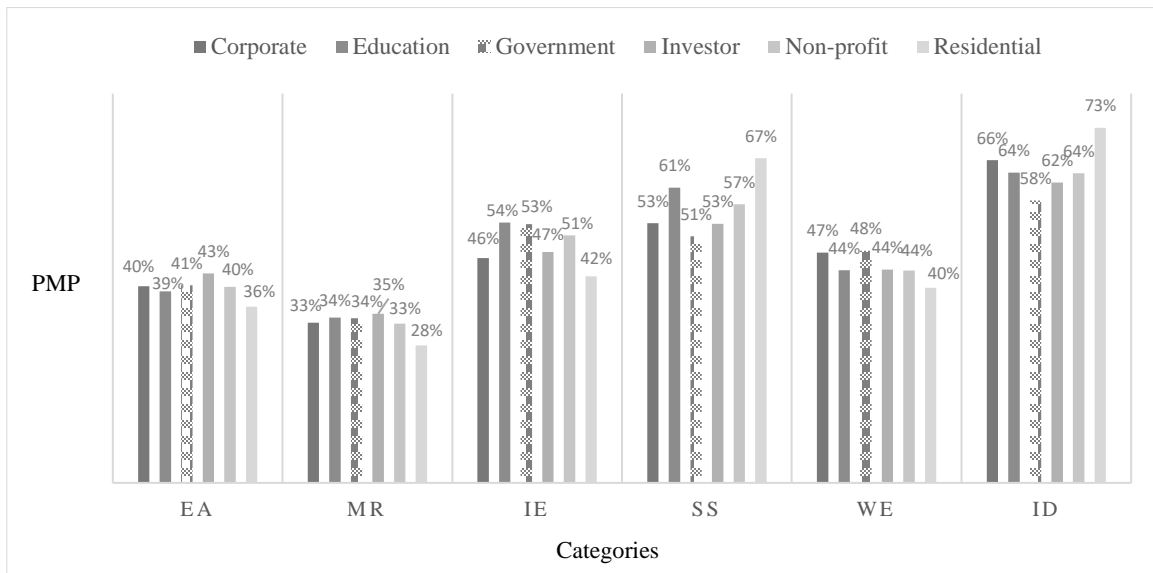


Figure 3. Ownership type

5. Conclusion

Based on large data for 11,209 LEED 2009 Type certifications in the U.S., this study analyzed trends by certification level, climate area, space type, and ownership type.

For the Certification level trend, the EA category has the highest maximum score, and it was difficult to achieve high scores. This category also requires technology and cost investment, and as a result, implies a considerably high barrier to satisfy this category. On the other hand, because ID has a maximum score of 6, this category does not carry as much weight as the EA category, and it seems to always yield a high score and is seen as easy to obtain a maximum score. All certification levels displayed a low scoring trend in the MR category related to the building and material recycling/re-use as about 60% of total data were NC type.

For the climate level trend, the ID category showed a low PMP in the hottest zone. But the PMP for the WE category was the highest. It seems that physically efficient category was preferred over design innovation. Accordingly, it is suggested that it might be inappropriate to compare jointly the zones with different climate features when comparing LEED certified buildings.

For the space type, residential and warehouse displayed differently in the SS category. The big difference was seen between the house where people spend most of their time and the warehouse which is used to store products and materials. With regards to ownership type, we expected that the government would be in the forefront coping with energy and environment constraints to have a high PMP at all types. On the contrary, the government showed a low trend.

This study analyzed LEED patterns to examine the LEED scoring trend from a macro level. Further trends can be identified by analyzing granular LEED patterns.

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