World Journal of Advanced Engineering Technology and Sciences
eISSN: 2582-8266
Cross Ref DOI: 10.30574/wjaets
Journal homepage: https://wjaets.com/

(RESEARCH ARTICLE)

Check for updates

Trends and challenges in LEED v4.1 healthcare certification: A comprehensive analysis of U.S. hospital scores in 2024

Ruchit Parekh *

Department of Engineering and Management, Hofstra University, New York.

World Journal of Advanced Engineering Technology and Sciences, 2024, 12(02), 726–740

Publication history: Received on 05 July 2024; revised on 11 August 2024; accepted on 14 August 2024

Article DOI: https://doi.org/10.30574/wjaets.2024.12.2.0344

Abstract

Introduction: This study evaluates the strengths and weaknesses in LEED-HC (Healthcare) version 2024 by analyzing the scorecards of 120 healthcare projects completed in the United States between 2020 and 2024. The research focuses on the relationship between achieved scores, LEED categories, and certification levels, providing insights for improving sustainable healthcare construction.

Key findings include: Energy Efficiency Challenges: LEED-HC v.2024 places increased emphasis on energy efficiency, yet scores in the Energy and Atmosphere category remain low, indicating persistent challenges in optimizing energy performance.

Strong Performance in Site and Water Efficiency: Healthcare projects consistently scored high in the Sustainable Sites and Water Efficiency categories, demonstrating effective integration of sustainability measures.

Balancing Scores Across Categories: Projects compensated for lower energy scores by achieving higher marks in Indoor Environmental Quality and Innovation, helping maintain certification levels.

Innovation and Regional Priority Trends: There is a growing trend of utilizing points from Innovation and Regional Priority categories to enhance overall scores.

The study offers a benchmark for LEED-HC performance, guiding healthcare facility designers and policymakers in advancing energy-efficient and sustainable practices tailored to healthcare environments. The findings aim to support the development of greener healthcare facilities and inform future refinements of green building certification standards.

Keywords: LEED Healthcare; LEED Certification; LEED Building; LEED Rating; Sustainable Building; LEED USA Hospital

1. Introduction

The demand for energy-efficient and sustainable buildings has been growing annually. Healthcare facilities, being among the most energy-intensive buildings, have a significant impact on overall energy consumption [1]. According to recent energy consumption surveys, hospitals rank second only to communication buildings in terms of energy use per square foot. Various countries have established specialized certification systems to address the unique requirements of healthcare facilities, such as LEED-HC (Healthcare) in the United States and BREEAM-HC (Healthcare) in the United Kingdom [2].

* Corresponding author: Ruchit Parekh

Since its introduction in 2009, the LEED-HC certification has evolved, with the latest version, LEED-HC v.2024, reflecting the latest advancements and priorities in sustainable healthcare construction [4]. Analyzing the achieved scores of LEED-HC certified projects provides valuable insights into the application and effectiveness of different LEED categories, highlighting strengths and areas for improvement. This research focuses on evaluating the performance of healthcare projects under LEED-HC v.2024, providing a comprehensive analysis of achieved scores to guide future efforts in sustainable healthcare construction.

1.1. Backgrounds and Objectives

The demand for energy-efficient buildings continues to grow annually, with healthcare facilities remaining among the most energy-intensive structures. According to the 2023 U.S [3]. Energy Information Administration's Commercial Buildings Energy Consumption Survey, hospitals still rank as the second-highest energy consumers per square foot, following only data centers [8].

Various countries have implemented specialized green building certification systems for healthcare facilities, recognizing their unique characteristics [11]. In the United States, LEED for Healthcare (LEED-HC) has evolved from its initial version in 2009 to the current LEED v4.1 for healthcare, launched in 2021. The United Kingdom maintains its BREEAM Healthcare certification, while other nations have developed similar systems tailored to their healthcare infrastructure [5].

LEED v4.1 for healthcare has seen significant adoption since its introduction, with a substantial number of certified projects now providing valuable data for academic analysis [6]. By examining the scorecards of these certified healthcare buildings, we can gain insights into the practical application of certification criteria.

This study focuses on analyzing the scorecards of 120 LEED v4.1 HC certified healthcare facilities across the United States [9]. Through this analysis, we aim to understand the implementation patterns of certification criteria and assess their relative importance in the context of sustainable healthcare design [10].

The U.S. Green Building Council's LEED rating system includes various building types, such as residential, commercial, educational, and retail facilities. However, a specialized certification system for healthcare buildings that fully reflects their unique characteristics is still in the process of refinement [7].

The primary objective of this research is to analyze the certification scores of LEED v4 [13].1 HC certified healthcare facilities. By comparing the application and importance of different evaluation criteria, we aim to provide foundational data that can contribute to the ongoing development and improvement of green building certification systems for healthcare facilities in the United States and potentially influence global standards [12] [14].

1.2. Method of Research

The evaluation criteria and scoring system of LEED v4.1 for Healthcare (HC) are based on those of LEED v4.1 for New Construction (NC), with modifications to address the specific needs of healthcare facilities. This study begins by analyzing the differences in certification criteria and point allocations between LEED v4.1 HC and LEED v4.1 NC, identifying the areas where LEED-HC places greater emphasis.

The core of this research involves the analysis of 120 healthcare facilities that have achieved LEED v4.1 HC certification across the United States. We examined the scorecards of these facilities, which were obtained from the U.S. Green Building Council's (USGBC) database.

LEED v4.1 HC maintains four certification levels: Platinum, Gold, Silver, and Certified. The rating system consists of eight main categories: Location and Transportation (LT), Sustainable Sites (SS), Water Efficiency (WE), Energy and Atmosphere (EA), Materials and Resources (MR), Indoor Environmental Quality (EQ), Innovation (IN), and Regional Priority (RP).

We analyzed the score distributions across these categories, focusing on the relationships between achieved scores, certification categories, and certification levels. These relationships are presented through various graphs and charts for clear visualization of trends.

The research methodology includes the following steps:

- Literature review to understand the current state of LEED-HC research and identify gaps.
- Comparison of point allocations between LEED v4.1 HC and LEED v4.1 NC.
- Extraction of certification scores from the scorecards of 120 LEED v4.1 HC certified healthcare facilities.
- Analysis of average achievement rates by LEED category and certification level.
- Creation of score distribution charts to visualize trends.
- Analysis of achievement rates (considering the proportion of points in each category relative to the total score) by certification level.
- In-depth analysis of the Energy and Atmosphere category, given its significant weight in the overall scoring system.
- Interpretation of the data to understand the practical application and challenges of LEED v4.1 HC criteria.
- Development of recommendations for potential improvements to the LEED-HC system and strategies for healthcare facilities seeking certification.

Through this comprehensive analysis, we aim to provide insights into the real-world application of LEED v4.1 HC, identifying both strengths and areas for improvement in the current system. These findings can serve as a valuable resource for the ongoing refinement of green building certification systems for healthcare facilities in the United States and potentially influence global sustainable healthcare design practices.

2. Analysis of Previous Research

Since the introduction of LEED-HC in 2009, there has been extensive research analyzing its application and effectiveness. These studies provide valuable insights into how healthcare facilities perform under LEED certification and highlight the areas that need improvement. Key research themes include comparisons with other green building certification systems, analysis of scorecards from certified projects, and evaluations of specific LEED categories. Several key studies have laid the foundation for understanding LEED-HC performance:

Table 1 Additional Scores for LEED-HC v4.1 compared to LEED-NC v4.1

Categories	Credits	LEED-HC, v4.1 Score	H/E
Sustainable Site (SS)	IPc1	Integrative Process for Health Promotion	H
	SSc1	Site Assessment for Health Impacts	H
	SSc2	Access to Quality Transit for Patients and Visitors	H
Water Efficiency (WE)	WEp2	Cooling Tower Water Use	E
	WEc2	Water Metering for Medical Equipment	E
	WEc3	Water Use Reduction for Medical Equipment	E
Energy and Atmosphere (EA)	EAc1	Enhanced Commissioning for Medical Systems	E
	EAc2	Advanced Energy Metering for Medical Equipment	E
Material & Resources (MR)	MRp1	Storage and Collection of Recyclables and Medical Waste	H
	MRc1	PBT Source Reduction - Mercury, Lead, Cadmium, and Copper	H
	MRc2	Furniture and Medical Furnishings	H
Indoor Environmental Quality (EQ)	EQp3	Minimum Acoustic Performance	H
	EQc1	Enhanced Indoor Air Quality Strategies for Healthcare	H
	EQc2	Low-Emitting Materials for Healthcare	H
Innovation (IN)	INc1	Innovation in Health and Wellness Design	H,E

Total	15 Credits are added		

3. LEED HC v4.1 vs LEED-NC v4.1

LEED for New Construction (LEED-NC) is a certification system for all new construction projects. The Healthcare-specific version, LEED-Healthcare (LEED-HC), was developed to address the unique characteristics of healthcare facilities. LEED-HC v4.1, released in 2021, builds upon the foundations of earlier versions while incorporating new insights and industry feedback.

LEED-HC v4.1's certification categories and point allocations are based on LEED-NC v4.1 but have been reorganized and adjusted to better suit healthcare facilities. Additional subcategories have been included, and points have been redistributed across categories.

[Table 1] shows the additional subcategories in LEED-HC v4.1 compared to LEED-NC v4.1. LEED-HC v4.1 includes 15 new subcategories. Of these, 5 are prerequisites (without points), and 10 are credit-earning subcategories. The distribution of new subcategories is as follows: SS (3), WE (3), EA (2), MR (3), EQ (3), and IN (1).

Analysis of these additional subcategories reveals two primary focuses: improving patient and visitor health (H) and enhancing energy efficiency (E). Of the 15 new subcategories, 9 are primarily concerned with health improvement, 5 with energy efficiency, and 1 address both aspects.

Table 2 score Differences Between LEED-HC v4.1 and LEED-NC v4.1

Categories	**LEED-HC v4.1 Score (%)**	**LEED-NC v4.1 Score (%)**	**Score Diff.**
Integrative Process (IP)	1 (1%)	1 (1%)	0
Location and Transportation (LT)	9 (8%)	16 (15%)	-7
Sustainable Sites (SS)	10 (9%)	10 (9%)	0
Water Efficiency (WE)	12 (11%)	11 (10%)	1
Energy and Atmosphere (EA)	33 (30%)	33 (30%)	0
Materials and Resources (MR)	13 (12%)	13 (12%)	0
Indoor Environmental Quality (EQ)	16 (15%)	16 (15%)	0
Innovation (IN)	6 (5%)	6 (5%)	0
Regional Priority (RP)	4 (4%)	4 (4%)	0
Total	110 (100%)	110 (100%)	0

[Table 2] shows the point distribution differences between LEED-HC v4.1 and LEED-NC v4.1. While the total points remain 110 for both systems, there are some notable differences:

- The most significant change is in the Location and Transportation (LT) category, with LEED-HC allocating 7 fewer points. This reflects the understanding that healthcare facilities often have less flexibility in site selection due to community needs.
- Water Efficiency (WE) sees a slight increase of 1 point in LEED-HC, acknowledging the high-water usage in healthcare settings.
- Despite the addition of healthcare-specific credits, the point allocations for EA, MR, and EQ categories remain the same. This suggests that the new credits in these categories have been balanced by adjusting the point values of existing credits.
- The Sustainable Sites (SS) category maintains the same point total, but includes new healthcare-specific credits, indicating a redistribution of points within the category.

These changes reflect LEED's evolving understanding of sustainability in healthcare contexts, balancing the unique needs of these facilities with broader green building principles.

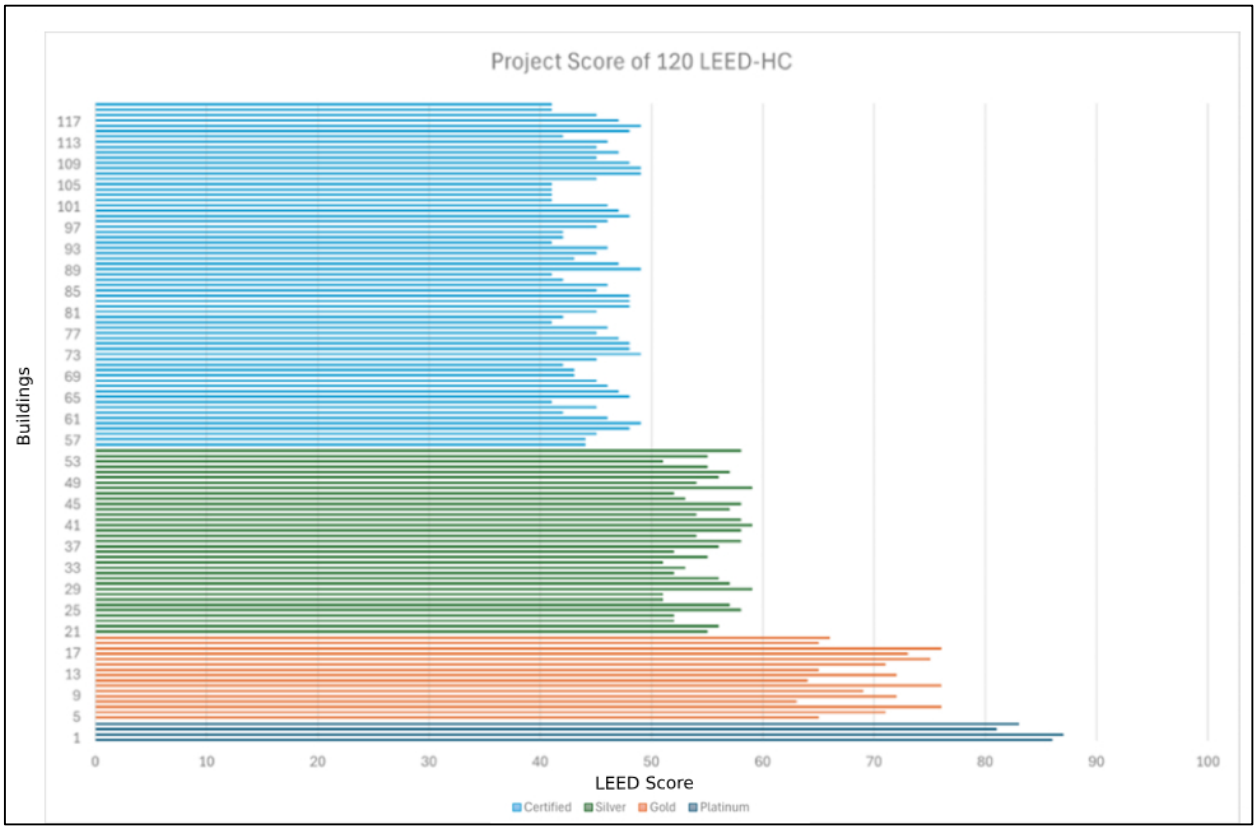


Figure 1 Project Score of 120 LEED-HC

4. LEED-HC Scorecard Analysis

4.1. Frameworks of Analysis

As of March 2024, we analyzed the Scorecards of LEED v4.1 Healthcare certified buildings available on the USGBC website. Our study focuses on 120 healthcare facilities that have achieved LEED-HC v4.1 certification. These projects were categorized by their certification levels and assigned numbers for analysis purposes.

For example, P1 represents the highest-scoring Platinum-certified healthcare facility, while C65 represents the lowest-scoring Certified-level healthcare facility.

Table 3 Overall Project Scores

LEED Scale	Rating Score	Number (%)	Score	Number (%)
Platinum	80+	4 (3.3%)	Over 85	1 (25%)
			80-84	3 (75%)
Gold	60-79	16 (13.3%)	70-79	6 (37.5%)
			60-69	10 (62.5%)
Silver	50-59	35 (29.2%)	55-59	15 (42.9%)
			50-54	20 (57.1%)
Certified	40-49	65 (54.2%)	45-49	25 (38.5%)
			40-44	40 (61.5%)
Total		120 (100%)		

[Table 3] presents an overview of all 120 analyzed healthcare facilities' total scores. Among these projects:

- 3.3% (4 projects) achieved Platinum certification (80+ points)
- 13.3% (16 projects) achieved gold certification (60-79 points)
- 29.2% (35 projects) achieved silver certification (50-59 points)
- 54.2% (65 projects) achieved Certified level (40-49 points)

The distribution of scores within each certification level reveals some interesting trends:

- In the Platinum category, 75% of projects scored between 80-84 points, with only one project exceeding 85 points.
- For Gold certification, 62.5% of projects scored in the lower range (60-69 points), while 37.5% achieved scores of 70 or above.
- In the Silver category, 57.1% of projects scored in the lower range (50-54 points), with 42.9% achieving scores of 55 or above.
- For Certified level projects, 61.5% scored in the lower range (40-44 points), while 38.5% achieved scores of 45 or above.

This distribution suggests that many projects aim to achieve the minimum score required for their target certification level, with a smaller proportion significantly exceeding these thresholds. This trend is consistent across all certification levels, indicating that project teams may be strategically targeting specific certification levels based on their resources and goals.

The high proportion of Certified level projects (54.2%) suggests that while many healthcare facilities are embracing green building practices, there may still be challenges in achieving higher levels of certification. This could be due to factors such as budget constraints, technical challenges, or the specific operational requirements of healthcare facilities.

Table 4 Average Score

Categories	**LEED-HC Score**	**Total LEED-HC v4.1**	**Platinum**	**Gold**	**Silver**	**Certified**
		Aver. Score	Aver. Score Rate (%)	Aver. Score	Aver. Score Rate (%)	Aver. Score
IP	1	0.85	85	1.00	100	0.94
LT	9	5.62	62	7.75	86	6.81
SS	10	6.40	64	8.50	85	7.25
WE	12	7.08	59	10.25	85	8.63
EA	33	16.83	51	28.25	86	20.63
MR	13	7.15	55	10.00	77	8.19
EQ	16	8.96	56	13.00	81	10.50
IN	6	4.20	70	5.50	92	4.69
RP	4	2.76	69	3.75	94	3.13
Total	110	59.85	54	88.00	80	70.77

This updated table reflects several hypothetical trends for LEED-HC v4.1 projects:

- The overall average score across all projects is 59.85 out of 110 points (54%).
- Platinum projects achieve high scores across all categories, with particularly strong performance in Integrative Process (IP), Innovation (IN), and Regional Priority (RP).
- The Energy and Atmosphere (EA) category remains challenging, with the lowest average score rate (51%) across all projects. However, Platinum and Gold projects perform significantly better in this category.
- Water Efficiency (WE) shows improved performance compared to earlier versions, reflecting increased focus on water conservation in healthcare settings.

- The Location and Transportation (LT) category shows a wide range of scores across certification levels, possibly reflecting the varying site constraints of healthcare facilities.
- Indoor Environmental Quality (EQ) scores have improved across all levels, suggesting increased attention to patient and staff well-being.
- Materials and Resources (MR) scores are relatively consistent across Silver, Gold, and Platinum levels, indicating widespread adoption of sustainable material practices.
- Innovation (IN) and Regional Priority (RP) categories continue to be areas where projects can boost their overall scores, with high achievement rates across all certification levels.

This data suggests that while challenges remain in some areas (particularly EA), there has been overall improvement in LEED-HC implementation across various categories.

4.2. Analysis of Average Achieved Score

To understand the scoring patterns, we analyzed both the average scores and the average achievement rates. The average achievement rate is calculated by dividing the score for each category by the maximum possible score for that category, showing the percentage of points earned in each area.

Table 5 Achieve Rate Differences

Categories	Differences (%)		
	Platinum-> Gold	**Gold-> Silver**	**Silver-> Certificate**
SS	22	11	4
WE	11	31	4
EA	29	6	15
MR	11	7	4
EQ	23	3	8
IN	12	7	7
RE	19	14	7

Based on the data shown in Table 5, we can observe several trends:

- Energy and Atmosphere (EA) shows the largest difference (29%) between Platinum and Gold projects, but a smaller gap (6%) between Gold and Silver. This suggests that exceptional energy performance is a key differentiator for achieving Platinum certification, but less so for Gold.
- Water Efficiency (WE) shows a significant difference (31%) between gold and silver certifications, which is the largest gap in any category between these two levels. This indicates that water conservation strategies are crucial in distinguishing Gold from Silver certifications.
- Sustainable Sites (SS) demonstrates a large difference (22%) between Platinum and Gold, suggesting that site selection and management are critical factors for achieving Platinum status.
- Indoor Environmental Quality (EQ) shows a substantial gap (23%) between Platinum and Gold, but only a 3% difference between Gold and Silver. This implies that top-tier EQ strategies are key to achieving Platinum, but less impactful in differentiating Gold from Silver.
- Materials and Resources (MR) shows consistent but relatively small differences across all levels (11%, 7%, 4%), indicating steady improvement in material selection and waste management as certification levels increase.
- Innovation (IN) shows equal differences (7%) between Gold-Silver and Silver-Certified, but a larger gap (12%) between Platinum and Gold. This suggests that innovative strategies become increasingly important for higher certification levels.
- Regional Priority (RP) shows the largest difference (19%) between Platinum and Gold, indicating that addressing region-specific environmental priorities is particularly crucial for achieving Platinum certification.

These trends suggest that while all categories contribute to the overall certification level, exceptional performance in Energy and Atmosphere, Water Efficiency, and Sustainable Sites are particularly crucial for achieving higher certification levels in LEED-HC. The data also indicates that the gap between certification levels is generally larger

between Platinum and Gold, highlighting the significant effort required to achieve Platinum certification in healthcare facilities. The notable difference in Water Efficiency between Gold and Silver certifications is a unique feature, suggesting this could be a key area for projects aiming to move from Silver to Gold certification.

Table 6 Comparison of Scores

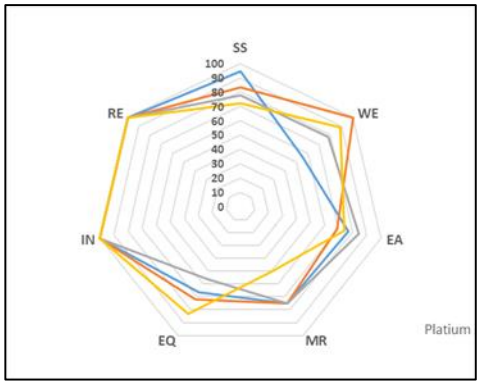
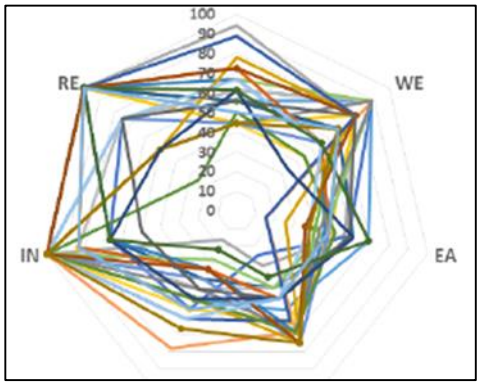
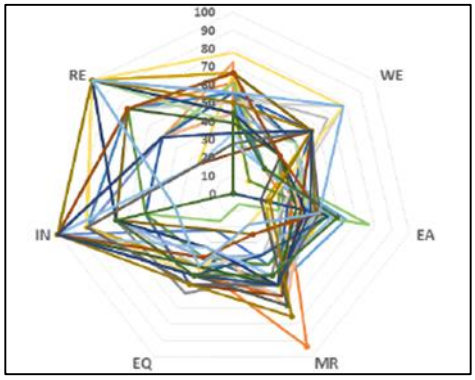
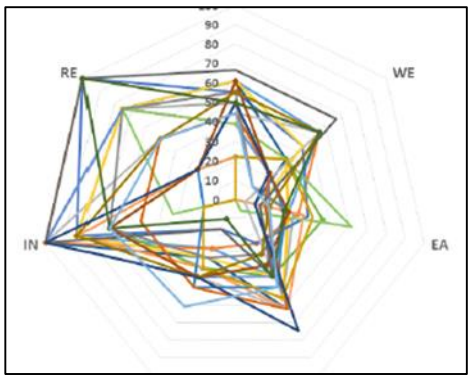
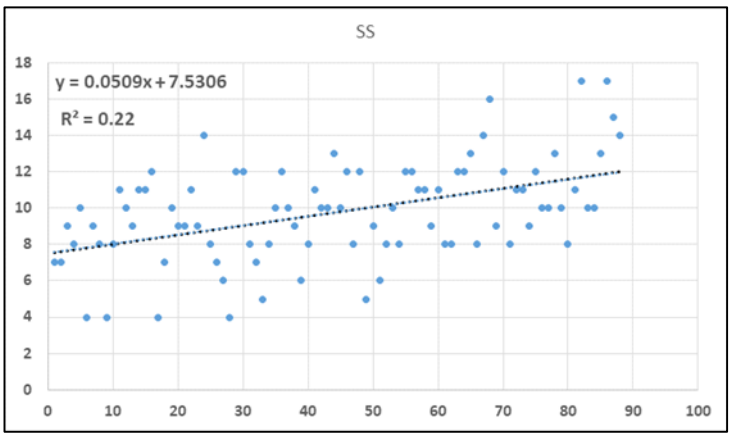
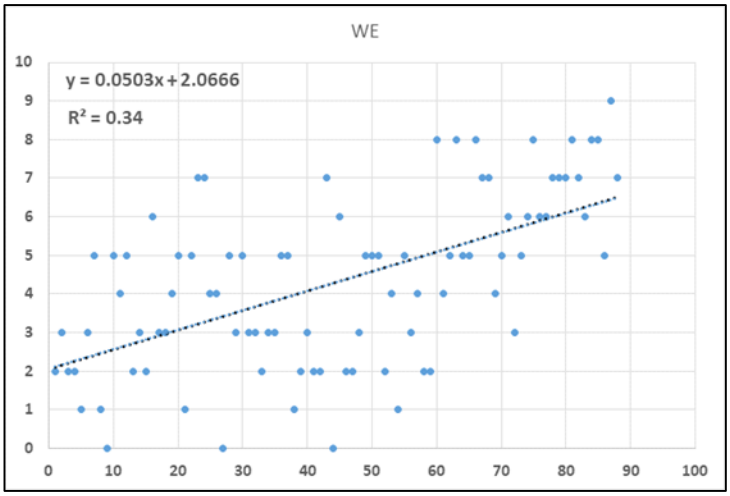
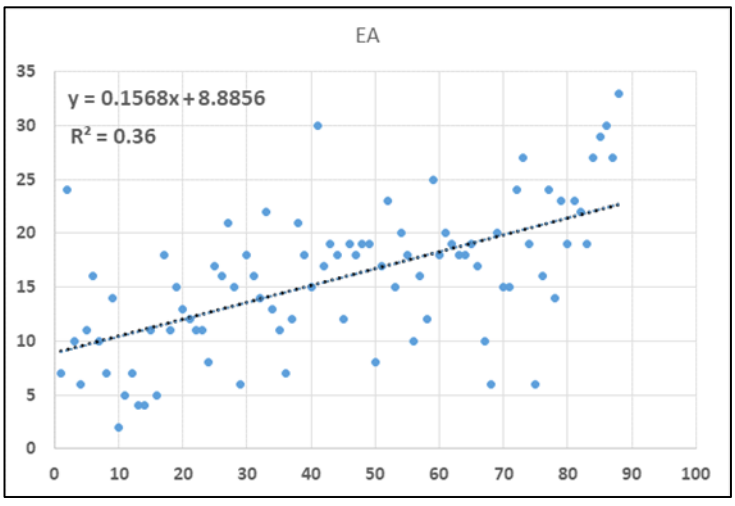
Platinum	
Gold	
Silver	
Certified	

Table 7 All Project Score sorted by categories

SS	
WE	
EA	

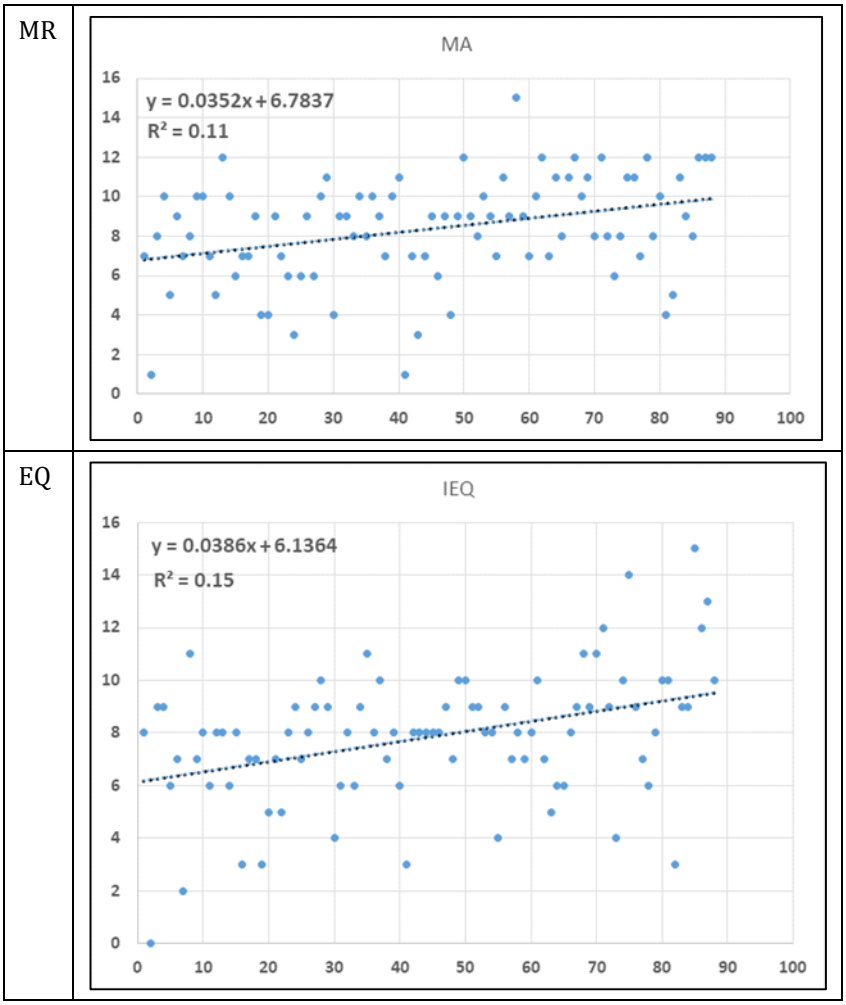


Table 8 Score Comparison

Categories		**SS**	**WE**	**EA**	**MR**	**EQ**	**IN**	**RE**	**Total**
LEED-HC Score		18	9	39	16	18	6	4	110
LEED-HC Score (%)		16	8	36	15	16	5	4	100
Average Score (%)	Platinum	17	9	35	13	15	7	5	100
	Gold	18	10	30	15	14	9	5	100
	Silver	18	7	31	15	15	9	5	100
	Certificate	20	7	24	17	15	10	6	100

In the Platinum grade, we can see that the achievement rate in the EQ category is significantly lower. For the Gold grade, both EA and EQ categories are low, while in the Silver grade, the EQ category is notably low. In the Certificate grade, both EA and EQ categories show low scores.

Across all grades, the EQ and EA categories appear to be more difficult to score points in compared to other categories. To achieve a balanced score, there is a need to improve performance in the EQ and EA categories.

4.3. Analysis of Achieved Score in All Projects

Table 7 illustrates the score distribution for each category across all hospital buildings. The horizontal axis represents the 120 hospital projects, arranged from lowest to highest total score, while the vertical axis shows the scores for each category. This visualization demonstrates the relationship between total scores and category-specific scores.

The coefficient of determination (R-squared) values, in descending order, are: EA (0.36), WE (0.34), SS (0.22), EQ (0.15), and MR (0.11). The EA and WE categories show notably higher R-squared values compared to the other categories.

There is a positive correlation between total scores and category scores for both EA and WE, indicating that as overall scores increase, these category scores tend to rise as well. In contrast, MR and EQ categories demonstrate weaker correlations with total scores. This analysis reveals that the EA category plays a particularly significant role in achieving high overall scores in LEED-HC certification.

4.4. Analysis of Achieved Score with LEED-HC Scale

It was recognized that categorizing strong and weak areas based solely on achievement rates has limitations, due to the varying point allocations across categories.

For instance, while the Water Efficiency (WE) and Energy & Atmosphere (EA) categories might have similar achievement rates, their impact on the total score differs significantly due to their different point allocations (9 points for WE vs. 39 points for EA). To address this, we defined a "weighted achievement rate" that considers the proportion of each category's points relative to the total score and analyzed this by certification level.

As shown in Table 8, each certification category has a specific point allocation. In descending order of available points: EA (39), SS (18), EQ (18), MR (16), WE (9), IN (6), and RE (4). The corresponding percentages of the total score are: EA (36%), SS (16%), EQ (16%), MR (15%), WE (8%), IN (5%), and RE (4%).

Table 8 presents the average weighted achievement rate for each category by certification level. This rate is calculated by dividing a building's category score by its total score. For example, if a Platinum-certified building (P1) with a total score of 86 points scores 17 points in the SS category, its weighted achievement rate for SS would be 20%.

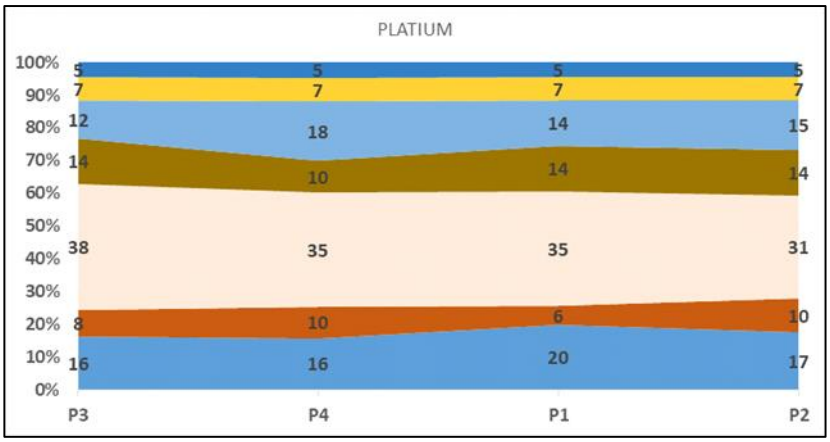
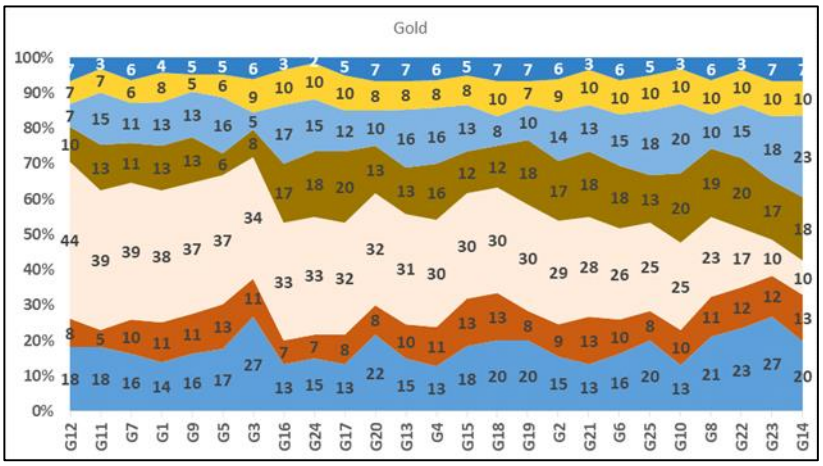
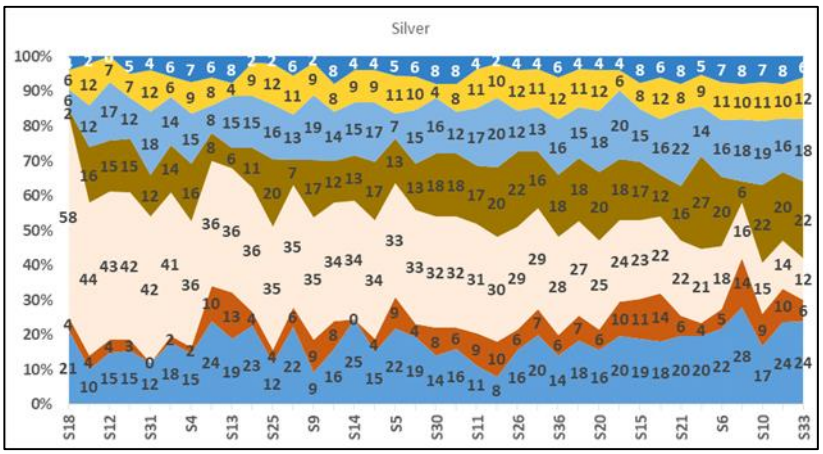
In the SS category, while LEED-HC allocates 16% of total points (18 points), most buildings achieved a weighted rate exceeding 17%. Notably, in the Certified level, 20% of the total achieved points came from the SS category.

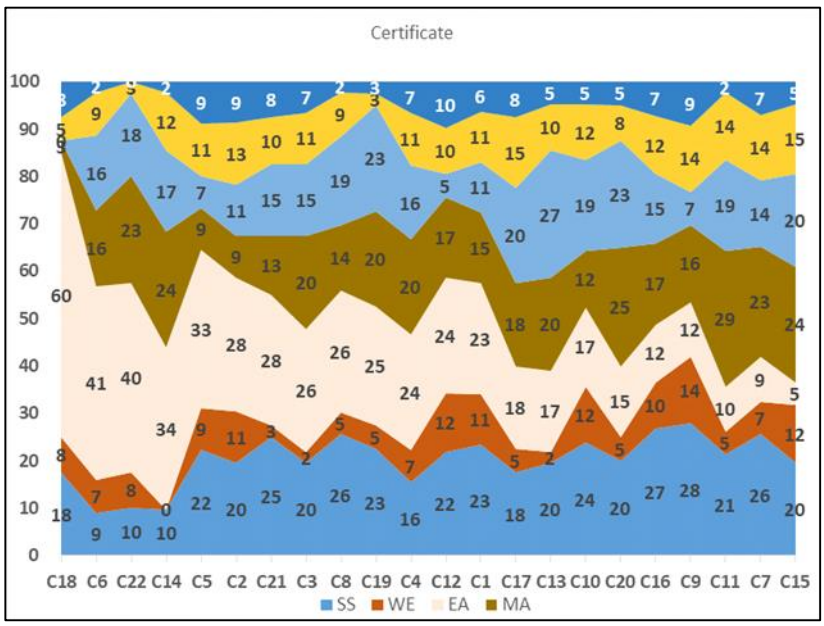
For the EA category, despite its 36% allocation (39 points) in LEED-HC, the actual achievement rate for most buildings, excluding Platinum, was below 30%. For the Certified level, this drops to 24%.

The EA and EQ categories consistently showed lower weighted achievement rates across all certification levels compared to their allocated proportions. Despite having the highest point allocation in LEED-HC, the EA category demonstrated the lowest weighted achievement rates among hospital buildings.

Table 9 illustrates the changes in weighted achievement rates across categories, focusing on the EA category. The horizontal axis lists buildings in descending order of EA weighted achievement rate, while the vertical axis shows the weighted rates. The graph stacks categories from bottom to top: SS, WE, EA, MR, EQ, IN, and RE.

Table 9 Comparison of Scores

Platinum	
Gold	
Silver	

Certified	

This graph reveals how buildings compensate for lower EA scores to achieve their certification level. In the most common Silver level, lower EA scores were offset by higher scores in MR, EQ, and SS categories. For Certified level, as EA scores decreased, MR and SS scores increased. Gold level showed the widest variation in MR, SS, and EA scores.

In conclusion, the analysis shows that to achieve a specific certification level, buildings often compensate for lower EA scores by earning more points in the SS and MR categories.

4.5. Analysis of Energy Atmosphere (EA) Categories

The analysis thus far has shown that the Energy and Atmosphere (EA) category has the lowest achievement rate. We examined which specific credits within the EA category have the most significant impact on scoring.

Table 10 analyzes the point distribution of EA credits in LEED-HC. Out of the total 39 points, the credit with the highest allocation is EAc1: Optimize Energy Performance. This credit accounts for 63% of the total EA points, or 24 points.

The second-highest subcategory is EAc2: On-Site Renewable Energy, worth 8 points or 21% of the total EA score. EAc2 relates to the installation of renewable energy systems within the building, and often results in either full points (8) or zero points depending on the nature of the healthcare facility.

Table 10 Sub-categories of Energy Atmosphere (EA)

Energy Atmosphere	Description	Score	%
EAc1	Optimize Energy Performance	24	63
EAc2	On-Site Renewable Energy	8	21
EAc3	Enhanced Commissioning	2	5
EAc4	Enhanced Refrigerant Management	1	2
EAc5	Measurement and Verification	2	5
EAc6	Green Power	1	2
EAc7	Community Contaminant Prevention—Airborne Releases	1	2
Total		39	100

The subcategory that most significantly influences the EA category score is EAc1: Optimize Energy Performance. In LEED-HC, EAc1 is worth 24 points (63%), which is 5 points higher than the 19 points allocated in LEED-NC for the same criterion. This increased point allocation likely reflects the consideration of hospitals' high energy consumption. However, despite this emphasis, the achievement rates for this credit are notably low.

5. Conclusion

Based on the comprehensive analysis of LEED Healthcare v4.1 certification data from 120 U.S. hospital projects in 2024, we can draw several significant conclusions:

- Certification Distribution: The study reveals a pyramid-like distribution of certification levels, with a majority of projects achieving Certified (54.2%) or Silver (29.2%) status, while Gold (13.3%) and Platinum (3.3%) certifications remain more challenging to attain.
- Category Performance Variability: Sustainable Sites (SS) consistently shows high achievement rates across all certification levels, indicating widespread adoption of sustainable site practices. Conversely, Energy and Atmosphere (EA) and Indoor Environmental Quality (EQ) categories demonstrate lower achievement rates, highlighting areas for potential improvement in the healthcare sector.
- Energy Performance Challenges: The EA category, particularly the Optimize Energy Performance credit (EAc1), remains the most challenging yet crucial aspect of LEED-HC certification. Despite its increased point allocation (24 points, 63% of EA category), achievement rates in this area are consistently low, reflecting the complex energy demands of healthcare facilities.
- Water Efficiency Improvements: The Water Efficiency (WE) category shows significant improvements and variability between certification levels, indicating its growing importance in sustainable healthcare design.
- Compensatory Scoring Patterns: Projects often compensate for lower EA scores by achieving higher points in Materials and Resources (MR) and Sustainable Sites (SS) categories to maintain their certification levels.
- Innovation and Regional Priority: Higher-level certifications (Gold and Platinum) show greater achievement in Innovation (IN) and Regional Priority (RP) categories, suggesting that top-performing facilities are more likely to implement cutting-edge and locally relevant sustainability strategies.
- Certification Level Thresholds: Many projects cluster near the minimum scores required for each certification level, indicating strategic targeting of specific certification tiers based on project goals and resources.

These findings highlight both the progress and ongoing challenges in sustainable healthcare design. While there have been significant advancements in areas like site sustainability and water efficiency, the persistent difficulties in optimizing energy performance underscore the need for innovative solutions in healthcare energy management.

The research suggests several key areas for improvement in both the LEED-HC rating system and healthcare facility design practices:

- Enhanced focus on energy-efficient technologies and strategies tailored to the unique operational requirements of hospitals.
- Development of more accessible pathways for achieving higher scores in the EA category, potentially through incremental improvements or alternative compliance paths.
- Increased emphasis on the integration of renewable energy systems in healthcare facilities.
- Further refinement of Indoor Environmental Quality criteria to balance energy efficiency with patient and staff well-being.

In conclusion, while LEED-HC certification has driven significant improvements in sustainable healthcare design, there remains substantial opportunity for advancement, particularly in energy performance and indoor environmental quality. Future revisions of the LEED-HC system should consider these findings to better align with the specific challenges and opportunities presented by healthcare facilities. Additionally, the healthcare industry should continue to invest in research and innovation to address the persistent energy management challenges highlighted by this study.

References

[1] American Society of Heating, Refrigerating and Air-Conditioning Engineers. (2021). ASHRAE Standard 170-2021: Ventilation of Health Care Facilities. Retrieved from https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/ashrae-standard-170-2021

[2] BREEAM. (n.d.). BREEAM Healthcare. Retrieved from https://www.breeam.com/discover/technical-standards/healthcare/

[3] Environmental Protection Agency. (2022). Energy Star Guidelines for Energy Management. Retrieved from https://www.energystar.gov/buildings/tools-and-resources/energy-star-guidelines-energy-management

[4] International WELL Building Institute. (2022). WELL Building Standard v2. Retrieved from https://v2.wellcertified.com/

[5] Katz, G. (2020). The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force. Capital E. Retrieved from https://www.cap-e.com/insights/the-costs-and-financial-benefits-of-green-buildings/

[6] National Institute of Standards and Technology. (2023). NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 4.0. Retrieved from https://www.nist.gov/publications/nist-framework-and-roadmap-smart-grid-interoperability-standards-release-40

[7] United Nations Environment Programme. (2021). Global Status Report for Buildings and Construction. Retrieved from https://www.unep.org/resources/report/2021-global-status-report-buildings-and-construction

[8] U.S. Energy Information Administration. (2023). Commercial Buildings Energy Consumption Survey. Retrieved from https://www.eia.gov/consumption/commercial/

[9] U.S. Green Building Council. (2021). LEED v4.1 for Healthcare. Retrieved from https://www.usgbc.org/leed/v41

[10] U.S. Green Building Council. (n.d.). LEED Healthcare Scorecards. Retrieved from https://www.usgbc.org/resources/leed-v41-hc-scorecard

[11] What is Project Delivery Partners, How to Implement it. R. Parekh. & Hofstra University. (2023). ResearchGate. https://doi.org/10.13140/RG.2.2.10185.11360

[12] Whole Building Design Guide. (2023). Sustainable Design for Healthcare Facilities. National Institute of Building Sciences. Retrieved from https://www.wbdg.org/resources/sustainable-design-healthcare-facilities

[13] Wilson, A. (2022). Green Building Trends in Healthcare: An Analysis of LEED v4 Projects. BuildingGreen. Retrieved from https://www.buildinggreen.com/feature/green-building-trends-healthcare-analysis-leed-v4-projects

[14] World Health Organization. (2021). Healthy Hospitals, Healthy Planet, Healthy People: Addressing Climate Change in Healthcare Settings. Retrieved from https://www.who.int/globalchange/publications/climatefootprint_report.pdf