



University of  
New Haven

University of New Haven  
**Digital Commons @ New Haven**

---

Civil Engineering Faculty Publications

Civil Engineering

---

2016

# Analysis of Credits Earned by LEED Healthcare Certified Facilities

Maryam Golbazi  
*University of New Haven*

Can B. Aktas  
*University of New Haven, caktas@newhaven.edu*

Follow this and additional works at: <http://digitalcommons.newhaven.edu/civilengineering-facpubs>



Part of the [Civil Engineering Commons](#)

---

## Publisher Citation

Golbazi, Maryam, and Can B. Aktas. "Analysis of Credits Earned by LEED Healthcare Certified Facilities." *Procedia Engineering* 145 (2016): 203-210.

## Comments

© 2016 The Authors. Published by Elsevier Ltd. in the journal *Procedia Engineering*. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>). Available at <http://dx.doi.org/10.1016/j.proeng.2016.04.062> A proceeding of ICSDEC 2016 – Integrating Data Science, Construction and Sustainability.



International Conference on Sustainable Design, Engineering and Construction

## Analysis of Credits Earned by LEED Healthcare Certified Facilities

Maryam Golbazi<sup>a, \*</sup>, Can B. Aktas<sup>b</sup>

<sup>a</sup> Graduate Student, Department of Civil and Environmental Engineering, University of New Haven, West Haven 06516, USA

<sup>b</sup> Assistant Professor, Department of Civil and Environmental Engineering, University of New Haven, West Haven 06516, USA

### Abstract

One of the main aims of the green building movement has been a desire to create a healthy indoor environment for building occupants. In terms of improving or enhancing occupant well-being, a unique case emerges for healthcare facilities, whose main existence is based on the principles of improving the health of their patients. In the U.S., the Leadership in Energy and Environmental Design (LEED) rating system has become the most widely recognized and used certification system for green buildings, including green hospital buildings. However, hospitals with high total scores may be green buildings but not necessarily the optimal green healthcare environment from a patient's wellbeing perspective. The goal of the study was to identify whether hospitals and healthcare facilities actually value the specific criteria that influence the health of patients and their recovery period. In-depth analysis of LEED healthcare specific credits revealed general tendencies and practices for green healthcare buildings.

Based on a statistical analysis, the mean of percent healthcare specific scores were calculated as 48% for those certified under LEED Healthcare, 62% for hospitals certified under LEED New Construction v3, and 52% for hospitals certified under LEED New Construction v2 rating systems. While hospitals included in the Healthcare category were initially expected to be the most successful ones in terms of achieving patient recovery and wellbeing related credits, they proved to earn the lowest percent of relevant points in this analysis. The result may be attributed to heightened restrictions and requirements of credits in the Healthcare scorecard, or hospitals may be valuing the level of certification more than those credits that were deemed relevant for patient wellbeing and rate of recovery, either due to lack of information or due to economic constraints. A high correlation coefficient was calculated among total scores and healthcare specific scores for the Healthcare dataset. On the other hand, correlation coefficients calculated for the other two datasets indicate a more random pattern among the two variables. For hospitals certified under the New Construction rating system, there seem to be weak support to claim that hospitals that receive high total scores and thus certification levels have high healthcare specific points as well.

*Keywords:* LEED Healthcare; Green building; Green hospital; Green healthcare

### 1. Introduction

Green buildings have gained public support due to the benefits they provide to the environment, society, as well as economic gains during the operation of the building. Considering the amount of time humans in urban areas spend indoors on a daily basis, the indoor environments of buildings have received renewed recognition and research in recent decades. Hospitals and healthcare facilities are a group of buildings that deal with a sensitive population group; the sick and the vulnerable. The primary reason of their existence is to enhance the wellbeing of their patients and the society overall. The indoor environment of such buildings have direct impacts on the wellbeing and recovery progress of patients. Hence, green buildings, with one of the primary goals of

\* Corresponding author. Tel.: +1-203-895-8969.

E-mail address: [golbazimaryam@gmail.com](mailto:golbazimaryam@gmail.com)

improving the indoor environment, have their objectives aligned parallel to those of the healthcare industry. Not surprisingly, the number of green building certified healthcare facilities are on the rise in the U.S. and globally.

However, green buildings also appeal to institutions due to their other indirect benefits such as improved public image, environmental stewardship, or simply as a marketing tool. Therefore, hospitals may become certified green building, but that may not necessarily mean a green healthcare environment. The goal of the study was to identify whether hospitals and healthcare facilities actually value the specific criteria that influence the health of patients and their recovery period. Leadership in Energy and Environmental Design (LEED) green building rating system and the data provided by U.S. Green Building Council (USGBC), which administers the LEED rating system have been used. A statistical correlation among total points received by certified healthcare facilities and number of healthcare specific points was also carried out.

## 2. Background

One of the most critical aspects and success factors of a hospital would be its patient safety and recovery rate. The most direct way of providing patient safety would be by reducing infections and providing a healthy environment for patients. Based on a study of 120 medical cases, infection within healthcare facilities was linked to the built environment. The two general mechanisms of pathogen transfer were air borne and through contact. The design of the built environment was found to impact patient safety [1]. Indoor environment quality has been considered as an important factor not only for patient recovery, but also for nurses and other staff satisfaction. Availability of daylight and uninterrupted views of nature in hospitals were found to decrease stress levels in the workplace for nurses [2].

In one of the fundamental studies on the subject, Ulrich et al. compared the wellbeing and recovery rates of patients staying in hospital rooms with windows facing trees and another group of patients staying in rooms with windows facing brick walls, showed that the former group of patients had experienced shorter recovery time compared to the latter group. The study was done on patients who were recovering after a surgery [3]. Accordingly, it was concluded that the built environment had a significant impact on patient recovery and wellbeing. Another study by Joarder and Price has been done on 263 patients to evaluate the importance of indoor environmental quality focusing on daylight and provision of view. The study indicates that length of stay decreases 7.3 hours by increasing light intensity by 100 lux inside the in-patient rooms. Length of stay also decreases by 17.4 hours using provision of view. The study also found that daylight had greater impact than other variables [4]. Another study by Phiri and Chen focusing on Evidence-Based Design presented the impact of environmental variables and argued the importance of daylight on patient recovery and its effects on physiology and psychology of patients [5].

USGBC is a non-profit national organization which administers the LEED green building rating system. Development of USGBC was based on committees formed of nation's headmost leaders from across the building industry deciding on the criteria for green buildings to promulgate environmentally responsible and profitable buildings as a healthy place to live [6].

Other studies on building design and performance compared the new LEED healthcare certified children's hospital, which had incorporated additional specific features such as improved daylight, green roof, healing gardens, private patient rooms, to its previous traditional structure. The impacts of the built environment on hospital's performance and on patients and occupants was also studied. The study concluded that following the move into the new LEED-certified building, the children's hospital reported significantly improved productivity, quality of care, and staff satisfaction, and reduced utility use per square meter, while their expense per patient in bed remained stable during this time [7, 8].

### 2.1. LEED: Leadership in Energy and Environmental Design

LEED green building certification program is a rating system for green buildings. It aims to incentivize a more healthy, responsible, and sustainable way for buildings around the world to be designed, constructed, maintained, and operated. LEED rating system is based on standards provided by leaders for buildings to eliminate negative impacts of buildings on the environment. The main aims of the rating system can be classified into 5 categories [9]:

- Sustainable site planning
- Safeguarding water and water efficiency
- Energy efficiency and renewable energy
- Conservation of materials and resources
- Indoor environmental quality.

To get LEED certification, buildings should meet all prerequisites and also obtain points in categories mentioned above to achieve different levels of certification. Prerequisites are inevitably required and they do not encompass any points for the building [10].

There are four levels of certification for buildings in the LEED rating system: Certified, Silver, Gold, and Platinum. The number of points each building earns determines the level of LEED certification that it receives. Version two with a total score of 69 is divided into 4 point ranges: 26-31 for Certified; 32-38 for Silver; 39-51 for Gold; and 52-69 for Platinum. Similarly, LEED version three with a total score of 110 was also divided into 4 point ranges as: 40-49 for Certified; 50-59 for Silver; 60-79 for

Gold; and 80+ for Platinum certification [13]. Summaries of total points allowed towards certification and the levels of certification in LEED 2009 and LEED 2.2 were presented in Table 1.

Table 1. Total Point and Certification Level Summaries for LEED 2009 & LEED 2.2 New Construction [10]

	LEED 2009 Points	LEED 2.2 Points
Base	100	64
Innovation in design	6	5
Regional priority	4	-
Total	110	69
Certified	40-49	26-32
Silver	50-59	33-38
Gold	60-79	39-51
Platinum	80+	52-69

## 2.2. LEED for Healthcare

LEED for Healthcare is provided for inpatient and outpatient healthcare facilities and licensed long term care facilities. The rating system is specific for healthcare environments and encompasses particular strategies relevant to healthcare environments. Bases of standards are similar to other rating systems under LEED and are classified in similar five categories. However, there are specific credits under each category that are relevant for sensitive healthcare environments [11].

It is important to note that as healthcare facilities have strict and intensive criteria due to the sensitivity of operations and vulnerability of occupants, prior to LEED Healthcare, they often had problems engaging LEED New Construction. Healthcare facilities are distinctly different from other types of buildings and uses and require day-round operations, have intensive energy and water use, have specific infection control requirements, and a heightened need for patient privacy [12].

## 2.3. LEED for New Construction

While LEED New Construction was designed for new buildings, many other building types were initially certified under this category as well. Commercial buildings as defined by standard building codes are eligible for certification under LEED for New Construction such as offices, institutional buildings (libraries, museums, churches, etc.), hotels, and residential buildings of 4 or more habitable stories [10]. The diverse list of facilities and uses included hospitals as well. Among the certified hospitals listed through USGBC, 81 of them were scored under the “New Construction” category [9]. As this number formed a significant portion of certified green buildings, New Construction credits that were relevant or similar to healthcare specific credits were reviewed in this study.

Another factor that needs to be taken into account was that these hospitals certified under New Construction category were certified either under LEED version 2 or version 3, where some differences existed between the two versions. Comparable credits that were analyzed in this study, and similar credits that were assumed to be equivalent during analysis were presented in Tables 2 and 3 respectively.

Table 2. Comparable credits for New Construction in LEED v2 and v3

Version 2 (out of 69 points)	Version 3 (out of 110 points)
WEc1.2: Water efficient landscaping - no potable water use or no irrigation	WEc1: Water efficient landscaping
WEc3.2: Water use reduction - 30% reduction	WEc3: Water use reduction

Table 3. Similar credits in LEED v2.1 and v2.2 that were assumed to be equivalent

Version 2.1 (out of 69 points)	Version 2.2 (out of 69 points)
EQc7.1: Thermal comfort - compliance with ASHRAE 55-1992	EQc7.1: Thermal comfort - design
EQc7.2: Thermal comfort - permanent monitoring system	EQc7.2: Thermal comfort – verification
EQc6.2: Controllability of systems - non-perimeter spaces	EQc6.2: Controllability of systems - thermal comfort

## 3. Methods

Data for this study were primarily obtained from the USGBC website. LEED scorecards for certified hospitals have been reviewed to assess which credits hospitals and healthcare facilities received during certification. There were a total of 127

certified hospitals on the USGBC website with their scorecards available for analysis. 19 of those hospitals were under the “Healthcare” category, 81 hospitals were classified under the “New Construction” category, and 27 of them were classified under various other categories. Overall, 100 hospitals (19 from Healthcare category and 81 from New Construction category) have been studied in detail and their scorecards have been analyzed considering specific selected criteria.

A scorecard is attributed to each certified hospital or healthcare facility. As the scorecard of every hospital is publicly available, the total scores received were analyzed. In line with the goal of the study however, the most relevant credits in each category have been further analyzed. As a result, hospitals have been evaluated in two cases. First, as a green building according to their total score which has been provided by USGBC, and second as a green healthcare environment which has been provided by this study according to their performance in healthcare specific credits.

To study 19 hospitals under Healthcare category, credits under the healthcare scorecard that were relevant to the wellbeing of patients were selected to evaluate the hospital’s effort in specific healthcare area. However, as most of the green hospitals were certified under the New Construction category in previous years rather than under Healthcare, it was deemed necessary to identify credits relevant to patient wellbeing in other scorecards as well. LEED credits chosen for the analysis from each of the respective rating systems were presented in Table 4.

Table 4. Specific healthcare credits analyzed in the study under various LEED rating systems

	<b>Healthcare</b>	<b>New Construction v2</b>	<b>New Construction v3</b>
<b>Sustainable Sites</b>	Site development - maximize open space	Site development - maximize open space	Site development - maximize open space
	Light pollution reduction	Light pollution reduction	Light pollution reduction
	Connection to the natural world - places of respite		
	Connection to the natural world - direct exterior access for patients		
<b>Water Efficiency</b>	Water efficient landscaping - no potable water use or no irrigation	Water efficient landscaping - no potable water use or no irrigation	Water efficient landscaping
	Water use reduction	Water use reduction - 30% reduction	Water use reduction
	Water use reduction - cooling towers		
	Water use reduction - food waste systems		
<b>Energy &amp; Atmosphere</b>	Optimize energy performance	Optimize energy performance	Optimize energy performance
	Community contaminant prevention - airborne releases		
<b>Materials and Resources</b>	Sustainably sourced materials and products	Construction waste management - divert 50% from disposal	Construction waste management
	PBT source reduction - mercury in lamps	Materials reuse - 5%	Materials reuse
	PBT source reduction - lead, cadmium and copper	Recycled content - 10% (post-consumer + 1/2 pre-consumer)	Recycled content
	Furniture and medical furnishings	Rapidly renewable materials	Rapidly renewable materials
	Resource use - design for flexibility		
<b>Indoor Environment Quality</b>	Outdoor air delivery monitoring	Low-emitting materials - adhesives and sealants	Low-emitting materials - adhesives and sealants
	Acoustic environment	Low-emitting materials - carpet systems	Low-emitting materials - flooring systems
	Low-emitting materials	Indoor chemical and pollutant source control	Indoor chemical and pollutant source control
	Indoor chemical and pollutant source control	Low-emitting materials - paints and coatings	Low-emitting materials - paints and coatings
	Controllability of systems - lighting	Controllability of systems - thermal comfort	Controllability of systems - thermal comfort
	Controllability of systems - thermal comfort	Thermal comfort - design	Thermal comfort - design
	Thermal comfort - design and verification	Thermal comfort - verification	Thermal comfort - verification
	Daylight and views - daylight	Daylight and views - daylight 75% of spaces	Daylight and views - daylight
Daylight and views - views	Daylight and views - views for 90% of spaces	Daylight and views - views	

The scorecards for the 81 hospitals have been evaluated and their total score as well as their specific healthcare score based on the developed model have been calculated and compared to each other. These data have been statistically analyzed to seek correlations among the two variables.

There still remained 27 other hospitals which were certified under different categories such as Existing Buildings or Commercial Buildings. However, the number of hospitals certified within each of these additional categories did not justify further analysis. The discrepancy among credits in these different rating systems also posed challenges in terms of a comparison. These 27 hospitals therefore have not been reflected in this study.

### 3.1. Statistical Correlation Analysis

Since studied hospitals were certified under different versions of LEED, they differed for total and healthcare scores that could be achieved. Rather than evaluate these scores as points, it was necessary to modify scores to a percentage in this study. Using percentage method enabled comparison between the scores and as a result to analyze the differences and obtain results.

Basic descriptive statistical measures of each dataset were calculated. The mean of the data was used to compare to other categories and were reported in the study. A correlation analysis between total points and healthcare points received was carried out to seek underlying trends in data.

## 4. Results and Discussion

The results of the study were presented and discussed based on the three distinct categories or datasets in the following sections. One factor worth mentioning at this point is that all results and related discussions were based on the data available from the USGBC website in terms of number of hospitals, their ratings, and their scorecards. However, the number of certified green hospitals and healthcare facilities were increasing, even within the duration of this study. While ultimate results and conclusions are not anticipated to change significantly, numbers presented here reflect only the current state of affairs. It was also interesting to note that there were number of certified hospitals listed on the USGBC website that did not report a scorecard. This omission of data disqualified them for this study as detailed information on the breakdown of points was necessary.

### 4.1. LEED Healthcare

LEED Healthcare category encompasses 19 certified healthcare facilities. Among these 19 hospitals, 6 had received “Certified” level, 4 hospitals had received “Silver” certification, 6 hospitals had received “Gold” certification, and 2 hospitals had received “Platinum” level certification. Credits which were directly related to health of the indoor environment and thus to the wellbeing of patients were analyzed in this study. Analysis results of these credit and the total points received by these hospitals were presented in Figure 1. The mean of total points and patient related healthcare specific points were calculated to be 49% and 48%, respectively, and hence no statistically significant difference was observed. This results can be used to suggest that hospitals certified under this rating system had given equal attention and dedication to credits that were related to the green building itself, as much as credits that were relevant to the wellbeing of patients. This is not to suggest that building or resource related credits are not important for hospital buildings, but there is clearly room for improvement for hospitals certified under the Healthcare rating system to increase their share of credits that most affect patient wellbeing, rate of recovery, and satisfaction.

Statistical correlation was sought between the total score of a hospital and patient related healthcare specific points. The correlation coefficient was calculated to be 0.94 for the dataset of LEED Healthcare buildings. Even though the two variables are not statistically independent, still, such a high correlation coefficient may indicate a positive link between the two variables. In other words, hospitals that received high total scores also received comparably high patient related healthcare scores as well.

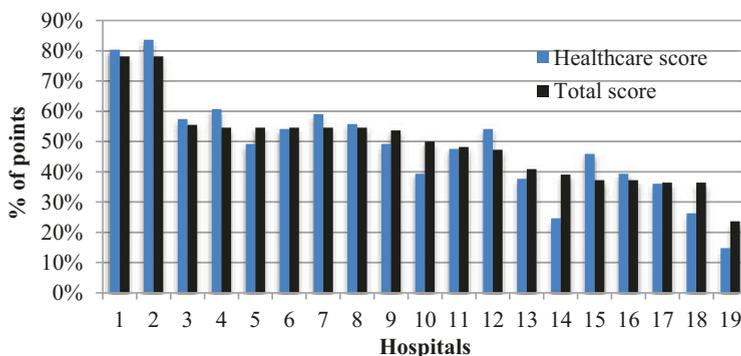


Fig. 1. Total and healthcare scores for hospitals certified based on the LEED v3 Healthcare scorecard

4.2. LEED New Construction

4.2.1. New Construction-Version 2.2

Green buildings certified under New Construction-version 2.2 includes 69 hospitals and healthcare facilities. The level of certification distribution among these hospitals were: 12 hospitals at the “Certified” level; 22 at the “Silver” level; 34 hospitals at the “Gold” certification level; and 1 hospital at the “Platinum” level of certification. Figure 2 presents the total score of buildings analyzed together with healthcare specific scores as a percentage of potential points. The maximum healthcare score for green buildings under this category was determined to be 27 based on the selected credits. The maximum score a building could receive under the rating system was 69 in this version of LEED. The mean percent of total and healthcare specific scores were calculated as 54% and 52%, respectively, where the difference was not statistically significant.

Among the 69 hospitals studied under this category, 15 hospitals were found to have distinctly higher percent of healthcare scores compared to their total score, while the rest achieving comparable or lower portion of points. From the function of a hospital building perspective, the former group of 15 buildings may be deemed more desirable based on the connection between patient wellbeing and the built environment in a hospital setting. For instance, using a minimum of 50% wood-based materials and products as required by MRc7, may be an important factor for a green building. However, it can be argued that it is secondary when compared to indoor chemical and pollutant source control required by EQc5, which is vital to have a healthy indoor environment for inbound patients who are already vulnerable and spend the majority of their stay inside hospital buildings.

The correlation coefficient for the dataset was calculated to be 0.68. However, considering the fact that the two variables of healthcare score and total score were not independent variables, the calculated value was not judged to be high enough to suggest a direct link between the two variables. Even though the mean percentages of the two variables were comparable, a claim that the two variables were positively correlated cannot be supported by the calculated coefficient value.

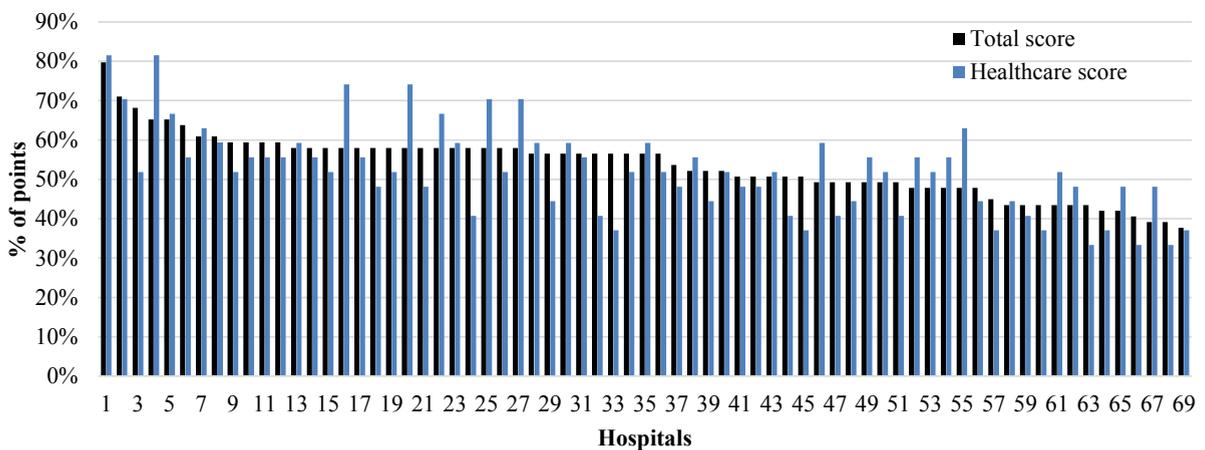


Fig. 2. Total and healthcare scores for hospitals certified based on the LEED New Construction v2.2 scorecard

4.2.2. New Construction-Version 3

Even though there were a total of 81 hospitals certified under the New Construction category, only 12 hospitals were certified based on the version 3 scorecard, the rest being certified under version 2. As for the distribution of certification levels: 1 of 12 hospitals had received “Certified” level; 7 hospitals had received “Silver” level; and 4 hospitals had received “Gold” certification level. Figure 3 presents the total and healthcare scores of these hospitals as a percent of their total. According to these results, the mean of total healthcare score among the 12 certified hospitals was 62%, which was more than the mean of total score received at 50%. Consequently, hospitals that have been scored in version three have paid due attention to the critical component between human health and green building. The correlation coefficient was calculated to be 0.66 for the dataset. However, considering the fact that the two variables of healthcare score and total score were not independent variables, the calculated value was not judged to be strong enough to suggest a direct link between the two variables. On the contrary, there seem to be weak support to claim that hospitals that receive high total scores and thus certification levels have higher healthcare specific points as well.

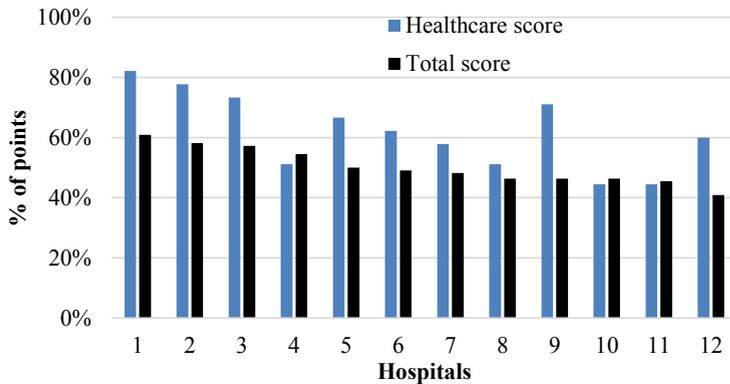


Fig. 3. Total and healthcare scores for hospitals certified based on the LEED New Construction v3 scorecard

According to statistical analysis, the mean of the percent healthcare score was calculated as 62% for hospitals certified under New Construction v3, 52% for hospitals certified under New Construction v2, and 48% for those certified under the Healthcare rating system. Based on these results, it was concluded that hospitals certified under New Construction v3 have had a stronger attempt at incorporating more elements from the scorecard that affect patient health and wellbeing when compared to hospitals certified under New Construction v2, or even those certified under the Healthcare rating system. While hospitals included in the Healthcare category were initially expected to be the most successful ones in terms of achieving patient recovery and wellbeing related credits, they proved to earn the lowest percent of relevant points in this analysis. The results can be attributed to two potential factors. This could have been caused by heightened restrictions and requirements of credits in the Healthcare scorecard. The other explanation could be that hospitals may be valuing the level of certification more than those credits that were deemed relevant for patient wellbeing and rate of recovery, either due to lack of information or due to economic constraints.

## 5. Conclusion

Green buildings provide many environmental, economic, and social benefits and hence their popularity and market share has risen in the recent decade. Any building in use has the potential to affect the wellbeing of its occupants, either positively or negatively. Green buildings in healthcare facilities play an even more important role, as building occupants other than staff members would be inbound patients who are already at a vulnerable stage of wellbeing. Hence, design of hospitals could have an important social and economic impact. The goal of the study was to identify whether hospitals and healthcare facilities actually value the specific criteria that influence the health of patients and their recovery period. The LEED green building rating system and data provided by USGBC were used. Descriptive statistical measures were used to evaluate and compare results.

According to statistical analysis, the mean of the percent healthcare specific score was calculated as 48% for those certified under Healthcare, 62% for hospitals certified under New Construction v3, and 52% for hospitals certified under New Construction v2 rating systems. Based on these results, it was concluded that hospitals certified under New Construction v3 have had a stronger attempt at incorporating more elements from the scorecard that affect patient health and wellbeing when compared to hospitals certified under New Construction v2, or even those certified under the Healthcare rating system. While hospitals included in the Healthcare category were initially expected to be the most successful ones in terms of achieving patient recovery and wellbeing related credits, they proved to earn the lowest percent of relevant points in this analysis. The results can be attributed to two potential factors. This could have been caused by heightened restrictions and requirements of credits in the Healthcare scorecard. The other explanation could be that hospitals may be valuing the level of certification more than those credits that were deemed relevant for patient wellbeing and rate of recovery, either due to lack of information or due to economic constraints.

A high correlation coefficient was calculated among total scores and healthcare specific scores for the Healthcare dataset. This may indicate that hospitals who receive high total scores also seek credits that affect patient's wellbeing. On the other hand, correlation coefficients calculated for the other two datasets indicate a more random pattern among the two variables. For hospitals certified under the New Construction rating system, there seem to be weak support to claim that hospitals that receive high total scores and thus certification levels have high healthcare specific points as well.

Overall, further emphasis is recommended for credits that could affect patient wellbeing for hospitals seeking LEED certification owing to their function and mission. Hospitals with high total scores may be green buildings but not necessarily the optimal green healthcare environment.

## References

- [1] R. Ulrich, C. Zimring, X. Quan, A. Joseph, R. Choudhary, Role of the Physical Environment in the Hospital of the 21st Century, The Center for Health Design, (2004).
- [2] G. Robin, H. Anna Gilmore; Healthy Buildings: Impact on Nurses and Nursing Practice;, Journal of Issues in Nursing; 2007
- [3] R. Ulrich, View through a window may influence recovery from surgery, *Science* 224(4647), (1984); DOI: 10.1126/science.6143402.
- [4] AR Joarder, ADF Price; Impact of daylight illumination on reducing patient length of stay in hospital after coronary artery bypass graft surgery; society of light and lightening; 2012.
- [5] M. Phiri; B. Chen, Sustainability and Evidence-Based Design in the Healthcare Estate; Springer briefs in applied sciences and technology; 2014.
- [6] L. Haselbach, The Engineering Guide to LEED New Construction: Sustainable Construction for Engineers – Appendix D: LEED 2009 vs. LEED 2.2, (2008)
- [7] C.L. Thiel, K.L. Needy, R. Ries, D. Hupp, M.M. Bilec, Building design and performance: A comparative longitudinal assessment of a Children’s hospital, *Building and Environment* 78 (2014) pp.130-136.
- [8] M.M. Bilec, M. Geary, R.J. Ries, K.L. Needy, M.K. Cashion, A method for quantifying the benefits of greening a healthcare facility, *Eng Manag J* 22(3) (2010), pp.3-11.
- [9] USGBC, United States Green Building Council, <http://www.usgbc.org>
- [10] USGBC, LEED 2009 for New Construction and Major Renovations Rating System (2008).
- [11] USGBC, LEED 2009 For Healthcare, (2010, Updated 2012).
- [12] J. Kriss, LEED for Healthcare Aims to Help Improve Health of Buildings, Patients, (2013).
- [13] USGBC, Green Building Rating System For New Construction & Major Renovations (LEED-NC) Version 2.1. (2002, Revised 2003).