ORIGINAL ARTICLE

Return on investment of a LEED platinum hospital: the influence of healthcare facility environments on healthcare employees and organizational effectiveness

Debra D. Harris

RAD Consultants, Austin, TX, United States

Correspondence: Debra D. Harris, Ph.D. Address: 3911 Greystone Dr., Austin, TX 78731, United States. E-mail: debra@rad-consultants.com

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Abstract

Objective: The purpose of this research study was to link hospital environments to the quality of care and the associated cost of care by examining the relationship among hospital environments and healthcare employee engagement, turnover, illness and injury.

Methods: This study used a multi-method research design and quantitative analysis of data sets from participating hospitals. Data included employee survey responses and human resource employee data provided by the hospital system. All statistical tests used an alpha level of .05. The analysis of the survey and human resource employee data tested for significant differences among employees at the participating hospitals; and used correlations and regression analysis to determine the direction and strength of the relationships where significant differences were evident.

Results: Results from the survey indicated that perceptions of the built environment affect employee engagement and health and well-being up to 14%. Turnover and injury reductions were significant and resulted in substantial cost differences; $2.17M cost reduction based on the facility replaced and annual cost avoidance of $2.24M when compared to the two newer hospitals that were not Leadership in Energy and Environmental Design (LEED) certified.

Conclusions: This study demonstrates that the quality of the hospital environment has social, environmental, and cost implications that aligns with the intention of sustainable design as defined by the United States Green Building Council (USGBC). Developing a built environment that supports productivity, efficiency, safety, and engagement contributes to the prosperity of the healthcare organization.

Key words

Return on investment, Employee engagement, Turnover, Safety, Sustainable design, Organizational effectiveness, Organizational culture

1 Introduction

The American College of Healthcare Executives' annual survey of top issues for hospitals cites financial challenges, followed by healthcare reform implementation, government mandates, and patient safety and quality [1]. Financial

constraints facing healthcare systems include new processes for Medicare reimbursement, cuts in government funding and Medicaid reimbursement, and challenges such as bad debt, decreasing patient volume, and increasing costs for personnel, supplies, and capital improvements. Patient safety and quality, echoed by the Institute of Medicine's (IOM) aims for safe, effective, patient-centered, efficient, timely and equitable health services, are tied to many financial challenges for hospitals and have lasting effects on patients. According to the Centers for Disease Control and Prevention (CDC), 1.7 million patients will suffer from healthcare acquired infections (HAI) each year [2]; falls account for at least 70% of hospital accidents [3], and occupational injuries for healthcare employees are increasing with job hazards including needle stick injuries, back injuries, violence, and stress [4]. With the implementation of healthcare reform, administrators have been searching for opportunities to reduce operating costs while increasing safety, quality and satisfaction for patients and healthcare employees.

Facility design and elements of the indoor environment contribute to real and perceived quality of care measurements, as defined by the Centers for Medicare & Medicaid Services (CMS), especially as patient satisfaction levels measured by the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) and other factors begin to impact pay for performance programs. Many of the top issues confronting hospitals may be influenced by both the indoor environment and the organizational culture of a healthcare system. Strategies that focus on cost implications (first costs, life-cycle costs, and cost avoidance), patient safety, and healthcare worker effectiveness require a comprehensive approach that links the success of healthcare facility occupant outcomes with the financial impacts on the healthcare organization.

According to the United States Green Building Council (USGBC) National Research Agenda [5], many claims state that green building strategies increase the level of indoor environmental quality and should be more supportive of health and productivity than buildings designed without green building strategies. However, research that studies the relationship between sustainable building design and human outcomes and return on investment have remained elusive; and study designs have not possessed the rigor, validity, or generalizability required to provide meaningful results. Indeed, while there have been opinion papers and discussions about the return on investment (ROI) of design interventions, such as sustainable building design or the evidence based design process, discussions have focused on "theoretical savings" based on typical operational costs and projected cost avoidance instead of an analysis of actual cost data.

The design intention of the Leadership in Energy and Environmental Design (LEED) platinum hospital was to construct a healthy indoor environment that complied with the principles of social (*e.g.*, supports quality of care, and family and patient-centered design), economic (*e.g.*, reduce operational costs and cost of care), and ecological sustainability (*e.g.*, reduce energy and water usage). This research study links hospital environments to the quality of care (social) and the associated cost of care (economical) by examining the relationship among hospital environments and healthcare worker engagement, perceptions and satisfaction, turnover, and incidents of illness and injury. In 2007, the healthcare system opened a children's hospital that is LEED® Platinum certified (LPC). In 2008 and 2009, the healthcare system opened two non-LEED hospitals (NL1 and NL2), constructed without an emphasis on sustainable building design as a primary goal. Three other existing facilities, including two general hospitals and one university medical center (NL3, NL4, and NL5, respectively), similar in size and services, are included in the study.

Standardized methods for assessing the sum value of sustainable facility design interventions – environmental, economic, and social – have not yet been defined. Varying opinions exist regarding the value of building a hospital that is LEED certified, and whether the design provides the intended and theorized benefits. The primary objective of this study was to compare healthcare employees' perceptions and human resource outcomes between a hospital that is LEED Platinum and five comparison hospitals that are not LEED certified – within a single healthcare system – in order to determine the social and economic value for constructing a hospital that is LEED certified. The secondary objective of this study is to develop a framework with standardized test methods for quantifying the value of sustainable building design related to facility return on investment and to human occupant outcomes.

Background

Quality research that validates the relationship between facility design interventions in healthcare facilities and their impact on healthcare employees is growing; however, the literature related specifically to sustainable building design on occupants and organizational effectiveness is notably limited. An integrative literature review [6] examined relationships between healthcare facility design interventions and healthcare worker outcomes, and found concentrations of peer reviewed research that focused on employee stress, employee satisfaction, indoor air quality, noise and sound, same-handed patient room design, neonatal intensive care units (NICUs), and the performance of patient handling tasks by healthcare employees. Studies that focus on factors related to sustainable design and healthcare worker outcomes were not found in the search. The following is a brief review of relevant literature addressing design impacts on healthcare worker outcomes.

Factors that influence healthcare employees' job satisfaction (*e.g.* burnout, stress, turnover intention and work related strain); have been supported by evidence [7, 8]. Healthcare employees' stress has been linked to noise within facilities [8]. Decibel levels in healthcare facilities tend to exceed recommended thresholds [9] that have been established by the Facility Guidelines Institute's (FGI) Guidelines for Design and Construction of Healthcare Facilities [10]. Excessive sound levels in hospitals are associated with irritation, fatigue, concentration problems, and tension headaches in healthcare employees [9].

The spatial organization of healthcare facilities and its influence on the well-being of healthcare employees has been affirmed in the design of single family room (SFR) NICUs. Healthcare employees have provided higher (more positive) responses for the following items when working in SFR NICUs in lieu of open bay (OB) NICUs [11]: job satisfaction; satisfaction with the indoor environment; psychological impact of the indoor environment on staff and families; and support provided by the indoor environment for privacy for families and infants. Another study on staff perceptions of work quality comparing the design of a SFR NICU [12] found higher (more positive) responses for: quality of life outside of work (except family life); personal health; interaction with NICU patients; quality of NICU work organization; staff privacy; parental privacy; noise level; ease of speech communication; lighting; task visibility; thermal comfort; air quality; and storage space quality.

The relationship among patient handling tasks, such as lifting, transferring or adjusting a patient's physical position, lift equipment, lift policies, and healthcare employees' preferences and injuries has been a topic of focus in the literature [13-17]. Healthcare employees selected mechanical ceiling lifts as the most preferred method for lifting and transferring patients; and a significant difference was found in perceived risk of injury, which was reduced, when using ceiling lifts [14, 15] or other types of mechanical lifts and patient handling equipment [17] as opposed to no assistive equipment. A significant difference was also found in healthcare employees' perceived musculoskeletal discomfort, which was reduced, when provided with patient handling equipment [14-16]. Implementation of a safe lifting program and provision of patient handling equipment resulted in a decrease in perceived physical discomfort for healthcare employees [17]; however, it is unknown whether the program or the equipment had the greater effect. Another study discusses performing a floor-to-toilet patient transfer in a simulated patient bathroom. The study found that a "restricted space" lengthens task performance time but results in a more beneficial posture for healthcare employees [18].

Mixed results have arisen when evaluating the effect of using patient handling equipment and implementing safe lifting policies on the occurrence and cost of healthcare worker injuries – one study resulted in a statistically significant difference in the occurrence, cost of injury claims, and the occurrence of lost work days, which were reduced [13]; two studies found no statistically significant difference in the occurrence of injury claims [15, 17]; and two studies reported a reduction on the cost of injury claims [14, 15].

Gaps in the literature about the influence of healthcare facility design on occupants are significant. Key topics specifically related to sustainable building design attributes include but not limited to the impact of sustainable facility design on healthcare employees, patients, and visitors; building and operational performance; cost implications; and organizational

effectiveness. Ascertaining the value of sustainable building design on occupants and healthcare organizational effectiveness, beyond the scope of minimizing the impact on natural resources, is critical in determining priorities and goals for the design of future hospitals.

2 Methods

This study used a multi-method research design and quantitative analysis of data sets from six participating hospitals within one healthcare system and included employee survey responses and human resource employee data provided by the hospital system. Institutional Review Board (IRB) approval was attained for this study via expedited review form the hospital's IRB and Clinical Research Steering Committee. All statistical tests used an alpha level of .05.

2.1 Employee survey

Participants for the healthcare employee survey included all employees whose primary employment was located at one of the six hospitals, who were age 18 or older and spoke English or Spanish fluently. The survey was distributed one time for a 40 day period via an online survey distribution program and employees were invited through email to participate. The survey included 69 questions divided into four sections, including background and demographics; employee engagement (EE), based on the Gallup® Organization's 13 Core statements [19] and the healthcare system's Associate Engagement Survey; employee health and well-being (HWB), based on the Copenhagen Burnout Inventory (CBI) [20] and the healthcare system's Associate Engagement Survey; and perceived quality of the indoor environment (PQIE). No standard, validated survey tool exists for general evaluation of the healthcare environment; therefore, questions were formulated based on key areas of interest studied throughout the literature [6, 11, 21-25] related to the impact of healthcare environments on healthcare employees. Simple random sampling was used for the healthcare worker survey, where each unit of the population was identified and independent. Descriptive statistics were conducted for all background and demographic measures.

2.1.1 EE

The initial set of inferential tests conducted focused on the association between demographic and related measures and employee engagement, using Spearman's correlations and independent-samples *t*-test. A one-way analysis of variance (ANOVA) was conducted to determine whether statistically significant differences exist among facilities regarding employee engagement. For inferential statistics, the Spearman's rho correlation was first conducted on all individual EE measures. Second, means were calculated for the PQIE Satisfaction and Agreement scales, followed by descriptive statistics. Third, the same descriptive statistics were then calculated on the PQIE Agreement scale. Fourth, a series of Spearman's correlations were conducted between the EE and PQIE scales. Lastly, a Pearson's correlation was conducted between both PQIE scale measures.

2.1.2 HWB

The health and well-being outcome measure consisted of two separate measures, the first measure focused on frequency (incidence), and the second measure focused on level of agreement. A series of two independent-samples *t*-tests and ANOVAs were conducted to determine whether statistically significant differences exist among demographic measures regarding the two HWB measures. Next, two one-way analyses of variance were conducted between both measures of HWB (frequency and agreement) and facility to determine if there were statistically significant differences on the basis of facility. Since reliability was found to be acceptably high for this scale, the mean was calculated, and descriptive statistics were conducted on the resulting calculation. For inferential statistics, descriptive statistics were first conducted on all individual HWB items. Second, additional descriptive statistics were conducted separately on the two HWB scales (Frequency and Agreement). Additional correlations were conducted between the measures of PQIE and HWB. A regression analysis was conducted with HWB Frequency on both PQIE measures (satisfaction and agreement). Finally, a regression analysis was conducted focusing on HWB Agreement.

2.1.3 PQIE

Initially, a series of descriptive statistics were conducted on all individual PQIE items. Next, Pearson's correlations were conducted between all continuous independent and dependent variables included in this data set, which also incorporates both measures of PQIE. Pearson's correlations were conducted between all continuous independent and dependent variables included in this data set, which also incorporates both measures of PQIE (satisfaction and agreement).

2.1.4 Final survey instrument analyses

A series of final regression analyses were conducted based on the predictors found to be statistically significant in the previous bivariate analyses. The first analysis measured the relationship between EE and both measures of PQIE. The second analysis measured the relationship between HWB and PQIE.

2.2 Human resource (HR)

Aggregated, de-identified data were obtained from the healthcare system's human resources and occupational health departments for all personnel who were employed in the six participating hospitals, and included the annual number of employee turnover occurrences (total, voluntary and involuntary) during fiscal years 2002-2012; the annual number of employee illness and injury incidents, defined as "recordable" by the U.S. Department of Labor Occupational Safety and Health Administration (OSHA), during fiscal years 2002-2012; and the annual cost of OSHA recordable employee illness and injury incidents that were reported to the healthcare system's occupational health department during fiscal years 2002-2011.

2.2.1 Employee turnover and associated costs

A series of descriptive statistics were conducted on employee turnover, which was measured as voluntary turnover, involuntary turnover, and total turnover. Spearman's correlations were conducted between turnover and age; and a series of independent-samples *t*-tests were conducted and compared respondent gender and turnover. A series of three one-way ANOVAs were conducted in order to determine whether significant differences in turnover exist on the basis of respondent race. Next, a series of three Spearman's correlations were conducted between measures of turnover and respondent education. Then, a series of Spearman's correlations were conducted between measures of turnover and years employed. Correlations were conducted between both measures of PQIE (satisfaction and agreement) and all three measures of employee turnover. Regression analyses were conducted on total turnover, voluntary turnover, and involuntary turnover. An ANOVA was conducted between turnover and facility to test for significant differences. An analysis of difference of proportions, using the two-proportion z-test, was conducted between the LEED Platinum facility and each non-LEED participating facility for 2012; and compared five years of pre/post data for the replaced facility (pre) and the LEED Platinum facility (post). Costs were determined by applying $331,800 for each percentage point reduction in turnover.

2.2.2 Employee injury and illness and associated costs

A series of analyses were conducted on the data regarding incidents of employee injury and illness, which focused specifically on OSHA recordable events. Initially, a set of descriptive statistics were conducted, providing summaries of cases per fiscal year and per facility. Second, additional descriptive statistics were conducted on job title for total reported incidents. Third, descriptive statistics were conducted on illness and injury as separate measures. Fourth, descriptive statistics were also conducted on the combination of both injuries and illnesses. Fifth, a series of Kruskal-Wallis ANOVAs were conducted in order to determine whether significant differences in injury and illness incidents exist for fiscal years. Sixth, a series of additional Kruskal-Wallis ANOVAs were conducted in order to determine whether statistically significant differences in injury and illness frequencies exist between facilities. Then, the final set of Kruskal-Wallis ANOVAs measured for statistically significant differences in illness and injury incidents among job titles. Finally, an analysis of difference in proportions, using the two-proportion z-test, was conducted between: the LEED Platinum facility

(FY 2007-2011) and the replaced facility (FY 2002-2006) for a pre/post comparison; the LEED Platinum facility and the two new non-LEED facilities for FY 2010-2011; and the LEED Platinum facility and the existing non-LEED facility, including two general hospitals and a university hospital for FY 2007-2011.

Further analyses were conducted focusing on costs of injuries, measured as the total incurred cost. First, descriptive statistics were used to compare means based on dollar amounts (*e.g*. number of incidents and type of injury). Second, a one-way ANOVA was conducted in order to determine whether statistically significant differences in costs incurred exist between fiscal years. Third, a chi-square analysis was conducted in order to determine whether a statistically significant association exists between injury type and physical location in the facility in which the injury took place. Fourth, an analysis was conducted focused upon whether statistically significant differences in costs exist among occupations. An additional one-way ANOVA was conducted to determine whether statistically significant differences in injury costs exist among injury types. Cost avoidance was assessed using established benchmarks based on OSHA and the Bureau of Labor Statistics tools representing national averages for direct and indirect costs associated with healthcare worker injuries that required days off from work.

3 Results

3.1 Employee survey

The sample (n = 1,991) was sufficient for analysis of survey response data among facilities with the number of responses to all questions exceeding the sample size required. The demographics of the sample are shown in Table 1. A very broad representation of departments within which participants work existed within the sample, with no single department constituting 10% or more of the current sample. The most common departments within which participants were currently working consisted of emergency departments and nursing patient care units. Each of the remaining departments composed less than 7% of the sample. The average participant had been employed in the healthcare industry for close to 16 years, and employed at this healthcare system for close to nine years.

Table 1. Demographic characteristics of survey participants

Demographic groups	Response (%)
Age	
24 and under	3
25-34	31
35-44	28
45-54	22
55-64	15
65+	1
Gender	
Male	21
Female	79
Race	
White	69
Black	5
Hispanic	16
American Indian	.3
Asian	4
Hawaiian/Pacific Islander	.3
Multiple races	4

(Table continued on page 43)

Table 1. (continued.)

Demographic groups	Response (%)
Education	
High school diploma	67
Associate degree	12
Bachelor degree	23
Master degree	42
Doctorate	12
Dr. of Philosophy (PhD)	2
Medical Dr. (M.D.)	.2
Other	2
Job title	
Nurse	35
Licensed clinical professionals	14
Clinical technicians	11
Clerical and non-clinical support	15
Other	25

3.1.1 EE

No significant difference was found among participants related to age, gender, race, level of education, and number of years employed. Significant differences among job titles were found with respect to the number of years employed in healthcare, the number of years employed by the healthcare system, and the number of years employed at the current facility in which participants were working.

No significant differences was found among facilities regarding employee engagement. Correlations among all 19 EE statements, composed of one statement focused on overall satisfaction with the healthcare system as place to work and 18 statements of agreement, were generally found to be moderate to very strong, statistically significant, and positive, $F(6, 1826) = 2.208$, $p = .04$.

Frequencies were also measured for participants' responses to all 18 EE statements; and responses of "agree" or "strongly agree" were very common. Analysis of responses to all 18 EE statements combined resulted in a mean of 5.51 with a median of 5.94, and a mode of 6.00, which indicates that the average participant's response was between "somewhat agree" and "agree". "Agree" was the most common response. Responses to the 18 EE statements combined were found to have a standard deviation of 1.50 with a minimum of 1 and a maximum of 7. Among responses to the 18 EE statements, participants agree that they feel safe at work, their job is valuable because of what they do, and they know what is expected of them at their job, $F(10, 2068) = 4.497$, $p < .001$.

Additional findings show that both of the PQIE scales are correlated with the EE scales, specifically, a significant, positive correlation, that was moderate in strength, resulted between PQIE Satisfaction and EE, $\rho(1223) = .257$, $p < .001$; and a significant, positive correlation resulted between PQIE Agreement and EE, $\rho(979) = .365$, $p < .001$, and was stronger than the correlation between PQIE Satisfaction and EE. Results of the regression analysis conducted with EE and including both scale measures of PQIE (Satisfaction and Agreement) as predictors indicated statistical significance in both cases, $F(2, 802) = 54.21$, $p < .001$; adjusted $R^2 = .117$. Specifically, a one-unit increase in PQIE Satisfaction is associated with a .12 unit increase in employee engagement; while a one-unit increase in PQIE Agreement was associated with a .22 unit increase in employee engagement. Additionally, the correlation of both PQIE scales are positively and strongly correlated, with statistical significance, $r(868) = .553$, $p < .001$.

3.1.2 HWB

HWB Agreement was associated with age positively and with statistical significance, $\rho(1982) = 3.41$, $p < .001$. No significant difference for gender or race was found regarding participants' levels of agreement with 12 statements focused

on HWB. Responses by males resulted in a slightly higher mean rating (more agreement with all 12 statements combined) when compared to females.

When comparing participants' levels of agreement with 12 HWB statements among all six facilities, no significant difference resulted. Responses for all HWB items combined varied widely based upon the HWB Agreement scales. Participants' agreement with 12 statements focused on HWB resulted in a mean of 5.13 with a median of 5.58 and a mode of 5.83. A standard deviation of 1.46 was indicated, with a minimum of 1 and a maximum of 7. Generally, participants from all six hospitals are confident that the work they do is important and contributes to something in a meaningful way. Participants were neutral for statements about feeling energized during the workday or that their energy level is good at the end of the workday. The LEED Platinum hospital rated higher than the other participating hospitals in agreement for employees feeling emotionally fulfilled from their work and time for friends and family outside of work. None of the mean ratings from any of the hospitals for any of the 12 statements were negative.

When rating how often each of six negative health and well-being situations occur to a participant, only two responses were significantly different from the LEED Platinum hospital, including "I feel susceptible to illness", $F(6,1889) = 2.364$, $p = .028$; and "I feel ill", $F(6, 1888) = 2.272$, $p = .034$ (see Figure 1).

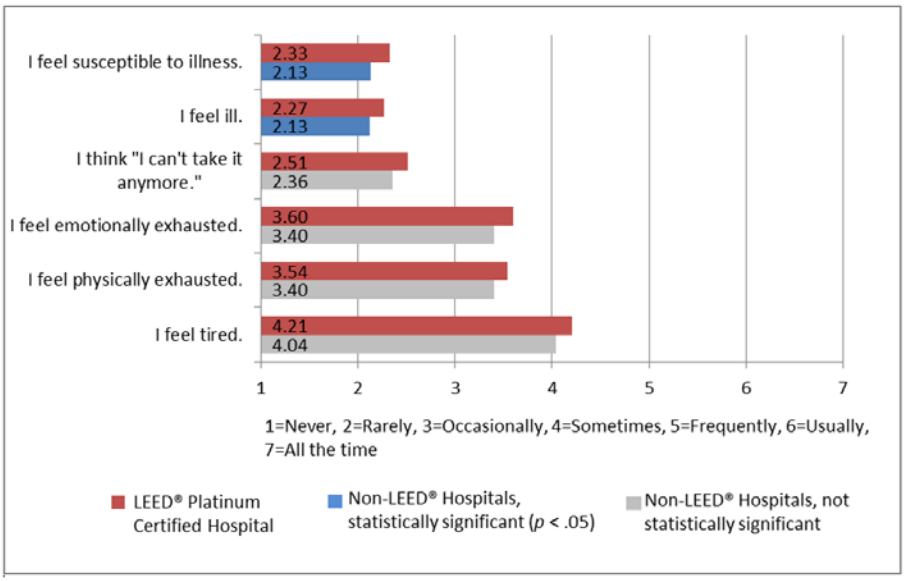

Figure 1. A comparison of means for healthcare employee responses regarding six statements focused on healthcare employees' health and well-being.

A significant negative correlation was found between the HWB Frequency scale and the HWB Agreement scale $r(1769) = -.536$, $p < .001$. Additionally, significant negative correlations were found between the PQIE Satisfaction scale and the HWB Frequency scale, $r(1302) = -.175$, $p < .001$; and the PQIE Agreement scale and the HWB Frequency scale, $r(1036) = -.251$, $p < .001$.

Results of the regression analysis conducted with HWB Frequency on both PQIE scales found significance with respect to both items. First, a one-unit increase in PQIE Satisfaction was associated with a .08 unit decrease in HWB Frequency. Additionally, a one-unit increase in PQIE Agreement was associated with a .18 unit decrease in HWB Frequency. The combined decrease was equal to 4% of the overall rating scale. This overall regression model achieved statistical significance, $F(1,812) = 27.696$, $p < .001$; adjusted R-squared of .059.

Correlations conducted between the PQIE scales and HWB Agreement scale found a significant, positive, moderate strength correlation resulted between HWB Agreement and PQIE Satisfaction, $r(1274) = .239$, $p < .001$; and found a

significant, positive, moderate strength correlation resulted between HWB Agreement and PQIE Agreement, $r(1027) = .363$, $p < .001$. Regression analysis with HWB Agreement on PQIE scales achieved significance, $F(2, 837) = 49.602$, $p < .001$; adjusted $R^2 = .104$.

3.1.3 PQIE

A review of frequencies for participants' responses to each of three survey statements focused on PQIE satisfaction suggested that, in the majority of cases, participants were most likely to indicate that they are completely satisfied. In a smaller number of cases, the modal response consisted of being mostly dissatisfied. Figure 2 shows satisfaction ratings with the indoor environment for LPC and the non-LEED hospitals. LPC was significantly higher than the non-LEED hospitals for each question, suggesting a higher level of overall satisfaction with the quality of the indoor environment of the facility where they work, $F(5, 1444) = 26.23$, $p < .001$; of the department where they work, $F(5, 1502) = 24.04$, $p < .001$; and of their personal workspace, $F(5, 1550) = 3.97$, $p = .001$. A comparison of participants' levels of agreement with 13 PQIE statements among participating facilities indicated a significant difference, $F(5, 1065) = 36.508$, $p < .001$. Three hospitals were found to be significantly different than LPC; however NL1 and NL2 were not significantly different (see Figure 3).

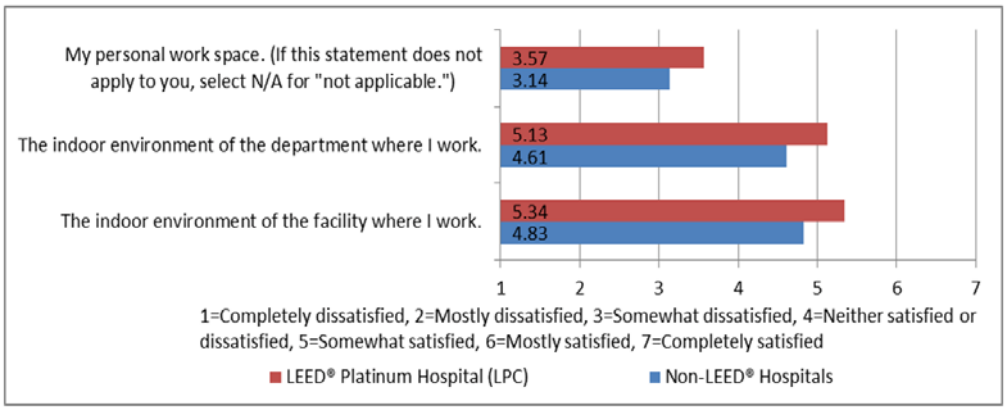

Figure 2. A comparison of mean ratings for participants' responses focused on satisfaction with the indoor environment.

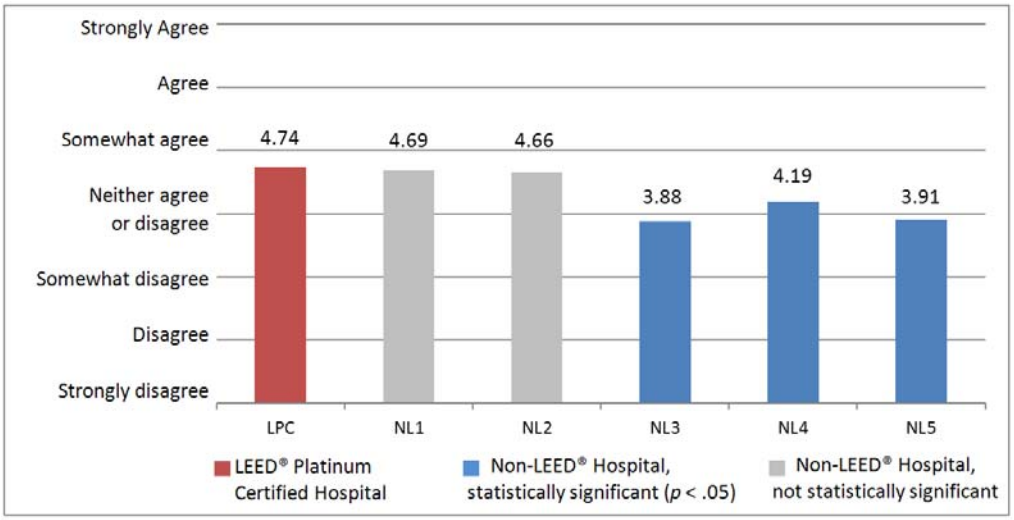

Figure 3. A comparison of means for employee levels of agreement with survey statements focused on perceived quality of indoor hospital environments among hospitals.

A review of participants' levels of agreement with each of 13 statements focused on PQIE suggests variability among responses between LPC and all non-LEED hospitals combined (see Figure 4). LPC rated significantly higher than the

other participating hospitals except for NL2, $F(63, 1065) = 1.261$, $p = .087$; and NL4, $F(63, 1065) = .878$, $p = .740$. The greatest difference between LPC and the non-LEED hospitals focus on access to window views and daylight, the indoor air quality, and aesthetics. The highest levels of agreement for participants at LPC pertained to statements about sufficient quantities of artificial light, healthy air quality, ease of wayfinding, cleanliness, and comfortable sound levels.

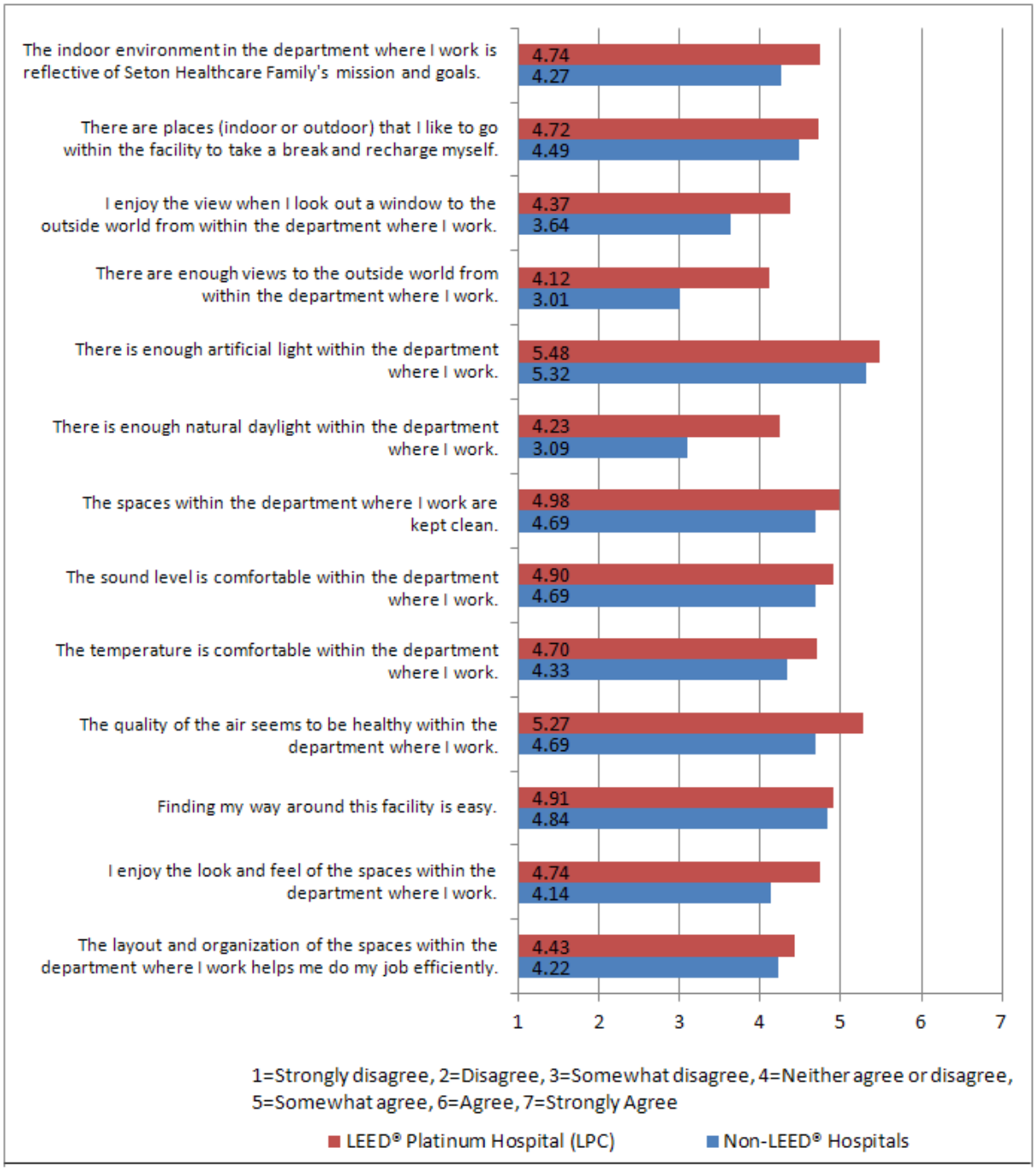

Figure 4. A comparison of mean ratings between a LEED Platinum hospital and five non-LEED hospitals for healthcare employee responses about perceived quality of the indoor environment

PQIE influence on organizational effectiveness

Employees' perceptions of the quality of indoor hospital environments had a significant effect on employee engagement and perceived health and well-being. Based on a seven-point Likert-type scale, a one point increase in the PQIE

Satisfaction and Agreement scales affected a 34% (12% and 22%, respectively) of a point increase in employee engagement, a 5% increase on the EE scale, overall.

PQIE Agreement and PQIE Satisfaction were associated with significant, positive effects on HWB Agreement. Based on a seven-point Likert-type scale, a one-point increase in PQIE Satisfaction and Agreement scales affected a 34% (8% and 26%, respectively) of a point increase in perceived health and well-being, a 5% increase on the HWB Agreement scale, overall. With regard to the HWB Frequency scale, a one-point increase in PQIE Satisfaction and Agreement scales affected a 26% (8% and 18%, respectively) of a point decrease in perceived frequency of undesirable health outcomes (*e.g.*, tiredness, physical or emotional exhaustion, susceptibility to illness), equating to a 4% reduction in negative health and well-being responses, overall.

3.1.4 Survey questionnaire validation

Research instrument validation is an iterative process and requires continuous evaluation, reevaluation, refinement, and development. The survey questionnaire is well-organized with clearly stated questions. This study tests two survey questionnaire sections, referred to as PQIE scales, which pertain to perceptions of the quality of indoor facility environments. One PQIE scale is based on levels of satisfaction and the other PQIE scale is based on levels of agreement. The questions that compose the PQIE scales are based on research from several disciplines, including environmental psychology, environmental design, neuroscience, economics, and natural sciences, that has focused on healthcare environments and outcomes related to patients, visitors, and healthcare employees (*e.g.*, satisfaction, preferences, perceptions, safety, and quality of care). A series of Cronbach's alpha tests specific to each set of questions demonstrate good internal consistency.

While a single study does not substantiate construct validity, correlations that fit the expected pattern contribute evidence of construct validity [26, 27]. Each PQIE scale correlated, with statistical significance, with EE scales and HWB scales, which were developed from validated surveys. A significant, positive and strong correlation resulted between PQIE Satisfaction and PQIE Agreement scales. Statistically significant, positive correlations also resulted between the Employee Engagement and the Health and Well-Being scales. In addition, this study found that both PQIE scales served as predictors, increasing the values of the HWB Agreement and EE scales with statistical significance. Although construct validity is a judgment based on the accumulation of correlations from numerous studies, results from this study's statistical analyses demonstrate good construct validity [27].

The EE and HWB scales were developed based on validated survey instruments. The PQIE scales were developed and informed by multiple surveys that fall into the area of study that examines occupant outcomes based on design interventions [6, 11, 19-25, 28]. Criterion-related validity is expressed by the correlation of the PQIE scales with the EE and HWB scales and other surveys that measure similar variables for healthcare employees. Repeating the use of the survey within a larger context of healthcare systems would increase validity of the survey instrument.

3.2 HR

3.2.1 Employee turnover

Employee turnover among the six hospitals was measured as voluntary turnover, involuntary turnover, and total turnover. Total turnover for fiscal years 2002-2012 had a mean of 13.86%, with a standard deviation of 3.96%, a minimum turnover of 9.88%, and a maximum of 19.80%. Voluntary turnover had a mean of 10.88%, with a standard deviation of 2.74%, a minimum turnover of 7.72% and a maximum of 15.86%. Involuntary turnover had a mean of 2.98% with a standard deviation of 1.55%, a minimum turnover of 1.61% and a maximum of 5.81% (see Table 2). When comparing participating hospitals for FY2012, LPC had significantly lower rates than NL1 ($z = -2.61$), NL2 ($z = -2.45$), and NL4 ($z = -2.17$) (see Figure 5). Five consecutive years of annual employee turnover rates at LPC were compared with the previous children's hospital it replaced, and was shown to be significantly lower with a reduction of 6.53%, $z = 3.70$ (see Figure 6).

Table 2. Employee turnover rates by facility, FY2012

Facility	n	Total (%)	Voluntary (%)	Involuntary (%)
LPC	492	11.13	8.86	2.27
NL1	475	14.30	8.73	5.58
NL2	176	14.71	12.22	2.49
NL3	233	10.05	8.44	1.61
NL4	151	13.50	10.28	3.22
NL5	473	9.88	7.72	2.16

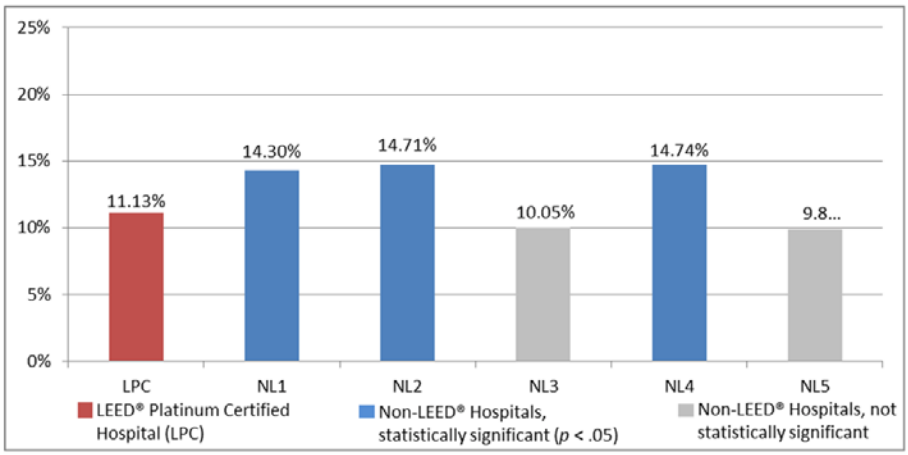

Figure 5. A comparison of total employee turnover rates for fiscal year 2012 between a LEED Platinum hospital and five non-LEED hospitals, with statistically significant differences resulting at $p < .05$.

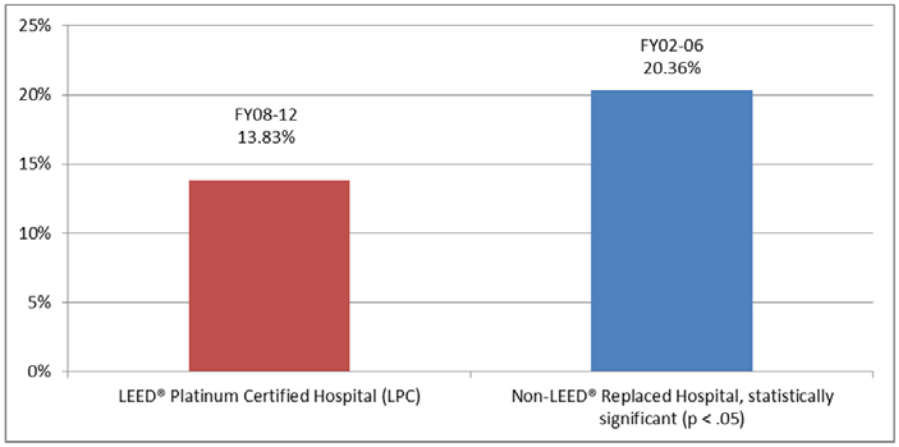

Figure 6. A comparison of total employee turnover rates, from five years consecutive combined, between LEED® Platinum Certified Hospital (LPC) and the hospital it replaced with statistically significant differences resulting at $p < .05$.

3.2.2 Cost of turnover

The cost of each percentage of turnover is estimated to be a conservative $331,800 [29]. The annual cost savings for LPC when compared to the replaced facility is $2.17M. When comparing NL1 and NL2 to LPC, the annual cost difference is $1.05M and $1.19M, respectively, showing a total annual reduction in operational costs of 2.24M.

3.2.3 Employee injury and illness

OSHA's reported annual number of employee illness and injury incidents at the six participating facilities for years FY2002-2011 were analyzed to compare differences. Preliminary tests were conducted to determine whether significant

differences in incidents of injury and illness existed among fiscal years. Significant differences among fiscal years did not result for the total number of both, illnesses and injuries, and the total number of illnesses alone; and did result for the total number of injuries, $K(9) = 84.464$, $p < .001$. As shown in Table 3, the highest mean for injuries and illnesses combined occurred in 2005 and 2007, while the highest mean number of illnesses alone also occurred in 2005. The highest mean number of injuries occurred in fiscal year 2007.

Table 3. Mean injury and illness rates by fiscal year

Year	n	Total (%)	Illness (%)	Injury (%)
2002	170	2.44	2.38	.05
2003	250	2.60	2.58	.02
2004	193	2.58	2.49	.09
2005	159	2.81	2.77	.04
2006	185	2.52	2.38	.14
2007	134	2.81	2.34	.48
2008	175	2.42	2.30	.12
2009	166	2.36	2.25	.10
2010	153	2.23	2.20	.03
2011	189	2.00	1.96	.04

LPC and the replaced facility were compared using FYs 2007-2011 (LPC) and FYs 2002-2006 for the replaced facility (see Table 4). A reduction of 7% at LPC was significant ($p = .05$). When LPC was compared with the newer facilities, NL1 and NL2 using FYs 2010-2011, a reduced rate of 3% of injury and illness rates for each facility were found to be significant ($p = .05$). Finally, LPC was compared with the remaining facilities in the study, NL3, NL4, and NL5 using FYs 2007-2011. A significant difference was found for LPC compared to NL4 (8%) and NL5 (3%). While LPC was lower than NL3 (1%), the difference was not found to be significant.

Table 4. Injury and Illness Rates comparing a LEED Platinum hospital with the replaced facility, two new non-LEED hospitals, and the existing hospitals by Facility over Specified Timeframes.

Facility	%	Fiscal Years	z-score (0.05 sig.)
LPC	0.11	2007-2011	
Replaced hospital	0.18	2002-2006	-4.23
LPC	0.04	2010-2011	
NL1	0.07	2010-2011	-2.75
NL2	0.07	2010-2011	-2.93
LPC	0.11	2007-2011	
NL3	0.12	2007-2011	*not sig.*
NL4	0.19	2007-2011	-4.52
NL5	0.14	2007-2011	-2.43

The most common body parts injured were the back and lumbar (24%). Other body parts that were likely to be injured were ankles, fingers, knees, shoulders and wrists, representing an additional 27% of injuries. The remaining body parts injured each accounted for 3% or less of the total injuries.

A small number of causes (actions that led to the injury) of injuries represented a substantial portion of the total reported incidents. Twenty-five percent of all reported injuries occurred when an employee fell; 20% of injuries were caused by lifting; and 8% of injuries were caused when an employee was pushing or pulling something (*e.g.*, medical equipment, patient bed).

When reviewing the occurrence of injuries based on the physical location within a hospital, 11% of injuries occurred in hallways; 5% occurred in operating rooms; 5% occurred in kitchens; and 3% occurred in emergency rooms. The most

likely place for a healthcare worker to suffer an injury was in patient rooms (28%). Of the injuries that occurred in patient rooms, most were caused by lifting (31%); pushing or pulling (11%); fall on the same level (9%); and injury caused by a fellow worker or patient (9%).

3.2.4 Cost of employee injury and illness

The cost of illness and injuries, based on reported annual cost of OSHA recordable employee illness and injury incidences for fiscal years 2002-2012, were measured as the total incurred direct cost. Among all participating facilities, the mean incurred cost was $3,121.39 with a median of $536.15. The standard deviation was $11,770.38 ranging from zero dollars to $234,236.95.

A statistically significant association exists between injury type and the physical location within a facility where an injury occurred, $\chi^2(5888) = 9083.236$, $p < .001$; however no significant difference in costs existed among physical location within a facility where an injury occurred. Costs were significantly different based on occupation, $F(410, 2809) = 1.222$, $p = .003$; and among injury types, $F(46, 2809) = 20.266$, $p < .001$.

Measuring the cost of injuries, direct and indirect, with data from the U. S. Bureau of Labor Statistics and workers' compensation, the OSHA "Safety Pays" calculator produced an estimated $79,000 for every injury that required days away from the job [30]. Using the difference of proportions statistic and OSHA's cost factor, LPC shows a cost savings of approximately $4.5M for FYs 2007-2011 when compared to the replaced facility. Furthermore, comparing reduced injury rates for LPC with NL1 (3%) and NL2 (3%), a combined cost savings of $3M is revealed for FYs 2010-2011; and the cost difference for LPC when compared to NL4 and NL5 is equal to $2.97M and $4.2M, respectively for FYs 2007-2011.

4 Discussion

The main objectives of sustainable design are to avoid resource depletion of energy, water and raw materials; prevent environmental degradation; and create built environments that are livable, comfortable, safe and productive [31]. According to Lovins, if an employer is committed to sustainability, increased productivity and job satisfaction will result, as well as greater profitability for the organization [32]. The intention of the design for LPC was to provide a sustainable building design that influenced environmental, social, and economical factors, contributing to quality of care. This study focuses on social outcomes for healthcare employees and related economic implications, which are influenced by hospital facility environments.

Rigorous research that quantifies the value of sustainable building design, for healthcare facilities, and its impact on the natural environment, social outcomes and economic outcomes is limited [6], especially related to the LEED rating system. In addition, rigorous research that studies the effects of facility design interventions on healthcare employees is growing but small [6-9, 11, 12, 14-18, 33]. Established concentrations of research on healthcare employee engagement and perceived health and well-being exist [34-47]. This study contributes by quantifying the influence of employees' perceptions of indoor facility environments on employee engagement and their own health and well-being, and providing evidence on human resource outcomes for healthcare employees related to organizational effectiveness.

Perceived quality of the indoor environment significantly influenced employee engagement, and employee health and well-being, demonstrating a positive relationship between the built environment and organizational culture. The results from this study demonstrate that healthcare employees' perceptions of indoor environments are linked to engagement, and health and well-being with a total impact factor of 14% on organizational effectiveness. Organizational culture is having a limiting effect on organizational effectiveness. Contrasting the positive impact of the quality of the indoor environment are indicators including morale, opportunities for development and advancement, recognition and positive feedback for a job well done, and valuing employee opinions.

Employees want to feel their opinion matters, their contribution at work is valued and that their environment supports productivity and efficiency. Engaging employees in the process of the design and planning of their work environment requires active participation, not just at middle and top level management, but with those who are charged with providing care on the front lines. Not only is this process beneficial to the goal of the design project, but may influence employee engagement, specifically in regard to employees feeling valued at work.

Employees agree that they felt safe and they knew what is expected of them at their jobs. They are confident in the importance of their work, remained certain that their work was a meaningful contribution, and agree that their work made them feel spiritually and emotionally fulfilled. Employees at the LEED hospital perceived their risk for illness to be significantly higher than the other facilities. However, the injury and illness findings showed that employees at the LEED hospital were less likely to be injured or become ill than employees at the non-LEED hospitals, showing that perceptions do not always reflect actual outcomes and that employees at the LEED hospital should be informed and educated about the successful provision of safety in their work environment.

All participants from the study hospitals agree that they have sufficient artificial light, acceptable levels of cleanliness, and that way finding is sufficient in their hospitals. Employees at the LEED hospital rated their facility higher for reflecting the mission and goals of the healthcare organization, cleanliness, a place for respite, thermal comfort, indoor air quality, sound levels, wayfinding and aesthetics. Opportunities for improvement exist among all participating hospitals, specifically for access to daylight and views. Hospitals have a particularly difficult time infiltrating natural light into the building where people are working. Given the LEED credit for 75% daylight penetration at the LEED Platinum hospital, access to natural light and views within the nursing station and other occupied work areas were limited; much of the natural light is located in patient environment and public corridors where healthcare employees are less likely to spend their working hours.

Overall, employees among participating hospitals are somewhat satisfied with the indoor environment of the facility and the department in which they work. Employees are more likely to be dissatisfied with their personal work space rather than their department or facility as a whole. Employees at the LEED hospital were consistently more satisfied than the comparison hospitals with the indoor environment of their facility, their particular department and their personal workspace. At the non-LEED hospitals, employees wanted more access to natural light and views to the outside world. Issues that surfaced the most frequently by employees among all hospitals centered on physical space (layout and space allocation), factors related to thermal comfort, and organizational culture. The layout of the LEED hospital is different than those of the comparison facilities with patient unit pods rather than traditional racetrack design, yet the findings indicated similar dissatisfaction with participants at the other facilities. Future design of facilities would benefit from careful analysis of layout and organization of spaces with consideration for employee work processes.

In 2012, LPC employee turnover rate was 11.13 percent, 3.57 percent lower than the national average [29]. The employee turnover rate has been significantly reduced at the LEED hospital (6.53%) when compared to the replaced hospital. The two newest hospitals (non-LEED) had significantly higher turnover rates, 3.17 and 3.58 percent than the LEED hospital; and the turnover rate at the LEED hospital was significantly lower than the other hospitals combined. Meaningful reductions in employee turnover is a strong indicator that the built environment influences behaviors and decisions of occupants, affecting the associated costs that impacts organizational efficiency. The cost implications of these changes are considerable when each percentage point in turnover equates to a conservative $331,800 [29]. The savings for the LEED hospital when compared to the replaced facility was $2.17M. When compared to the newer hospitals, the annual combined reduction in operational costs was $2.24M.

The rate of injury and illness at the LEED hospital was significantly lower when compared to the replaced hospital and the other participating facilities. Using the “Safety Pays” calculator estimate of $79,000 for direct and indirect costs of each injury that required days away from the job, the LEED hospital shows a cost savings of approximately $4.5M when compared to the replaced hospital. An annual cost reduction of approximately $10.2M is revealed when the LEED

hospital is compared to the existing non-LEED facilities [30]. The reduction in injury and illness along with associated cost avoidance denotes a compelling contrast between the LEED hospital and the non-LEED hospitals in the study.

The most common causes of injuries were falls; and strains from lifting, pushing or pulling. The most common body part injured was the back. A focus on types of injuries and locations within the hospital may inform strategies to reduce employee injury and associated costs. Injuries at this hospital system are reflective of hospital injuries across the nation. Slip, trip and fall (STF) injuries and back strains from patient handling and other manual tasks are high risks associated with employment in healthcare organizations. Design strategies – flooring material selections based on coefficient of friction and impact force (reduce severity of a fall injury), clear floor space around patient beds (patient handling leverage), and a focus on patient room safety are recommended to reduce the risk and therefore the costs associated with employee injuries and illnesses.

While the response of the healthcare worker survey exceeded the size needed for analysis for comparisons between facilities, the size of the sample required for within facility analysis was insufficient, a limitation of the study. The results of this study stand on their own; however, the results would have benefited by aligning patient surveys with the healthcare worker survey to have comparative data from both primary user groups of the facilities. A deeper analysis within each facility is warranted to investigate specific factors leading to the results of this study.

5 Conclusions

The value of sustainable building design for healthcare facilities on building performance is mixed, though there is evidence that the reduction of energy and water consumption reduce operational costs. Based on the findings of this study, perceptions of the indoor environment have a combined 14% effect on employee engagement and employee health and well-being.

In spite of shared organizational cultures, policies, and expectations, differences between the LEED and non-LEED hospitals show that the LEED hospital effectively reduced turnover and injury rates; and costs associated with turnover, retention, and injuries, including the newer facilities where the perception of the quality of the indoor environment was similar to the LEED hospital. This is especially important since there was no significant difference in employee engagement across the participating facilities.

Indications of the importance of organizational culture are apparent when comparing the participating hospitals. Recognizing the constraints of employee satisfaction with their immediate work situation is imperative to increase overall satisfaction with the healthcare system as a place to work. The built environment plays a significant role in the outcomes of occupants and is recommended to become part of the culture of the healthcare organization. The design of the hospital environment can contribute to organizational culture and effectiveness by improving engagement and health and well-being. Increase engagement by being inclusive and constructive in the development of processes for program and design development.

Assessing return on investment for building design, specifically for healthcare facilities is a complicated process that involves evaluation of building performance, operational efficiencies, and human capital. This study focused on human capital and included engagement, turnover, safety, cost, and efficacy. For future facilities, sustainable design and LEED certification is recommended with consideration for design attributes supported by evidence to improve healthcare worker outcomes for engagement, retention, and safety. This research is novel and is part of an overall study to determine return on investment of sustainable and evidence-based designs. More research is needed to provide the foundation for knowledge-based decision making for facility design. This study demonstrates that the quality of the hospital environment has social, environmental, and cost implications that align with the intention of sustainable design as defined by the USGBC.

Conflict of interests

The author declares that she has no conflict of interests.

References

[1] Freund LM. American College of Healthcare Executives Announces Top Issues Confronting Hospitals: 2012 Chicago, IL: American College of Healthcare Executives. 2013 [cited 2013 April 17]. News release. Available from: http://www.ache.org/Pubs/Releases/2013/Top-Issues-Confronting-Hospitals-2012.cfm.

[2] Klevens RM, Edwards JR, Richards Jr CL, Horan TC, Gaynes RP, Pollock DA, *et al*. Estimating Health Care-Associated Infections and Deaths in U.S. Hospitals, 2002. Public Health Reports. 2007; 122(2): 160-6. PMid: 17357358.

[3] Currie LM. Fall and injury prevention. Annu Rev Nurs Res. 2006; 24: 39-74. Epub 2006/11/03. PMid: 17078410.

[4] NIOSH. Guidelines for Protecting the Safety and Health of Health Care Workers Washington, DC: Center for Disease Control and Prevention. 2010 [cited 2010 July 7, 2010]. Available from: http://www.cdc.gov/niosh/docs/88-119/stress.html.

[5] U.S. Green Building Council Research Committee. A National Green Building Research Agenda. 2008.

[6] Detke LA, Harris DD, Particini CA. Hospital facility design's influence on health care workers. The Internet Journal of Healthcare Administration. 2013; 8(2). Epub August 2013.

[7] Alimoglu MK, Donmez L. Daylight exposure and the other predictors of burnout among nurses in a University Hospital. International Journal Of Nursing Studies. 2005; 42(5): 549-55. PMid: 15921986. Language Code: eng. Date Revised: 20061115. Date Created: 20050530. Date Completed: 20050830. Update Code: 20111122. Publication Type: Journal Article.

[8] Applebaum D, Fowler S, Fiedler N, Osinubi O, Robson M. The Impact of Environmental Factors on Nursing Stress, Job Satisfaction, and Turnover Intention. Journal of Nursing Administration. 2010; 40(7/8): 323-8. PMid: 59670920. http://dx.doi.org/10.1097/NNA.0b013e3181e9393b

[9] Ryherd EE, Waye KP, Ljungkvist L. Characterizing noise and perceived work environment in a neurological intensive care unit. Journal of the Acoustical Society of America. 2008; 123(2): 747-56. PMid: 28792029. http://dx.doi.org/10.1121/1.2822661

[10] Facility Guidelines Institute. Guidelines for Design and Construction of Health Care Facilities. Chicago: ASHE (American Society for Healthcare Engineering). 2010.

[11] Shepley MM, Harris DD, White R. Open-Bay and Single-Family Room Neonatal Intensive Care Units. Environment & Behavior. 2008; 40(2): 249-68. PMid: 31122664. http://dx.doi.org/10.1177/0013916507311551

[12] Smith TJ, Schoenbeck K, Clayton S. Staff perceptions of work quality of a neonatal intensive care unit before and after transition from an open bay to a private room design. Work. 2009; 33(2): 211-27. doi: 10.3233/wor-2009-0868. PMid: 44319356.

[13] Chhokar R, Engst C, Miller A, Robinson D, Tate RB, Yassi A. The three-year economic benefits of a ceiling lift intervention aimed to reduce healthcare worker injuries. Applied Ergonomics. 2005; 36(2): 223-9. 2004.10.008. PMid: 17343815. http://dx.doi.org/10.1016/j.apergo.2004.10.008

[14] Engst C, Chhokar R, Miller A, Tate RB, Yassi A. Effectiveness of overhead lifting devices in reducing the risk of injury to care staff in extended care facilities. Ergonomics. 2005; 48(2): 187-99. PMid: 15764316. Language Code: eng. Date Revised: 20061115. Date Created: 20050314. Date Completed: 20060412. Update Code: 20111122. Publication Type: Journal Article.

[15] Miller A, Engst C, Tate RB, Yassi A. Evaluation of the effectiveness of portable ceiling lifts in a new long-term care facility. Applied Ergonomics. 2006; 37(3): 377-85. PMid: 19591406. http://dx.doi.org/10.1016/j.apergo.2005.05.012

[16] Li J, Wolf L, Evanoff B. Use of mechanical patient lifts decreased musculoskeletal symptoms and injuries among health care workers. Injury Prevention: Journal Of The International Society For Child And Adolescent Injury Prevention. 2004; 10(4): 212-6. PMid: 15314047. http://dx.doi.org/10.1136/ip.2003.004978

[17] Yassi A, Cooper JE, Tate RB, Gerlach S, Muir M, Trottier J, *et al*. A randomized controlled trial to prevent patient lift and transfer injuries of health care workers. Spine. 2001; 26(16): 1739-46. PMid: 11493843. Language Code: eng. Date Revised: 20090709. Date Created: 20010808. Date Completed: 20010927. Update Code: 20111122. Publication Type: Clinical Trial.

[18] Holman GT, Blackburn T, Maghsoodloo S. The effects of restricting space: A study involving a patient-handling task. Professional Safety. 2010; 55(7): 38-46. PMid: 52551504.

[19] Buckingham M, Coffman C. First, Break All the Rules, What the World's Greatest Managers Do Differently. New York, NY: Simon & Schuster. 1999.

[20] Kristensen TS, Borritz M, Villadsen E, Christensen KB. The Copenhagen Burnout Inventory: A new tool for the assessment of burnout. Work & Stress. 2005; 19(3): 192-207. PMid: 18909025. http://dx.doi.org/10.1080/02678370500297720

[21] Harris DD, Shepley MM, White RD, Kolberg KJS, Harrell JW. The impact of single family room design on patients and caregivers: executive summary. Journal of Perinatology. 2006; 26: S38-S48. PMid: 22543252. http://dx.doi.org/10.1038/sj.jp.7211583

[22] Ulrich RS, Zimring C. The role of the physical environment in the hospital of the 21st century: a once-in-a-lifetime opportunity. 2004 June 28, 2010. Available from: http://healthdesign.org/research/reports/physical_environ.php.

[23] Sadler BL, DuBose J, Zimring CM. The business case for building better hospitals through evidence-based design. Herd. 2008; 1(3).

[24] Chaudhury H, Mahmood A, Valente M. Nurses' perception of single-occupancy versus multioccupancy rooms in acute care environments: an exploratory comparative assessment. Applied Nursing Research: ANR. 2006; 19(3): 118-25. PMid: 16877190. Language Code: eng. Date Revised: 20061115. Date Created: 20060731. Date Completed: 20061012. Update Code: 20111122. Publication Type: Comparative Study.

[25] Hodder JN, Holmes MWR, Keir PJ. Continuous assessment of work activities and posture in long-term care nurses. Ergonomics. 2010; 53(9): 1097-107. PMid: 20737335. Language Code: eng. Date Created: 20100825. Date Completed: 20101229. Update Code: 20111122. Publication Type: Journal Article.

[26] Westen D, Rosenthal R. Quantifying construct validity: two simple measures. Journal Of Personality And Social Psychology. 2003; 84(3): 608-18. PMid: 12635920. http://dx.doi.org/10.1037/0022-3514.84.3.608

[27] Dimitrov DM, Rumrill JPD. Pretest-posttest designs and measurement of change. Work. 2003; 20(2): 159. PMid: 12671209.

[28] Maslach C, Jackson SE, Leiter MP, Schaufeli WB, Schwab RL. Maslach Burnout Inventory Manual. 3rd ed. Menlo Park, CA: Mind Garden, Inc. 1996.

[29] NSI Nursing Solutions I. 2013 National Healthcare & RN Retention Report. East Petersburg, PA NSI Nursing Solutions, Inc., 2013.

[30] Harris S. The $14 Billion Case for Safety in Healthcare. Franklin, TN: UL, LLC. 2014.

[31] WBDB Sustainable Committee. Whole Builidng Design Guide Washington, DC: National Institute of Building Sciences; 2012 [cited 2013 August 8, 2013]. Available from: http://www.wbdg.org/design/sustainable.php.

[32] Lovins H. Employee Engagement Is Key to Sustainable Success2012.

[33] Tsiou C, Efthymiatos G, Katostaras T. Noise in the operating rooms of Greek hospitals. Journal of the Acoustical Society of America. 2008; 123(2): 757-65. PMid: 28792028. http://dx.doi.org/10.1121/1.2821972

[34] Adriaenssens J, De Gucht V, Van Der Doef M, Maes S. Exploring the burden of emergency care: predictors of stress-health outcomes in emergency nurses. Journal of Advanced Nursing. 2011; 67(6): 1317-28. PMid: 60468159. http://dx.doi.org/10.1111/j.1365-2648.2010.05599.x

[35] Ang SH, Bartram T, McNeil N, Leggat SG, Stanton P. The effects of high-performance work systems on hospital employees' work attitudes and intention to leave: a multi-level and occupational group analysis. International Journal of Human Resource Management. 2013; 24(16): 3086-114. PMid: 89026276. http://dx.doi.org/10.1080/09585192.2013.775029

[36] Bogaert P, Clarke S, Willems R, Mondelaers M. Staff engagement as a target for managing work environments in psychiatric hospitals: implications for workforce stability and quality of care. Journal of Clinical Nursing. 2013; 22(11/12): 1717-28. PMid: 86864348. http://dx.doi.org/10.1111/j.1365-2702.2012.04341.x

[37] Drach-Zahavy A, Marzuq N. The weekend matters: exploring when and how nurses best recover from work stress. Journal of Advanced Nursing. 2013; 69(3): 578-89. PMid: 85479834. http://dx.doi.org/10.1111/j.1365-2648.2012.06033.x

[38] Fiabane E, Giorgi I, Sguazzin C, Argentero P. Work engagement and occupational stress in nurses and other healthcare workers: the role of organisational and personal factors. Journal of Clinical Nursing. 2013; 22(17/18): 2614-24. PMid: 89023839. http://dx.doi.org/10.1111/jocn.12084

[39] Garrosa E, Moreno-Jiménez B, Rodríguez-Muñoz A, Rodríguez-Carvajal R. Role stress and personal resources in nursing: A cross-sectional study of burnout and engagement. International Journal of Nursing Studies. 2011; 48(4): 479-89. PMid: 59775742. http://dx.doi.org/10.1016/j.ijnurstu.2010.08.004

[40] Hornung S. Alienation matters: Validity and utility of Etzioni's theory of commitment in explaining prosocial organizational behavior. Social Behavior & Personality: An International Journal. 2010; 38(8): 1081-95. PMid: 52981037. http://dx.doi.org/10.2224/sbp.2010.38.8.1081

[41] Lawrence LA. Work Engagement, Moral Distress, Education Level, and Critical Reflective Practice in Intensive Care Nurses. Nursing Forum. 2011; 46(4): 256-68. PMid: 69870826. http://dx.doi.org/10.1111/j.1744-6198.2011.00237.x

[42] Lee SM, Lee D, Kang C-Y. The impact of high-performance work systems in the health-care industry: employee reactions, service quality, customer satisfaction, and customer loyalty. Service Industries Journal. 2012; 32(1): 17-36. PMid: 69701406. http://dx.doi.org/10.1080/02642069.2010.545397

[43] Poulsen MG, Poulsen AA, Khan A, Poulsen EE, Khan SR. Work engagement in cancer workers in Queensland: The flip side of burnout. Journal of Medical Imaging & Radiation Oncology. 2011; 55(4): 425-32. PMid: 64904508. http://dx.doi.org/10.1111/j.1754-9485.2011.02281.x

[44] Sawatzky J-AV, Enns CL. Exploring the key predictors of retention in emergency nurses. Journal of Nursing Management. 2012; 20(5): 696-707. PMid: 78028965. http://dx.doi.org/10.1111/j.1365-2834.2012.01355.x

[45] Setti I, Argentero P. Organizational features of workplace and job engagement among Swiss healthcare workers. Nursing & Health Sciences. 2011; 13(4): 425-32. PMid: 67480377. http://dx.doi.org/10.1111/j.1442-2018.2011.00636.x

[46] Tones M, Pillay H, Fraser J. The influence of demographics and work related goals on adaptive development for work related learning amongst private hospital employees. Contemporary Nurse: A Journal for the Australian Nursing Profession. 2010; 36(1/2): 143-58. PMid: 59528693.

[47] Wonder AH. Engagement in RNs Working in Magnet®-Designated Hospitals. 2012; 42: 575-9. http://dx.doi.org/10.1097/NNA.0b013e318274b5a8