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Sustainable Building Certification in Healthcare and Patient Satisfaction

Brian Jay Goehner

Walden University

Walden University

College of Health Sciences

This is to certify that the doctoral study by

Brian Goehner

has been found to be complete and satisfactory in all respects,
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Review Committee
Dr. Brittany Smalls, Committee Chairperson, Health Sciences Faculty
Dr. Karin Polifko, Committee Member, Health Sciences Faculty
Dr. Rabeh Hijazi, University Reviewer, Health Sciences Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2020

Abstract

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by

Brian Jay Goehner

MS, University of San Diego, 2010

MBA, Webster University, 2003

BS, University of Phoenix, 2001

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Healthcare Administration

Walden University

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Abstract

Eco-friendly healthcare delivery concepts are becoming more accepted as hospital leaders seek to control energy costs, mitigate contributions to climate change, and preserve scarce resources. Leadership in Energy and Environmental Design (LEED) offers healthcare leaders a framework for designing and constructing sustainable facilities that meet efficiency goals. The purpose of this quantitative cross-sectional study was to build an understanding of whether LEED certification influences Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) ratings. Using complex systems theory as the framework, the research questions were focused on exploring if higher levels of LEED certification led to greater HCAHPS overall hospital ratings, if an association existed between LEED certification and HCAHPS overall hospital ratings, and if there were differences in HCAHPS scores across the survey's 10 dimensions between LEED-certified and non-LEED-certified hospitals. Data from the United States Green Building Council, Centers for Medicare and Medicaid Services, and American Hospital Directory were analyzed using descriptive statistics, analysis of variance, Pearson correlation, regression, and independent samples *t* tests. Results of the analyses showed that higher LEED certification did not produce greater HCAHPS overall hospital ratings, LEED certification was not associated with HCAHPS overall hospital ratings, and that LEED-certified hospitals exhibited higher HCAHPS ratings for certain dimensions of the HCAHPS survey. The study contributes to positive social change by developing a deeper understanding about LEED adoption among hospitals in the United States, which can reduce healthcare's environmental footprint.

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Dedication

This study is dedicated to my late grandparents whose love, patience, and support provided the foundational motivation for my academic and professional success. To my family and friends who accepted my absence from their lives while I pursued this journey, thank you for your encouragement and understanding. And finally, I dedicate this study to my partner in crime and life, Angelica Tan. Your many selfless sacrifices and late-night cheerleading sessions kept me grounded and inspired – You are my Heart!

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Section 1: Foundation of the Study and Literature Review

Introduction

Hospital buildings use a considerable amount of energy to operate sophisticated heating, air conditioning, and ventilation systems; to provide lighting; and to support laundry, laboratory, sterilization, information technology, food preparation and delivery, and refrigeration services (Commercial Buildings Energy Consumption Survey [CBECS], 2012). Financial resources directed toward energy procurement and consumption have contributed to the unsustainable rise in the national costs of healthcare delivery (Sagha Zadeh, Xuan, & Shepley, 2016). Therefore, hospital facility design and maintenance practices that consider energy management and conservation have taken on greater importance in healthcare financial and operational decision-making. However, the intersection between sustainable, energy-efficient healthcare organizations and the patient experience is underresearched.

This section presents the study topic and provides background information on the growing importance of sustainability, the Leadership in Energy and Environmental Design (LEED) sustainability certification, and the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) patient satisfaction survey. After explaining the problem statement, purpose of the study, and research questions, I provide an overview of complex systems theory and how it pertains to LEED and patient satisfaction. Next, an examination and evaluation of the existing literature pertaining to key variables and concepts is followed by definitions, assumptions, scope, and delimitations. The section concludes with a rationale for the study's significance and comments supporting the need for this research.

Problem Statement

The influence of LEED sustainability initiatives on HCAHPS ratings is not clearly understood. In the United States, LEED has become the predominant and most widely recognized green building certification system; however, green hospitals may not necessarily reflect optimal healthcare environments from patient perspectives if a greater value is placed on achieving certification than on patient recovery and well-being-related LEED credits (Golbazi & Aktas, 2016). Additionally, few researchers have investigated the benefits of sustainable facilities in healthcare contexts (Sadatsafavi & Shepley, 2016). For example, a ProQuest dissertation abstract search using the terms *LEED*, *sustainable*, or *green* coupled with *HCAHPS* yielded zero results for all publication dates. The gap in the research literature concerning LEED certification's impact on HCAHPS ratings warrants additional study.

This research topic is meaningful to healthcare for two reasons. First, the physical environment plays a role in patient perceptions; when planning building projects that target the physical environment, healthcare leaders should consider patient experiences related to noise levels, thermal comfort, room comfort, perceived cleanliness, and visual information messaging (American Society for Healthcare Engineering, 2016). Wingler and Hector (2015) concurred, emphasizing the impact of the built environment on healthcare constituents and advocating for design decisions that focus on factors that improve patient care. Second, it is necessary to understand if pursuing additional LEED credits to achieve advanced LEED certification levels results in commensurately higher HCAHPS scores. Hospitals earn advanced LEED certification levels by accumulating credits; hospitals that earn 40 credits become LEED certified, whereas hospitals that earn 80 or more credits achieve the highest, platinum, designation. Hospitals must incur upfront costs to become LEED certified and to achieve higher LEED certifications. Expenditures tied to LEED certification efforts that improve operational efficiency and sustainability metrics but either fail to yield improvements in or diminish the patient experience may not be recoupable. This concern is important because patient satisfaction has been legislatively linked to financial reimbursements and because consumers have greater access to comparative data for more informed medical decision making. For example, the Patient Protection and Affordable Care Act enacted into law in 2010 mandated that HCAHPS survey results would contribute to the Centers for Medicare and Medicaid Services' value-based incentive payment program (CMS, 2017a). Accordingly, there is a compelling need to determine the influence of LEED certification on HCAHPS patient satisfaction ratings.

Purpose of the Study

The overall purpose of this cross-sectional, quantitative study was to build an understanding of how different levels of LEED certification influence overall hospital HCAHPS scores; to establish if an association exists between LEED certification and HCAHPS ratings; and to determine if there are differences in HCAHPS scores across the survey's 10 dimensions between LEED-certified and non-LEED-certified healthcare facilities. CMS (2017b) described the HCAHPS survey as a measurement of patient satisfaction, and for this reason, the terms *HCAHPS* and *patient satisfaction* will be used interchangeably throughout this study.

Using complex systems theory as the theoretical framework, this study will offer relevant insights into the gap in the research literature by analyzing how HCAHPS scores in LEED- and non-LEED-certified facilities differ. I also evaluated whether achieving additional LEED points and higher certification levels influences HCAHPS scores. To address the aims of the study, two independent variables were selected. The first independent variable is the level of LEED certification among healthcare organizations, with *certified* representing the lowest level of certification and *silver*, *gold*, and *platinum* representing consecutively higher levels of certification. The second independent variable is LEED certification. The HCAHPS ratings represent the 10 dependent variables: (a) nurse communication, (b) doctor communication, (c) staff responsiveness, (d) communication/medicine, (e) discharge information, (f) care transition, (g) cleanliness, (h) quietness, (i) recommend hospital, and (j) overall hospital rating. It is not known how and to what degree the independent variables impact the dependent variables in healthcare organizations.

Research Questions and Hypotheses

RQ1: Based on the U.S. Green Building Council's (USGBC) LEED-certified healthcare facilities and the CMS HCAHPS ratings from January 1, 2018, through December 31, 2018, is there a difference in mean HCAHPS overall hospital ratings among successively higher LEED rating levels for LEED-certified hospitals in the United States?

$H_0$1: There is no difference in mean HCAHPS overall hospital ratings among successively higher LEED rating levels for LEED-certified hospitals in the United States.

H_a1: There is a difference in mean HCAHPS overall hospital ratings among successively higher LEED rating levels for LEED-certified hospitals in the United States.

RQ2: Based on the USGBC's LEED-certified healthcare facilities and the CMS HCAHPS ratings from January 1, 2018, through December 31, 2018, is there an association between LEED certification and HCAHPS overall hospital ratings for hospitals in the United States, while controlling for bed size, years LEED-certified, geographic region, and ownership type?

$H_0$2: There is no association between LEED certification and HCAHPS overall hospital ratings for hospitals in the United States.

H_a2: There is an association between LEED certification and HCAHPS overall hospital ratings for hospitals in the United States.

RQ3: Based on the USGBC's LEED-certified healthcare facilities and the CMS HCAHPS ratings from January 1, 2018, through December 31, 2018, is there a difference in the mean HCAHPS ratings for the survey's 10 dimensions between LEED-certified and non-LEED-certified hospitals in the United States?

$H_0$3: There is no difference in mean HCAHPS ratings between LEED-certified and non-LEED-certified hospitals for the survey's 10 dimensions.

H_a3: There is a difference in mean HCAHPS ratings between LEED-certified and non-LEED-certified hospitals for the survey's 10 dimensions.

Theoretical Foundation for the Study

Although numerous definitions of a *system* exist, common elements include the presence of a group of items, relationships among the items, contributions to a larger whole, and a purpose among items within the group (Cordon, 2013). Systems theory is predicated on the concepts of interconnectedness, dynamic interactions, and continuous environmental exchanges among the components of a system (von Bertalanffy, 1950). Initially, researchers used systems theory to describe behaviors within biological, sociological, and economic structures where, for example, reciprocal influences exist, such as those between a cell and its environment (von Bertalanffy, 1950). More recently, the holistic views of systems theory have permeated numerous and diverse domains, including organizational behavior, information technology, and healthcare delivery (Gulick Jr., 2019).

One of the most noteworthy attributes of systems theory is its capacity to promote conceptualization of complex multifaceted interactions between a system and its components (Peters, 2014). The rapidly changing field of global healthcare delivery exemplifies this type of sophisticated environment, wherein a systems perspective improves the quality of the observations of the whole, its parts, and their connections (Peters, 2014). Healthcare researchers have leveraged systems theory to understand where they should collect additional data, to better define hypotheses, and to better determine how interventions impact patient health (Peters, 2014).

The theoretical framework for this study was complex systems theory, which according to Kannampallil, Schauer, Cohen, and Patel (2011) expands on systems theory by including the properties of nonlinear behavior, emergence, and nondecomposability. Nonlinear behavior occurs in systems when a small change in one component leads to significant differences in outcomes (Plsek & Greenhalgh, 2001); *emergence* describes unanticipated behavioral properties resulting from interactions among system components (Kannampallil et al., 2011). Systems that cannot be understood by evaluating their components in isolation are said to be nondecomposable (Kannampallil et al., 2011).

Improvement initiatives introduced to systems, such as those found in healthcare, produce heterogeneous interactions within environmental, individual, and wider contexts (Lennox et al., 2018). For instance, researchers have determined that LEED-based interior building designs influence human factors such as provider-patient interactions, worker performance, thermal comfort, and staff effectiveness when performing critical tasks (Kim et al., 2015). Therefore, it is reasonable to suggest that implementation of a LEED program within a healthcare facility inspires systemic effects in cross-organizational structural, ecological, environmental, and human dimensions, reflecting the complex interrelationships found in care settings. LEED’s influence on patient satisfaction viewed within a complex systems theory framework has not been researched and reported in the literature, which reinforces the uniqueness of this study and its theoretical foundation.

The application of a complex systems theory framework to the analysis of LEED certification and patient satisfaction is appropriate because the built environment and patient population represent two different but intersecting systems in healthcare. Other theoretical frameworks that consider patient satisfaction either fail to account for environmental influences and the wider systemic determinants where patient care occurs or minimize the explicit and latent effects of the environment on patient perceptions of care. For example, Linder-Pelz's (1982) expectancy-value theory considers patient satisfaction only from the perspective of patients' prior beliefs, values, and expectations; Aragon's (2003) primary provider theory specifically links patient satisfaction to satisfaction with the primary provider, wait time for the provider, and satisfaction with the provider's assistants; and Andersen's (1995) behavioral model considers the physical environment but places greater emphasis on the use of health services as a predictor for patient satisfaction.

Nature of the Study

The nature of this study centers on quantitative research consistent with understanding how LEED certification and its individual certification levels influence HCAHPS ratings. Cross-sectional, ratio-level data from HCAHPS survey scores from the CMS and a listing of LEED-certified healthcare institutions from the USGBC's website provided foundational information for the quantitative analysis. A non-LEED-certified comparison group of healthcare facilities was required to evaluate HCAHPS scores between LEED-certified and non-LEED-certified facilities. The non-LEED-certified facilities were selected using purposive sampling based on geographical proximity, bed size, and ownership type similar to those of the LEED-certified organizations.

The specific quantitative approaches that were used to address the research questions were a one-way analysis of variance (ANOVA), a Pearson correlation coupled with multiple linear regression analysis, and an independent samples *t* test. RQ1 required an ANOVA to determine if there were differences between successively higher LEED certifications and HCAHPS ratings. RQ2 was best answered using a Pearson correlation and multiple linear regression analysis to evaluate if an association existed between LEED certification and HCAHPS overall hospital ratings. An independent samples *t* test was used for RQ3 to assess if LEED-certified hospitals have higher HCAHPS ratings than non-LEED-certified hospitals. Descriptive statistics, including mean HCAHPS scores and frequency distributions were used to describe LEED certification, healthcare institutions, and distribution of patient satisfaction scores included in the study.

Literature Search Strategy

The literature search strategy targeted peer-reviewed documents that were written within the last 5 years and found within Walden University's online library and Google Scholar. Specific databases searched included Academic Search Complete, BioMed Central, Business Source Complete, CINAHL Plus, and MedLine with Full Text, Emerald Insight, GreenFile, and Thoreau. The initial list of search terms focused on a combination of *LEED, Leadership in Energy and Environmental Design, health care, healthcare, hospital, patient satisfaction, HCAHPS,* and *satisfaction*. Because the preliminary literature search produced few results, additional search terms, including *green, green practices, green design, sustainable, environmental stewardship,* *environmental quality*, and *waste reduction* were appended into the existing search term combinations to expand the list of potential articles.

Literature Review Related to Key Variables and Concepts

The modern discourse on sustainability began with a written call to action advanced by the United Nation's World Commission on Environment and Development (WCED, 1987) titled *Our Common Future*. The report outlined an agenda for change based on identifying and implementing long-term sustainable development strategies, leveraging environmental concerns to produce greater intercountry cooperation, recommending management strategies for addressing global environmental concerns, and standardizing definitions of long-term environmental issues (WCED, 1987). Key to the suggestions outlined in the report was a focus on promoting a prosperous future through sustainably driven economic growth and purposeful political action that considered contemporary scientific evidence (WCED, 1987).

Pathways toward sustainable development described in the United Nations' Global Sustainable Development Report 2019 (UNGSDR) closely emulated the themes discussed in the WCED's 1987 report, albeit with greater urgency. For example, the UNGSDR advocated six fundamental tenets for hastening progress toward global sustainability, including reinforcing human well-being, shifting economies toward sustainability, building sustainable food and nutrition systems, slashing carbonization while increasing access to energy, promoting sustainable metropolitan development, and securing the global environmental commons while also highlighting the failure of nations to reach sustainability goals articulated in prior versions and sounding the alarm on ongoing irreversible damage to biophysical systems (Messerli et al., 2019). Embedded within the metropolitan development chapter of the UNGSDR report is an overview of the resources consumed by cities and their buildings. The report's authors emphasized that cities account for 41% of the water source area of the earth's surface while only occupying 2% of the overall land surface, contribute to 70% of greenhouse gas emissions, and consume 90 billion tons of raw materials, such as gravel, sand, steel, and wood. The rising consumption of finite resources used to establish cities and construct their buildings, coupled with an enormous generation of carbon and greenhouse gas emissions, underscores a need for greener buildings that produce a neutral or beneficial impact on the biosphere and its inhabitants.

The terms *green building, built environment,* and *sustainable construction* are synonyms for the same concept and have been defined as facilities purposefully designed, built, operated, renovated, and disposed of using environmental principles (Kibert, 2004); buildings that are planned, designed, constructed, and operated based on energy use, water use, indoor environmental quality, and material selection considerations (USGBC, 2019a); and construction that reduces or eliminates adverse impacts or creates positive impacts using ecologically friendly features such as renewable energy, efficient use of resources, and use of nontoxic, sustainable materials (World Green Building Council, 2019). The green building movement gained traction in the United States in the late 1990s with the number of green building certification applications through the USGBC doubling each year from 1999 through 2003 (Kibert, 2004). Since 2004, green building concepts and construction have made significant inroads into federal, state, and private building projects. The Coldwell Banker Richard Ellis commercial real estate service, in conjunction with Maastricht University, developed the U.S. Green Building Adoption Index, which from 2005 to 2019 showed that the percentage of office buildings in the 30 largest U.S. office markets receiving green certification steadily increased from 3% to 13% over the measurement period (Coldwell Banker Richard Ellis, 2019).

Hospitals are one of the most energy-intensive enterprises, consuming 836 trillion BTUs of energy and releasing 2.5 times more carbon emissions per square foot than commercial office buildings annually (U.S. Department of Energy, 2009). However, the adoption of green building design, construction, and operation in healthcare has been slower than in other industries. A 2012 analysis of LEED-registered buildings from the USGBC revealed that only 1,514 out of 46,416 LEED projects were linked to healthcare organizations, and only 1.2% of existing healthcare facilities were registered with LEED (Sagha Zadeh et al., 2016).

Historically, healthcare administrators have prioritized patient health, safety, and quality over sustainable building projects (Sagha Zadeh et al., 2016). Additionally, healthcare leaders have struggled to reconcile the compatibility of sustainable construction with healthcare outcomes (Sagha Zadeh et al., 2016). More recent data support the synergistic benefits of green building design and healthcare's patient-oriented objectives, which has positively shifted the trend toward greater integration of sustainable approaches in healthcare facilities (Sagha Zadeh et al., 2016).

One way patient perceptions of care is measured is through the CMS HCAHPS survey, which collects the voice of the patient across several dimensions and aggregates the results into summary indices available online for public review. The significance of HCAHPS data results from its use as a comparison tool when consumers select hospital services, a quality improvement mechanism for benchmarking against other measured organizations, and as a reimbursement criterion for CMS's Hospital Value-Based Purchasing Program (HCAHPSonline.org, 2017). The impact of certain hospital characteristics on patient perceptions of care measured through the HCAHPS process has received attention through several research efforts. Lehrman et al. (2010) found that top-performing hospitals in patient care experience were frequently small, rural, and located in Alabama, Kentucky, Mississippi, and Tennessee. Similarly, McFarland, Ornstein, and Holcombe (2015) determined that increasing hospital size predicted adverse HCAHPS scores. Magnet status has also been found to be a predictor for higher patient satisfaction scores (Chen, Koren, Munroe, & Yao, 2014). Given the preference that healthcare leaders place on patient well-being and the focus on how hospital characteristics influence patient satisfaction, it is imperative to understand how a greater emphasis on sustainable care environments can influence patient perceptions of care.

U.S. Green Building Council

Organizational overview. The USGBC was established in 1993 to encourage sustainability in the building industry and to develop a green building rating system that guides facility design, construction, operations, and maintenance (USGBC, 2019b). The organization champions four guiding priorities, including (a) government leadership by example in sustainable policy development and resource efficiency; (b) private sector market transformation driven by financial and structural incentives; (c) advancements in building codes and regulations based on green building certification; and (d) community-wide sustainability that fosters community connectivity and wellness, improves economic growth, and reduces environmental impacts (USGBC, 2019b). The USGBC's (2019b) LEED green building certification program, established in 2000, has become a benchmark standard for evaluating and certifying facilities built on environmentally sound concepts.

Dependent Variables

This section of the literature review explores existing research on patient satisfaction and the organizational elements measured in the HCAHPS survey. The HCAHPS survey framework deconstructs patient satisfaction into five organizational components: (a) care from nurses, (b) care from doctors, (c) hospital environment, (d) hospital experience, and (e) discharge information (HCAHPSonline.org, 2018). Associations between these organizational factors and patient satisfaction are well-supported in the literature.

Care from nurses. Kutney-Lee et al. (2009) studied the relationship between nursing and patient satisfaction across 430 hospitals in California, Pennsylvania, New Jersey, and Florida. The researchers found significant associations between favorable patient-to-nurse ratios in hospitals and *high overall rating of hospital, definite recommendation*, and *satisfaction with discharge communication* scores on the HCAHPS survey. One potential explanation for these results is that nurses with smaller patient loads can spend more time with their patients, listening to patient concerns and explaining courses of care. Research on implicit rationing of nursing care and patient satisfaction conducted by Papastavrou, Andreou, Psangari, and Merkouris (2014) and missed nursing care activities and patient satisfaction studied by Lake, Germack, and Viscardi (2016) determined care rationing and missed nursing tasks adversely impacted patient satisfaction, indirectly supporting the patient-to-nurse ratio conclusions noted by Kutney-Lee et al. (2009).

Care from doctors. Physicians exercise a critical role in the delivery of patient care through leading care teams, performing diagnoses, and prescribing treatments (Chen, Zou, & Shuster, 2017). An observational, retrospective study based on an analysis of 51,896 surveys of 914 physicians concluded that patient satisfaction is related to specialty and age such that obstetricians, surgeons, and increasing age resulted in higher patient satisfaction scores among inpatient adults (Chen et al., 2017). An empirical study of the demographic, professional, and empathy data of 847 Cleveland Clinic physicians concluded that specialty and sex influenced empathy, which in turn was correlated with higher scores on multiple HCAHPS items (Chaitoff et al., 2017). Like Chen et al. (2017), Chaitoff et al.'s (2017) research confirmed an association between physician specialties such as psychiatry, pediatrics, obstetrics, and gynecology and increased empathy and patient satisfaction scores.

Patient satisfaction with physician care is also influenced by how frequently and how closely doctors interact with their patients. Schmocker et al. (2016) studied the number of patient-physician interactions for patients with lengths of stay over 21 days and found that fewer consultations were strongly predictive of higher patient satisfaction with physician communication. These results were novel and counterintuitive since clinicians normally presume that greater physician-patient interactions are more favorably received by patients (Schmocker et al., 2016).

Finally, physician interpersonal characteristics have been found to impact patient satisfaction. Research performed by Farber et al. (2015) confirmed a positive association between physician ‘gaze time’ and patient satisfaction even in situations characterized by high electronic health record usage while Pollak et al. (2011) determined that physicians who used reflective statements and who displayed greater empathy generated higher patient satisfaction scores. Likewise, Boissy et al. (2016) found that an interventional communication skills course enhanced physician relationship-centered communication skills such as attitude and empathy, which then favorably impacted patient satisfaction scores.

Hospital environment. There is a growing body of evidence that the healthcare environment influences patient experience. Design components that integrate ample parking, ease of access, natural lighting, noise control, and architecture that facilitates feelings of patient inclusion influence levels of patient satisfaction (Jacobs, 2016). Siddiqui, Zuccarelli, Durkin, Wu, and Brotman (2015) investigated changes in patient satisfaction arising from the relocation of care services to a building with patient-centered design and observed statistically significant improvements in patient satisfaction measures related to quietness, cleanliness, temperature, and room décor. Facility enhancements and strategies specifically targeting noise control yielded commensurate improvements in patient satisfaction (Hedges, Hunt, & Ball, 2019; Walker & Karl, 2019), and directed approaches for providing cleaner healthcare environments resulted in more favorable measures of patient satisfaction (Fornwalt & Riddell, 2014).

Hospital experience. The HCAHPS survey measures patients' hospital experience with questions related to medication administration, pain management, and restroom assistance (HCAHPSonline.org, 2018). Medication shortages (McLaughlin et al., 2013) and delays in medication administration (Juarez, Chahoud, & Brody, 2019) have been shown to increase patient complaints and reduce patient satisfaction, while research that evaluated self-administered medication processes have suggested improvements in patient satisfaction through reinforcement of patient autonomy for certain patient groups (Richardson, Brooks, Bramley, & Coleman, 2014). Otani, Chumbler, Herrmann, and Kurz (2015) and Buvanendran et al. (2015) determined that inpatients who required medication for pain during hospitalization or who experienced increased pain intensity while hospitalized or at discharge experienced reduced care satisfaction. At present, there is no literature that discusses the relationship between restroom assistance and patient satisfaction.

Discharge instructions. The methods in which discharge instructions were administered shaped how patients perceive discharge processes. A patient's apprehension, uncertainty, or lack of understanding during the discharge phase of the care pathway led to increased readmission rates and reduce satisfaction with the hospital experience (Waniga, Gerke, Shoemaker, Bourgoine, & Eamranond, 2016). Discharge instructions that incorporated pictograph enhancements (Hill et al., 2016), teach-back approaches (Kelly & Putney, 2015; Gillam, Gillam, Casler, & Curcio, 2016; Scott, Andrews, Bulla, & Loerzel, 2019), and multimodality processes that assimilated video, medication sheets, and teaching rooms (Hovsepian, McGah, & O'Brien, 2017) bolstered patient satisfaction scores.

Independent Variable

Leadership in Energy and Environmental Design certification. The USGBC awards LEED certification according to credits earned across a range of categories, such as location and transportation, sustainable sites, water efficiency, materials and resources, and indoor environmental quality (USGBC, 2019c). Credits earned in each category are aggregated and the total value is used to award the appropriate LEED designation. Table 1 lists the LEED certification levels and the corresponding credits required to attain particular designations.

Table 1

Leadership in Energy and Environmental Design Certification Rating Levels

	Certified	Silver	Gold	Platinum
Points	40–49	50–59	60–79	80+

LEED projects are classified as building design and construction, interior design and construction, building operations and maintenance, neighborhood development, homes, cities and communities, recertification, and LEED zero (USGBC, 2019c). Healthcare facilities applying for LEED certification do so under the LEED building design and construction, healthcare dimension (LEED BD+C: Healthcare). There are eight measured content areas in the LEED BD+C: Healthcare category, focusing on location and transportation, sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation, and regional priority (USGBC, 2019d). The USGBC's LEED BD+C: Healthcare checklist contains several prerequisite tasks in five of the eight categories; the prerequisites do not contain a point value but must be accomplished to gain any point credit for a particular category (USGBC, 2019d).

Covariates

Number of licensed beds. The number of licensed beds represents the relative size of a healthcare organization; common perceptions suggest that larger hospitals have access to more human and economic resources and offer a wider array of services to their patients. Research has supported distinctions among hospitals based on their size. For example, McFarland, Johnson Shen, Parker, Meyerson, and Holcombe (2017) observed that larger hospitals tend to receive lower aggregate patient satisfaction scores than smaller hospitals, and Brown et al. (2014) found that greater hospital capacity was related to lower 30-day readmission rates. Including the number of licensed beds as a control variable will validate the contribution, if any, of hospital size on the results of this study. Lopez-Gonzalez, Pickens, Washington, and Weiss (2012) recommended stratifying hospitals as small, medium, or large according to region, location, and teaching status.

Geographic region. Distinctions exist in how states adopt and administer healthcare policies across the nation (CMS, 2019a). Differences in policies drive variations in caregiver, patient, and health system behaviors, access to care, reimbursements, and utilization. The Healthcare Cost and Utilization Project's (HCUP) 2018 statistical brief noted that the West had the lowest rate of hospitalizations, but the highest average cost per stay and the East South Central division received a disproportionately higher share of hospital stays while the Pacific and Mountain divisions had a disproportionately lower share of hospital stays relative to the U.S. population in 2016 (Freeman, Weiss, & Heslin, 2018). Although I could not locate any studies that investigated how region impacted HCAHPS scores, it is conceivable that geographic region could influence the relationship between LEED certification and patient satisfaction and should be considered. For this study, hospitals will be assigned to a geographic region according to the U.S. Census Bureau’s nine divisions: (a) Pacific, (b) Mountain, (c) West North Central, (d) East North Central, (e) Middle Atlantic, (f) New England, (g) South Atlantic, (h) East South Central, and (i) West South Central.

Type of hospital. Research has discerned that for-profit, nonprofit, and government-owned ownership categories motivate differences in healthcare decision-making and business practices. Freedman and Lin (2018) found evidence that nonprofit hospitals are less likely to offer unprofitable care services in markets characterized by greater for-profit competition, and Hansen and Sundaram (2018) observed that nonprofits employ higher levels of noncare provider staff than for-profit hospitals, which reduced operating margins but significantly improved quality and patient satisfaction measures. Additionally, nonprofit hospitals demonstrated a higher propensity for adopting population health management activities than government and privately owned hospitals (Meghan, Atkins, Liu, & Tregerman, 2018). Variations in hospital characteristics across ownership types could impact associations between LEED and measures of patient satisfaction. This study will include ownership type as a covariate according to nonprofit, privately owned, and government-owned categories.

Definitions

Centers for Medicare and Medicaid Services (CMS): A division of the U.S. Department of Health and Human Services tasked with administering the nation's major healthcare plans and producing and distributing research reports on the state of the nation's healthcare system (CMS, n.d.).

Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS): A national, standardized survey of patients' experience of hospital care that is administered to a random sample of adult patients between 48 hours and six weeks post-discharge (CMS, 2017b).

Hospital Value-Based Purchasing Program: A CMS program that rewards acute care hospitals with financial incentives for meeting quality care metrics for Medicare beneficiaries (CMS, 2017a).

Implicit rationing of nursing care: A failure to deliver necessary nursing services due to a lack of resources (Papastavrou et al., 2014).

Leadership in Energy and Environmental Design (LEED): A green building rating system administered by the United States Green Building Council that awards certification to residential, commercial, and community builders for meeting a set of predefined sustainability criteria (USBGC, 2019c).

Licensed number of beds: The maximum number of beds that a healthcare entity is legally allowed to operate, although many facilities do not use all the beds they are licensed for (Agency for Healthcare Research and Quality, 2005).

Magnet status: A recognition program developed by the American Nurses Credentialing Center for healthcare organizations that pursue and implement successful nursing strategies and practices designed to improve patient outcomes (American Nurse Credentialing Center, n.d.).

Ownership type: A classification that stratifies hospital ownership according to non-profit, for-profit, federal, or government-owned status (Niles, 2019).

Patient satisfaction: A measure of whether a patient's expectations were met during a healthcare encounter (Agency for Healthcare Research and Quality, 2017).

Sustainable development: "A process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs" (World Commission on Environment and Development, 1987, p. 17).

Teach back: A method for confirming a patient's understanding of his discharge instructions by asking him to articulate the instructions in his own words (Agency for Healthcare Research and Quality, 2015).

Assumptions

In this study, I examined the relationship between LEED certification, successive levels of LEED certification, and patient satisfaction. It is possible that the addition of other variables to the model could provide a more robust explanation of the relationship between LEED certification and patient satisfaction, although I could find no studies that determined an optimal variable mix. Therefore, three common hospital characteristics, including the number of licensed beds, geographic region, and type of hospital, were selected for inclusion in the model as covariates.

A second assumption is that the CMS HCAHPS data collection processes were based on sound data collection techniques insofar as patients submitted accurate data during their surveys, no pattern existed among missing data in the data set that could prejudice results, patients selected to participate in the HCAHPS survey were chosen at random across the nation, and HCAHPS scores were validated as appropriate measures of patient satisfaction. Similarly, this study assumes that the USGBC accurately identified and classified certified healthcare organizations according to the correct level of certification and that the LEED certification database accurately presented all the current, certified healthcare organizations in the United States.

Scope and Delimitations

Scope of Study

The primary goals of this study were to determine if successive levels of LEED certification produced differences in HCAHPS overall hospital ratings, to understand if LEED certification was related to HCAHPS overall hospital ratings, and to evaluate the influence of LEED certification on HCAHPS ratings. Three secondary data sets provided the foundation for this study: patient satisfaction data was obtained from the CMS HCAHPS website, LEED certification data was extracted from the USGBC's LEED certification directory, and hospital characteristics were acquired from the American

Hospital Directory’s website. All data captured by the HCAHPS survey were deidentified for specific patient information by the CMS.

Delimitations

The boundaries for this study included only hospitals located in the United States and patient satisfaction scores obtained from the CMS HCAHPS survey from January 1, 2018, through December 31, 2018. Although hospitals employ a diverse panel of patient satisfaction instruments to evaluate perceptions of care, instruments beyond the HCAHPS survey were not considered in this study to reduce the adverse effects of confounding variables and to preclude differences in validity and reliability among instruments. Examples of theories most related to the area of study that were not considered include the impact that healthcare service quality, sociodemographic characteristics, and provider interpersonal skillsets have on patient satisfaction.

Generalizability

It is feasible that the analytical model and the corresponding results of this study could be generalized to other types of healthcare institutions such as outpatient clinics, long-term care facilities, academic medical centers, and ambulatory surgical centers interested in pursuing LEED certification. Further, healthcare administrators could use this study’s design to examine if LEED certification produces differential effects on patient satisfaction scores in healthcare organizations with dissimilar ownership types.

Significance of Study

Significance to Practice

This study is distinct because examinations of occupant responses to LEED-certified healthcare facilities is an underresearched subject in the literature (Xuan, 2016) even though there is an increasing focus on and adoption of LEED initiatives within the healthcare industry (Kim et al., 2015). The results of this study will provide healthcare leaders with an awareness of how LEED certification impacts patient perceptions and if incremental investments in obtaining credits for advanced LEED credentials have a related influence on improving HCAHPS overall hospital ratings. The importance of understanding the factors that shape patient satisfaction has increased in recent years as healthcare facilities seek to use patient survey information for self-assessment, accreditation, and compensation related to reimbursement rates (Shirley & Sanders, 2013).

Significance to Social Change

The findings could contribute to positive social change through two mechanisms. First, a positive association between LEED certification and increased HCAHPS ratings could influence the number of healthcare organizations that adopt green building practices and could stimulate further research into sustainable healthcare environmental initiatives that impact patients and healthcare delivery processes. Findings that demonstrate a weak or inverse association between LEED certification and HCAHPS ratings also provide social change utility since healthcare leaders could use these conclusions to direct scarce resources to other evidence-based programs that increase patient satisfaction rather than to LEED certification efforts.

Summary and Conclusions

A review of the literature revealed insufficient research into the linkages between sustainable healthcare facilities and patient satisfaction and, more specifically, if sustainable building certification influenced HCAHPS scores across hospitals within the United States. Although hospitals represent one of the most energy-demanding establishments (U.S. Department of Energy, 2009), leaders in these organizations have traditionally positioned patient-centered improvements, such as care delivery and quality, over building-efficiency projects (Sagha Zadeh et al., 2016). More recently, researchers have uncovered associations between hospital characteristics such as size and location and patient satisfaction (Lehrman et al., 2010; McFarland et al., 2015), suggesting that sustainable building design and construction could become increasingly important in healthcare decision-making that considers patient satisfaction ratings.

As hospitals experience greater competition for price and quality sensitive patients and increased pressure to provide value-based care, a need to reconcile investments in sustainable buildings with their effects on patient satisfaction develops. This study aims to fill the gap in the literature by corroborating or refuting a relationship between LEED certification and HCAHPS ratings for hospitals located in the United States. The healthcare administration domain of knowledge could benefit from the results of this study, enabling more informed decision-making for administrators considering investments in sustainable facilities and LEED certification.

This section introduced the concepts of LEED and patient satisfaction, detailed the purpose of the study, research questions and hypotheses, and theoretical foundation for the study, and provided a comprehensive literature review that revealed a significant gap in the current body of literature related to the influence of LEED certification on patient satisfaction ratings. Definitions of key terms, assumptions, scope, delimitations, and significance to practice and social change were also explained. The following section describes the research design and rationale, methodology, threats to validity, and ethical procedures.

Section 2: Research Design and Data Collection

Introduction

In 2018, healthcare spending in the United States reached $3.6 trillion, or 17.7% of the nation's gross domestic product (CMS, 2019b). To counter the increasing costs of providing care, healthcare leaders have focused efforts on facility sustainability projects that not only reduce energy consumption but also decrease environmental impact. Current research supports an economic case for sustainable building design and maintenance, demonstrating financial benefits from lower water and energy usage, maintenance and repair, reduced space reconfiguration, worker retention and recruitment, decreased risk and insurance rates, and better resale value (U.S. Department of Energy, 2019). Alternatively, few researchers have examined the impact that sustainable hospitals have on patient experience, particularly how LEED certification initiatives influence patient satisfaction. The purpose of this cross-sectional quantitative study was to further an understanding of how different levels of LEED certification influenced HCAHPS overall hospital ratings, to discern if there was an association between LEED certification and HCAHPS overall hospital ratings, and to determine if there were differences in HCAHPS scores across the survey's major dimensions between LEED-certified and non-LEED-certified healthcare facilities.

This section begins with a discussion of the research design and rationale and then transitions into methodology, which provides background information on the population, sampling and sampling procedures used to collect the data, and instrumentation and operationalization of constructs. Threats to validity are discussed and are then followed by an explanation of ethical procedures. I conclude with a summary that incorporates the significant elements of the section.

Research Design and Rationale

In this quantitative study, I used secondary data analysis to explore the relationship between LEED certification and patient satisfaction. Secondary data analysis is an increasingly popular method for conducting efficient healthcare research and is based on an investigation of existing data (Cheng & Phillips, 2014). The secondary data sets for this study included patient satisfaction scores obtained from the CMS HCAHPS survey from January 1, 2018, through December 31, 2018; the current list of LEED-certified hospitals retrieved from the USGBC's public website; and the publicly available American Hospital Directory. The independent variable was LEED certification, and the dependent variable was patient satisfaction, as measured by HCAHPS survey ratings. LEED certification is a nominal level variable, while HCAHPS ratings are ratio-level variables. The independent and dependent variables are related through the following research questions:

RQ1: Based on the USGBC's LEED-certified healthcare facilities and the CMS HCAHPS ratings from January 1, 2018, through December 31, 2018, is there a difference in mean HCAHPS overall hospital ratings among successively higher LEED rating levels for LEED-certified hospitals in the United States?

RQ2: Based on the USGBC's LEED-certified healthcare facilities and the CMS HCAHPS ratings from January 1, 2018, through December 31, 2018, is there an association between LEED certification and HCAHPS overall hospital ratings for hospitals in the United States, while controlling for bed size, years LEED certified, geographic region, and ownership type?

RQ3: Based on USGBC's LEED-certified healthcare facilities and the CMS HCAHPS ratings, is there a difference in the mean HCAHPS ratings for the survey's 10 dimensions between LEED-certified and non-LEED-certified hospitals in the United States?

Covariate variables included the number of licensed beds (continuous), years LEED-certified (continuous), geographic region (nominal), and type of hospital (nominal).

Research Design

The intent of this study was to understand if there are differences in overall hospital HCAHPS ratings for successively higher levels of LEED certification, if there is a relationship between LEED certification and HCAHPS overall hospital ratings, and if there are differences in HCAHPS ratings between LEED-certified and non-LEED-certified hospitals in the United States. A cross-sectional quantitative research design addressed the study's intent and contained four elements. First, descriptive statistics for each independent and dependent variable were computed and analyzed. Next, mean HCAHPS overall hospital ratings were compared using analysis of variance (ANOVA) to determine if a statistically significant difference among HCAHPS overall hospital scores existed for successive levels of LEED certification relative to RQ1. For RQ2, a Pearson correlational analysis was used to determine the strength of association between the independent and the dependent variables. A Pearson product-moment correlation is appropriate for determining the strength and magnitude of association between two variables measured on an interval or ratio scale (Creswell, 2017). A multiple regression analysis was then used to evaluate the relationship of the predictor variable to the dependent variable while controlling for bed size, years LEED-certified, geographic region, and type of hospital. Finally, RQ3 was analyzed using an independent samples *t* test to indicate if there were statistically significant differences between mean HCAHPS ratings across the survey's 10 dimensions for LEED-certified and non-LEED-certified hospitals.

Rationale

A cross-sectional quantitative research design based on ANOVA, correlational analysis, and independent samples *t* tests was appropriate for answering the research questions in this study because LEED certification and HCAHPS rating data are cross-sectional or representative of a moment in time. Furthermore, ANOVA, correlational analysis, and *t* tests provide insight into the differences and relationships that exist among variables (Creswell, 2017). Regression analysis also models the relationship among variables and provides predictive capability when certain conditions are met (Frankfort-Nachmias & Leon-Guerrero, 2018). In the context of this study, a predictive regression model could aid healthcare administrators in decision-making activities related to LEED implementation while concurrently recognizing its effect on HCAHPS ratings.

Methodology

Population

The target population for this study was the set of all LEED-certified hospitals located in the United States. The specific LEED certification that pertains to hospitals and other healthcare institutions is LEED BD+C, which is based on new construction or significant renovation to building core and shell (USGBC, 2019e).

Sampling and Sampling Procedures

The study sample consisted of a subset of all the LEED-certified hospitals located in the United States certified under the LEED BD+C standard; hospitals located outside the United States or those certified under an alternative LEED standard were excluded from this study. The list of LEED-certified hospitals was narrowed to include only those hospitals that participated in the HCAHPS survey process and that received LEED certification prior to the HCAHPS survey reporting period. A convenience sample strategy was used to select the non-LEED-certified hospital comparison set and employed bed size, ownership type, and geographic region criteria as a basis for inclusion.

Procedures for data collection. The USGBC's website provides publicly available information for all LEED-certified healthcare institutions. Access to the USGBC's list of certified hospitals did not require any special access permissions. HCAHPS patient satisfaction survey data are also publicly available online from Medicare.gov, and no special permissions were necessary to access any of the related online databases. The American Hospital Directory's website offers free, publicly available hospital profiles, which include key characteristics, services provided, utilization statistics, accreditation status, and financial information for 7,000 hospitals located in the United States (American Hospital Directory, 2019).

Sample size estimation. The G*Power calculator is a tool used for estimating sample sizes for several types of statistical tests (Heinrich Heine Universität Dusseldorf,

2020) and was used to establish the recommended sample size for this study. Because the research design called for an ANOVA, correlational and regression analysis, and a *t* test, G*Power calculations were completed for each instance, and the output with the greatest sample size was selected for this study. The sample size for the a priori ANOVA was 84, which was calculated using effect size = .4, alpha = .05, power = .85, and number of groups = 4. With alpha = .05, power = .85, and two-tailed test selection, the resulting sample size for the a priori bivariate correlation was 96. The sample size for the two-tailed a priori *t* test was 114 for each group using effect size = .4, alpha = .05, power = .85. Cunningham and McCrum-Gardner (2007) noted that the minimum acceptable beta or Type II error is usually .20, indicating that the minimum acceptable power, calculated as $1 - \beta$, is .80. I selected power = .85 to increase the likelihood of detecting a difference in medium-to-large effect size. After data cleansing, the final sample size only contained 22 LEED-certified hospitals, which did not meet the G*Power suggested sample size and precluded the use of random sampling.

Instrumentation and Operationalization of Constructs

Instrumentation. The development of a new or the use of an existing data collection instrument was not required for this study as the LEED certification registry and HCAHPS survey ratings are secondary, archival data sets. The LEED certification registry and HCAHPS survey ratings are publicly available data sources, and no special permissions are required to access and use the information in this study.

Operationalization of variables. Two independent, four covariate, and 10 dependent variables were used in the data analysis. The level of LEED certification, including certified, silver, gold, and platinum, formed the independent variable for RQ1, while LEED certification alone formed the independent variable for RQ2 and RQ3. HCAHPS survey major graded areas represented the 10 dependent variables. Table 2 summarizes the operationalization of the independent, covariate, and dependent variables.

Table 2

Operational Definitions of Variables

Name	Level of measurement	Values of variables
Level of LEED certification	Ordinal	1 Certified 2 Silver 3 Gold 4 Platinum
LEED certification	Ratio	0 - 110
Bed size	Ratio	0 - 1,000
Years LEED certified	Ratio	1 - 7
U.S. census region	Nominal	1 West - Pacific 2 Northeast - New England 3 South - South Atlantic 4 Midwest – East North Central 5 South – East South Central 6 Northeast – Middle Atlantic 7 South – West South Central
HCAHPS nurse communication	Ratio	0 - 100
HCAHPS doctor communication	Ratio	0 - 100
HCAHPS staff responsiveness	Ratio	0 - 100
HCAHPS communication/medicine	Ratio	0 - 100
HCAHPS discharge information	Ratio	0 - 100
HCAHPS care transition	Ratio	0 - 100
HCAHPS cleanliness	Ratio	0 - 100
HCAHPS quietness	Ratio	0 - 100
HCAHPS overall hospital rating	Ratio	0 - 100
HCAHPS recommend hospital	Ratio	0 - 100

Data analysis plan. The data analysis began with downloading information from the USGBC, American Hospital Directory, and HCAHPS survey rating websites into Microsoft Excel. The data extracts were screened for missing data elements, and hospitals with incomplete information pertaining to LEED certification or overall hospital

HCAHPS scoring were excluded from the study. Additionally, only hospitals that had achieved LEED-certification for an entire facility were included in the study, whereas hospitals with certain LEED-certified departments were excluded. After the data sets were cleaned in Microsoft Excel, they were exported into the Statistical Package for Social Sciences Version 25 (SPSS) for Microsoft Windows for analysis.

The following research questions and hypotheses provide the basis for this study:

RQ1: Based on the U.S. Green Building Council's (USGBC) LEED-certified healthcare facilities and the CMS HCAHPS ratings from January 1, 2018, through December 31, 2018, is there a difference in mean HCAHPS overall hospital ratings among successively higher LEED rating levels for LEED-certified hospitals in the United States?

> $H_0$1: There is no difference in mean HCAHPS overall hospital ratings among successively higher LEED rating levels for LEED-certified hospitals in the United States.
>
> H_a1: There is a difference in mean HCAHPS overall hospital ratings among successively higher LEED rating levels for LEED-certified hospitals in the United States.

RQ2: Based on the USGBC's LEED-certified healthcare facilities and the CMS HCAHPS ratings from January 1, 2018, through December 31, 2018, is there an association between LEED certification and HCAHPS overall hospital ratings for hospitals in the United States, while controlling for bed size, years LEED-certified, geographic region, and ownership type?

$H_0$2: There is no association between LEED certification and HCAHPS overall hospital ratings for hospitals in the United States.

H_a2: There is an association between LEED certification and HCAHPS overall hospital ratings for hospitals in the United States.

RQ3: Based on the USGBC's LEED-certified healthcare facilities and the CMS HCAHPS ratings from January 1, 2018, through December 31, 2018, is there a difference in the mean HCAHPS ratings for the survey's 10 dimensions between LEED-certified and non-LEED-certified hospitals in the United States?

$H_0$3: There is no difference in mean HCAHPS ratings between LEED-certified and non-LEED-certified hospitals for the survey's 10 dimensions.

H_a3: There is a difference in mean HCAHPS ratings between LEED-certified and non-LEED-certified hospitals for the survey's 10 dimensions.

The hypotheses for RQ1 were tested using a one-way, two-tailed ANOVA to determine if there was a statistically significant difference among the HCAHPS overall hospital score means for different levels of LEED certification. A p-value less than alpha = .05 would substantiate rejection of the null hypothesis and acceptance of the alternate hypothesis. A post-hoc, Tukey's honest significant difference (Tukey HSD) test is appropriate for identifying where the specific differences occurred among the groups tested if the null hypothesis was rejected; a p-value less than alpha = .05 in the Tukey HSD indicates a statistically significant difference between pairs of groups tested.

The hypotheses for RQ2 were tested using a combination of a Pearson correlation and multiple regression analysis. The Pearson correlation revealed if there was an association between LEED certification, the control variables, and HCAHPS overall hospital ratings. Subsequently, a regression analysis was performed for two models. The first model contained just the independent and dependent variable and the second model contained the independent variable, control variables, and the dependent variable. Two regression models were needed to determine if the addition of the control variables improved regression model two's R^2 value relative to model one.

An independent samples *t* test was used to test the hypotheses for RQ3. The null hypothesis was rejected and the alternate hypothesis accepted if the resulting p-values were less than alpha = .05. A Levene's test for equality of variances is a required component of the *t* test; the Levene's test evaluates the null hypothesis that the population variances are equal (Frankfort-Nachmias & Leon-Guerrero, 2018). If the F statistic is equal to or less than .05, the null hypothesis for the Levene's test is rejected and equal population variances is not assumed (Frankfort-Nachmias & Leon-Guerrero, 2018).

Threats to Validity

External Validity

Threats to external validity occur when inferences are drawn from a sample and are incorrectly applied to other situations, persons, or settings (Creswell, 2017). The sample for this study was drawn from the population of LEED-certified for-profit, not-for-profit, and government-owned hospitals, which could have vastly different operating cultures, patient populations, access to economic and technical resources, and strategic goals than small outpatient clinics, defense healthcare facilities, and nursing homes. As a result, broadly extrapolating the results of this study to other circumstances should be approached with caution.

Internal Validity

HCAHPS data was collected from a self-reported survey instrument that is administered by participating hospitals to a random sample of adult patients between 48 hours and 6 weeks after discharge (CMS, 2017b). Because HCAHPS survey data is a secondary data set, I do not have a means for improving internal validity. However, I do recognize that HCAHPS data could be affected by recall and self-reporting bias.

Statistical Conclusion Validity

Statistical conclusion validity is concerned with the reasonableness of the relationship conclusions drawn from the data (Trochim, 2020). Threats to statistical conclusion validity occur when researchers conclude that a relationship exists, when in fact there is no relationship or when researchers determine that no relationship exists, when in fact an association is present (Trochim, 2020). Ensuring sufficient statistical power provides a means for reducing the threat to statistical conclusion validity (Trochim, 2020); the statistical power selected for this study was .85, which denotes an 85% chance of discovering a relationship in the data if one exists. The small sample size of 22 LEED-certified hospitals previously noted suggests that statistical conclusion validity could be compromised and that the results of this exploratory study should be interpreted with caution.

Ethical Procedures

Prior to the data collections process, I obtained Institutional Review Board (IRB) approval from Walden University's IRB, Number 05-01-20-0653448. There were no human participants in this study, and there were no patient confidentiality concerns because all of the data in the LEED certification registry and HCAHPS survey database were publicly available, and HCAHPS patient information was de-identified by the CMS. Moreover, obtaining data from the HCAHPS survey database did not present a risk of harm from unauthorized disclosure of personally identifiable information for the survey's participants since the data was anonymous and retrospective. All data sets used for this study were stored on my personal computer and iCloud account, password-protected, and deleted after publication of the study.

Summary

The purpose of this quantitative study was to develop an understanding of how LEED certification influenced patient satisfaction as measured by HCAHPS ratings. This section discussed the research design and its rationale, the target population, sampling procedures and sample size estimation, and instrumentation and operationalization of variables. Section 2 also provided a detailed plan for the data analysis, presented threats to external, internal, and statistical conclusion validity, and addressed ethical procedures related to IRB approval and data handling and storage. The following section will present the data analysis and findings as they relate to the research questions and hypotheses.

Section 3: Presentation of the Results and Findings

Introduction

The foremost purposes of this quantitative research study were to examine if hospitals with higher levels of LEED certification have higher HCAHPS overall hospital ratings, to explore if a relationship exists between LEED certification and HCAHPS overall hospital ratings, and to determine if there were statistically relevant differences in HCAHPS major graded area ratings between LEED-certified and non-LEED-certified hospitals. In the United States, LEED is the gold standard for developing sustainable, environmentally friendly healthcare facilities (Sadatsafavi & Shepley, 2016); however, a review of the literature exposed a gap between LEED certification and its potential impact on patient satisfaction. Descriptive and inferential statistical techniques were employed to analyze the data sets and address the following research questions and their hypotheses:

RQ1: Based on the USGBC’s LEED-certified healthcare facilities and the CMS HCAHPS ratings from January 1, 2018, through December 31, 2018, is there a difference in mean HCAHPS overall hospital ratings among successively higher LEED rating levels for LEED-certified hospitals in the United States?

$H_0$1: There is no difference in mean HCAHPS overall hospital scores among successively higher LEED rating levels for LEED-certified hospitals in the United States.

H_a1: There is a difference in mean HCAHPS overall hospital scores among successively higher LEED rating levels for LEED-certified hospitals in the United States.

RQ2: Based on the USGBC's LEED-certified healthcare facilities and the CMS HCAHPS ratings from January 1, 2018, through December 31, 2018, is there an association between LEED certification and HCAHPS overall hospital ratings for hospitals in the United States, while controlling for bed size, years LEED-certified, geographic region, and ownership type?

H_02: There is no association between LEED certification and HCAHPS overall hospital ratings for hospitals in the United States.

H_a2: There is an association between LEED certification and HCAHPS overall hospital ratings for hospitals in the United States.

RQ3: Based on USGBC's LEED-certified healthcare facilities and the CMS HCAHPS ratings, is there a difference in the mean HCAHPS ratings for the survey's 10 dimensions between LEED-certified and non-LEED-certified hospitals in the United States?

H_03: There is no difference in mean HCAHPS ratings between LEED-certified and non-LEED-certified hospitals for the survey's 10 dimensions.

H_a3: There is a difference in mean HCAHPS ratings between LEED-certified and non-LEED-certified hospitals for the survey's 10 dimensions.

In Section 3, I explain the data collection of the secondary data set, describe the results of the statistical analyses, and summarize the answers to the research questions. Section 4 will include an explanation of the application to professional practice and the implications for social change.

Data Collection of Secondary Data Set

Following approval from Walden University's IRB (05-01-20-0653448), data were retrieved from the USGBC's LEED certification database, the American Hospital Directory, and from the CMS hospital compare website. Data collection for the LEED and American Hospital Directory data sets is an ongoing process; as hospitals become LEED-certified or as new hospitals gain regulatory approval for operation, they are added to their respective data sets. The data collection period for the CMS HCAHPS data set spanned the period from July 1, 2018, to June 30, 2019. Recruitment and response rate characterizations do not apply to the LEED and American Hospital Directory because these data sets are not survey driven. Recruitment and response rates for the CMS HCAHPS survey varies by hospital and is annotated in the data set. The CMS data includes footnotes that advise data users if the number of cases or patients is too low to accurately assess hospital performance. Data quality protocols were not outlined by the USGBC or American Hospital Directory on their websites and were not annotated in the corresponding data sets. CMS addresses HCAHPS data quality in its comprehensive CAHPS Hospital Survey Quality Assurance Guidelines, Version 15 publication (CMS, 2020).

The USGBC's LEED certification database contained 81 healthcare organizations, of which only 31 organizations participated in the HCAHPS survey process. Data cleansing further reduced the LEED sample size to 22 organizations due to organizations obtaining LEED certification after the CMS HCAHPS data collection period or the presence of HCAHPS footnotes that referenced insufficient participation in the data collection cycle. The HCAHPS survey data set contained 3,423 U.S. healthcare organizations. Hospital characteristics contained in the American Hospital Directory data set were manually appended to the LEED data set in Microsoft Excel and included ownership type and number of beds. The U.S. census region was also manually added to the LEED data set based on an organization's state of residence noted in the American Hospital Directory data extract. The final MS Excel data product was imported into SPSS for analysis.

The most significant discrepancy in the use of the secondary data set from the plan presented in Section 2 was that the USGBC's LEED certification database contained considerably fewer LEED-certified hospitals than what was indicated during the sample size estimation (N = 114). As a result, all data analysis was conducted using 22 hospitals based on prior eligibility criteria. Inadequate sample size can limit the generalizability of research findings (Tipton, Hallberg, Hedges, & Chan, 2017). A second discrepancy in the use of the secondary data set from the plan in Section 2 was that of the 22 LEED-certified organizations, 19 were classified as nonprofit, two were classified as for-profit, and one was categorized as a government-owned organization. The abbreviated number of for-profit and government-owned hospitals relative to the greater number of nonprofit hospitals in the sample was unexpected.

Descriptive and Organizational Characteristics of the Sample

The secondary data set contained 81 LEED-certified organizations, of which 59 hospitals were eliminated due to LEED-certification timing, lack of significant HCAHPS data points, or nonparticipation in the HCAHPS survey process. Table 3 presents the frequency distributions of the descriptive variables for the remaining 22 hospitals in the sample.

Table 3

Frequency Distribution of Descriptive Variables

Descriptive characteristics	All hospitals *N* = 22	%
LEED certification type/(points):		
Certified (40 to 49)	6	27.3
Silver (50 to 59)	11	50.0
Gold (60 to 79)	5	22.7
Years certified:		
1 to 2	5	22.7
2 to 3	3	13.6
3 to 4	6	27.3
4 to 5	6	27.3
> 5	2	9.1
Bed size:		
0 to 150	10	45.5
151 to 300	7	31.8
301 to 450	1	4.5
> 600	4	18.2
Geographic region		
Midwest - East North Central	8	36.4
South - West South Central	4	18.2
South - South Atlantic	3	13.6
Northeast - New England	2	9.1
South - East South Central	2	9.1
West – Pacific	2	9.1
Northeast - Middle Atlantic	1	4.5

The data in Table 3 shows that the independent variable, LEED certification type, contained three corresponding point categories, with 50% of the certifications occurring in the LEED silver grouping. The covariate *years certified* and *bed size* data in Table 3 indicate that the majority (54.6%) of the hospitals in the sample were LEED certified for 3 to 5 years, and 77.3% of the hospitals have fewer than 300 beds. Table A1 provides additional sample descriptive statistics, including length of LEED certification, number of beds, and HCAHPS ratings by LEED certification type.

Several key themes emerged from the descriptive statistics offered in Table A1. First, LEED-Gold hospitals had the highest mean number of years with LEED certification and had the greatest mean number of beds. Next, the mean HCAHPS ratings for the overall hospital, recommend hospital, communication about medicines, nurse communication, doctor communication, and care transition categories were all within 1 percentage point for each LEED certification level. Finally, LEED-certified hospitals with the highest gold ratings had the lowest mean scores for the cleanliness and quietness HCAHPS assessments.

Sample Representativeness of the Population

The sample for this research study was obtained from the USGBC's LEED certification directory, which contained 81 LEED-certified healthcare organizations in the United States. Each LEED-certified healthcare organization was then cross-referenced against the CMS HCAHPS database to confirm participation in the HCAHPS survey process and to validate receipt of LEED certification prior to the HCAHPS reporting period. This refinement activity yielded a final sample size of N = 22 hospitals. Because the sample size of N = 22 exactly matched the population of LEED-certified hospitals that participate in HCAHPS reporting, the sample is completely representative of the LEED-certified hospital population. Alternatively, the sample of LEED-certified hospitals was relatively small compared to the other 3,401 non-LEED-certified U.S. hospitals that participated in the HCAHPS reporting period; therefore, generalizing data from this study to other HCAHPS-participating organizations should be conducted carefully.

Results

The research design for this study contained three research questions, with each requiring a discrete statistical test. A one-way ANOVA, Pearson correlation followed by a multivariate regression, and an independent samples *t* test were used to analyze data for RQ1, RQ2, and RQ3, respectively. The following section includes an evaluation of the statistical assumptions, findings for the statistical analyses, and post-hoc tests organized by research question.

Research Question 1

RQ1 states, “Based on USGBC LEED-certified healthcare facilities and the CMS HCAHPS ratings, is there a difference in mean HCAHPS overall hospital scores among successively higher LEED rating levels for LEED-certified hospitals located within the United States?” Frankfort-Nachmias and Leon-Guerrero (2018) specified that a one-way ANOVA is appropriate for comparing means among more than two groups and that four assumptions about the characteristics of the sample are required, including that random, independent samples are used, the level of measurement for the dependent variable is interval-ratio, the population is normally distributed, and the population variances are equal. The first assumption was only partially met because the level of LEED certification is independent, but the sample was not randomly drawn. Assumption two was met since the HCAHPS overall hospital rating is a scale-level variable. Normality was tested for the overall hospital linear mean scores for each category of the independent variable in SPSS using the Shapiro-Wilk test with a p-value of .05. The Shapiro-Wilk test for normality is the most appropriate method for determining normality in sample sizes where $n \leq 50$ (Mishra et al., 2019). Table 4 presents the results of the test and indicates that the p-values for each LEED certification category were greater than .05, which confirms the data are approximately normally distributed and the null hypothesis should not be rejected.

Table 4

Shapiro-Wilk Test for Normality of Overall Hospital Linear Mean Score

LEED certification level	Statistic	df	Sig.
Certified	.866	6	.212
Silver	.957	11	.735
Gold	.914	5	.492

Note. Sig. = Significance

The final assumption regarding equality of population variances was also met; the dependent variable variances for the LEED certified, silver, and gold samples were 2.3, 1.9, and 2.3, respectively; Frankfort-Nachmias and Leon-Guerrero (2018) advised that identical sample variance is not required to satisfy the equality of variance condition.

The independent variable for the ANOVA was level of LEED certification, including certified, silver, and gold, and the dependent variable was HCAHPS overall hospital linear mean score. The one-way ANOVA was performed in SPSS using an alpha of .05. Table 5 contains the ANOVA's descriptive components, and Table 6 displays the output of the ANOVA assessment.

Table 5

ANOVA Descriptive Statistics

LEED certification level	N	*M*	SD
Certified	6	90.3	1.5
Silver	11	90.5	1.4
Gold	5	89.6	1.5
Total	22	90.3	1.4

The data in Table 5 shows that the overall hospital linear mean scores and their standard deviations were remarkably consistent for each LEED certification level. The overall hospital linear mean score was lower for LEED-gold facilities than for LEED-certified and LEED-silver hospitals.

Table 6

Results for One-Way ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.1	2	1.6	.8	.5*
Within Groups	39.3	19	2.1		
Total	42.4	21			

Note. Sig. = Significance; * = $p > .05$, two-tailed

The one-way ANOVA results expressed in Table 6 show an F-statistic of .8 and a p-value of .5. A smaller F-statistic indicates that there is less between-group variance than within-group variance, which increases the chance of failing to reject the null hypothesis (Frankfort-Nachmias & Leon-Guerrero, 2018). The F-statistic's p-value of .5

is also greater than alpha of .05, signifying that the null hypothesis for RQ1 should not be rejected—there is no meaningful statistical difference in mean overall hospital HCAHPS scores among successively higher LEED rating levels for LEED certified hospitals in the United States. A post-hoc, Tukey HSD test was not needed to identify where the specific differences occurred among the groups tested because the ANOVA demonstrated that no statistically significant difference in mean HCAHPS overall hospital scores existed among the LEED certification levels.

Research Question 2

RQ2 explored whether there was an association between LEED certification and HCAHPS overall hospital ratings for hospitals located within the United States while controlling for bed size, years LEED certified, geographic region, and ownership type. The independent variable, the number of LEED certification points, and the dependent variable, overall hospital linear mean score, are scale level variables. Covariates, including the number of licensed beds and number of years LEED certified are scale-level variables while geographic region and ownership type are nominal-level variables.

I used SPSS to create scatterplots for visually examining if a linear relationship exists between the continuous or scale-level variables before performing correlational analysis. Figures 1, 2, and 3 display the results of the scatterplot analysis.

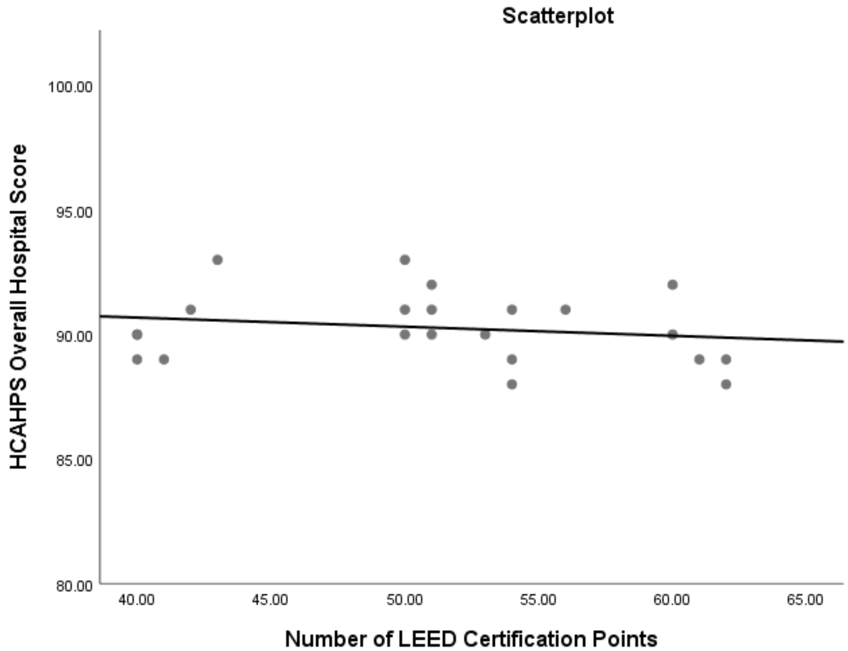

Figure 1. Scatterplot of overall hospital score by LEED certification points.

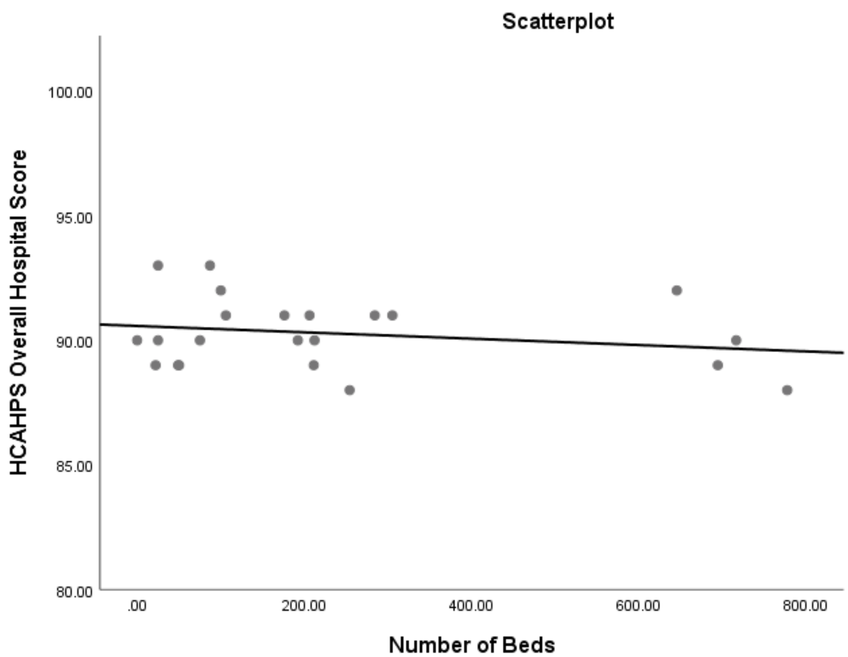

Figure 2. Scatterplot of overall hospital score by number of hospital beds.

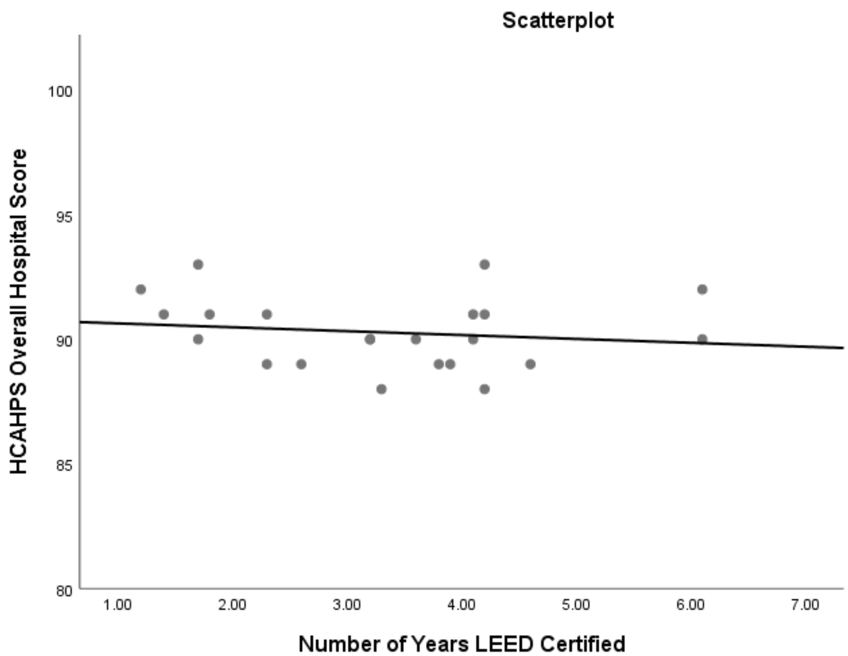

Figure 3. Scatterplot of overall hospital score by number of years LEED certified.

The scatterplots in Figures 1, 2, and 3 show the outcome of plotting the independent variable or covariates (x-axis) against the dependent variable (y-axis). All the scatterplots in these figures portray nominal, negative correlations, indicating that as the number of LEED certification points, number of beds, or number of years LEED-certified values increase, there is a slight reduction in the HCAHPS overall hospital score.

A Pearson correlation is a summary statistic that reveals the strength of association between two variables (Schutt, 2018). A two-tailed Pearson correlation analysis with an alpha of .05 was used to quantify and confirm the observations from the scatterplot evaluation. Table 7 displays the output from the SPSS Pearson test and shows that the independent variable (number of LEED certification points) and covariates (number of beds and number of years LEED-certified) all have nominal, negative correlations with the dependent variable (HCAHPS overall hospital score). However, because the significance is greater than alpha of .05 for all three correlational analyses, no statistically significant relationship exists between the independent and dependent variables and the covariates and dependent variable.

Table 7

Results of Pearson Correlation Test (N = 22)

		Number of LEED Certification Points	HCAHPS Overall Hospital Score	Number of Beds	Number of Years LEED Certified
Number of LEED Certification Points	*r*	1	-0.192	0.405	0.009
	P value		0.391*	0.061*	0.968*
HCAHPS Overall Hospital Score	*r*	-0.192	1	-0.220	-0.151
	P value	0.391*		0.325*	0.503*
Number of Beds	r	0.405	-0.220	1	-0.239
	P value	0.061*	0.325*		0.284*
Number of Years LEED Certified	*r*	0.009	-0.151	-0.239	1
	P value	0.968*	0.503*	0.284*	

* = $p > .05$, two-tailed

Although the scatterplots and Pearson correlation analyses confirmed no statistically significant relationships existed between the independent and dependent variables and the scale-level covariate and dependent variables, there is still confirmation-utility in performing a regression analysis that considers the simultaneous influence of the independent and covariate variables on the dependent variable. Two models formed the basis of the linear regression analysis. The first model only included the independent and dependent variables, while the second model incorporated the covariates into the analysis. The purpose of the two-model logic was to determine if an improvement in model fit occurred when controlling for bed size, years LEED-certified, geographic region, and ownership type.

There are four assumptions associated with linear regression: linearity, independence of observations, normality of distribution of residuals, and homoscedasticity or equal variance (Gerstman, 2015). Linearity, independence, and homoscedasticity can be evaluated using a scatterplot of the regression's standardized residuals and predicted values.

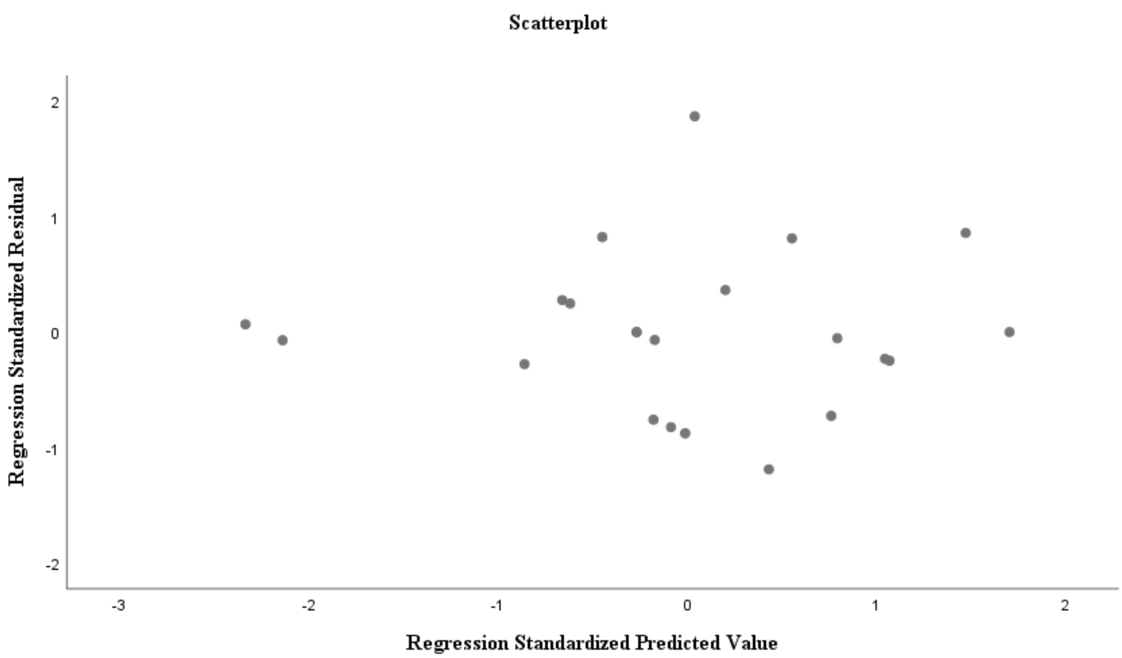

Figure 4. Scatterplot of standardized residuals against standardized predicted values.

The scatterplot in Figure 4 shows that there is approximately the same number of data points above and below the '0-line,' indicating that the linearity condition has been satisfied. Additionally, Figure 4 shows that the residual observations are independent—there is no pairing or matching of data points. The data points in Figure 4 also do not exceed +/-3 standard deviations, which confirms the presence of homoscedasticity. The

Shapiro-Wilk test for normality in Table 8 shows $p > .05$, so the null hypothesis stipulating that the data are approximately normally distributed should not be rejected. The favorable results observed in Figure 4 and Table 8 confirm that all four regression assumptions have been met.

Table 8

Shapiro-Wilk Test for Normality of Standardized Residuals

	Statistic	df	Sig.
Standardized Residual	.943	22	.228

Note. Sig. = Significance

Before performing the regression analysis, the geographic region and ownership type covariates were recoded from string variables into numeric variables using the transform function in SPSS. The recoding of these covariates into numeric data facilitated their inclusion in regression model 2 and allowed SPSS to calculate unstandardized coefficients, standardized coefficients, *t* statistics, and significance data in relation to each category's reference variable. The reference variable for geographic region was 'West – Pacific,' and the reference variable for ownership type was 'Government-Owned.'

The simple correlation (R) in Table 9's regression model summary shows that the independent and dependent variables in model 1 had a slight positive association (.192) while the independent, covariate, and dependent variables taken together in model 2 demonstrated a much stronger positive association (.715). However, the difference in the adjusted R-square values between the regression models was practically zero, suggesting that the regression equation did not improve with the addition of the covariates. A Durbin-Watson (DW) check for serial autocorrelation is only required for time-series data and is not relevant for cross-sectional survey data where there is no time series ordering (Albright & Winston, 2017). Consequently, a DW test for autocorrelation was not included in the regression model summary.

Table 9

Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.192[a]	0.037	-0.011	1.428
2	.715[b]	0.511	-0.026	1.439

[a]Predictors: (Constant), LEED Certification Points; [b]Predictors: (Constant), LEED Certification Points, Northeast_New_England, For_Profit, Number of Years LEED Certified, South_South_Atlantic, Northeast_Middle_Atlantic, South_East_South_Central, Number of Beds, South_West_South_Central, Midwest_East_North_Central, Not_For_Profit

Table 10 displays the SPSS regression ANOVA output. When the F-ratio is small, the explained variation is minor compared to the unexplained variation and the regression model provides little explanatory power (Albright & Winston, 2017). The F-ratio in Table 10 was nominal for both regression models. Further, the ANOVA analysis revealed that model 1’s p-value of .391 and model 2’s p-value of .535 were both greater than alpha = .05, illustrating that both models failed to achieve statistical significance.

Table 10

Regression ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.566	1	1.566	0.768	.391[a]
	Residual	40.797	20	2.040		
	Total	42.364	21			
2	Regression	21.665	11	1.970	0.952	.535[b]
	Residual	20.699	10	2.070		
	Total	42.364	21			

[a]Predictors: (Constant), LEED Certification Points; [b]Predictors: (Constant), LEED Certification Points, Northeast_New_England, For_Profit, Number of Years LEED Certified, South_South_Atlantic, Northeast_Middle_Atlantic, South_East_South_Central, Number of Beds, South_West_South_Central, Midwest_East_North_Central, Not_For_Profit

An evaluation of the regression coefficients listed in Table 11 affirmed that the independent variable and quantitative covariates had no statistically significant impact on the dependent variable; p-values or significance was greater than alpha = .05 in all instances. Also, the nonquantitative covariates (geographic region and ownership type) showed no statistically significant difference from their reference variables.

Table 11

Regression Coefficients

Model		Unstandardized Coefficients β	Std. Error	Standardized Coefficients β	t	Sig.
1	(Constant)	92.143	2.156		42.733	0.000
	LEED Certification Points	-0.037	0.042	-0.192	-0.876	0.391
2	(Constant)	90.115	3.212		28.056	0.000
	LEED Certification Points	-0.002	0.064	-0.008	-0.025	0.981
	Number of Beds	-0.004	0.002	-0.655	-1.647	0.131
	Number of Years LEED Certified	-0.491	0.280	-0.475	-1.755	0.110
	Not_For_Profit	0.902	2.743	0.223	0.329	0.749
	For_Profit	0.078	3.109	0.016	0.025	0.980
	Northeast_New_England	2.449	1.532	0.507	1.599	0.141
	South_South_Atlantic	2.938	1.562	0.727	1.880	0.089
	Midwest_East_North_Central	1.757	1.216	0.609	1.445	0.179
	South_East_South_Central	4.456	2.005	0.923	2.223	0.050
	Northeast_Middle_Atlantic	1.867	2.068	0.280	0.903	0.388
	South_West_South_Central	1.345	1.450	0.374	0.927	0.376

Note. Sig. = Significance

Research Question 3

The final research question examined if there were differences in mean HCAHPS ratings for the survey’s 10 dimensions between LEED-certified and non-LEED-certified hospitals located within the United States. The 10 HCAHPS survey dimensions consist of nurse communication, doctor communication, staff responsiveness, communication about medicines, discharge information, care transition, cleanliness, quietness, recommend hospital, and overall hospital rating. Independent samples *t* tests were used to assess differences in mean HCAHPS ratings for LEED-certified and non-LEED-certified hospitals for samples meeting all the *t* test assumptions; a nonparametric test was used to compare sample data that were not normally distributed.

Two independent sample *t* tests were used to detect if differences in mean HCAHPS ratings exist between LEED-certified and non-LEED-certified hospitals for data sets that passed the *t* test's statistical assumptions. The first *t* test included the 22 LEED-certified hospitals and the remaining 3,401 non-LEED-certified hospitals. Since there was a considerable difference in the size of the two samples in the first *t* test, a second *t* test was performed using the 22 LEED-certified hospitals and a purposive sample of 22 non-LEED-certified hospitals to confirm if the first *t* test's outcomes held when the sample sizes were equivalent. The purposive non-LEED-certified sample was selected using first geographic region, then ownership type, and finally bed size hospital characteristics in a best effort to match LEED-certified hospitals with a non-LEED-certified complement.

Statistical assumptions pertinent to the *t* test include independent samples, continuous data, homogeneity of variances, random samples, and normal distribution of the data (Frankfort-Nachmias & Leon-Guerrero, 2018). The two samples of LEED and non-LEED-certified hospitals were independent in that there was no relationship between the groups. All HCAHPS sample data are continuous, and the sample variances were analyzed using Levene's test in SPSS. Random sampling was not used to select the samples of LEED-certified and non-LEED-certified hospitals due to a shortage of LEED-certified hospitals in the United States and a need to intentionally select non-LEED-certified comparison organizations with characteristics similar to the LEED-certified facilities.

Normality was appraised using Shapiro-Wilk tests. For *t* test 1, a Shapiro-Wilk test for normality was performed for the LEED-certified organizations and their HCAHPS dimensions using SPPS; the results of this test are displayed in Table 12. A normality test was not performed for the remaining 3,401 hospitals in *t* test 1 because, according to Frankfort-Nachmias and Leon-Guerrero (2018), normality is assumed for sample sizes of $N > 50$. The Shapiro-Wilk test results in Table 12 revealed that HCAHPS dimensions 'communication about medicines' and 'doctor communication' had significance less than alpha of .05, denoting that these data samples deviated from a normal distribution and should be examined using a nonparametric test. The remaining Shapiro-Wilk test data samples met the normality assumption with significance greater than alpha of .05.

Table 12

Shapiro-Wilk Test for Normality of LEED-Certified Hospital HCAHPS Dimensions

HCAHPS Dimension	Statistic	df	Sig.
Staff Responsiveness	0.960	22	0.49
Overall Hospital	0.939	22	0.19
Communication About Medicine	0.843	22	0.00*
Nurse Communication	0.942	22	0.22
Doctor Communication	0.908	22	0.04*
Cleanliness	0.976	22	0.85
Care Transition	0.947	22	0.27
Discharge Information	0.960	22	0.48
Quietness	0.910	22	0.05
Recommend Hospital	0.954	22	0.37

* = $p < .05$; Sig. = Significance

For *t* test 2, A Shapiro-Wilk test was completed for the 22 non-LEED-certified hospitals identified in the purposive sample. Table 13 presents the results of the normality test, showing that the HCAHPS dimension ‘discharge information’ was the only element with significance less than alpha of .05 and with a non-normal distribution. The balance of the HCAHPS dimensions in Table 13’s Shapiro-Wilk test results met the normality assumption with significance greater than alpha of .05.

Table 13

Shapiro-Wilk Test for Normality of Non-LEED-Certified Hospital HCAHPS Dimensions

HCAHPS Dimension	Statistic	df	Sig.
Staff Responsiveness	0.977	22	0.86
Overall Hospital	0.924	22	0.09
Communication About Medicine	0.982	22	0.94
Nurse Communication	0.961	22	0.51
Doctor Communication	0.970	22	0.71
Cleanliness	0.963	22	0.56
Care Transition	0.934	22	0.15
Discharge Information	0.886	22	0.02*
Quietness	0.981	22	0.92
Recommend Hospital	0.932	22	0.13

* = $p < .05$, two-tailed

Table 14 summarizes the results of the assumption testing and identifies the appropriate test for each of the HCAHPS dimensions. Although the sample data for RQ3 did not meet all of the *t* test assumptions, I chose to proceed with the analysis. This decision presents limitations that are discussed in Section 4.

Table 14

Summary of t Test Assumption Testing Outcomes

Dimension	Independent Samples	Continuous Data	Homogeneity	Random Selection	Normality	Test
Staff respons.	Yes	Yes	No	No	Yes	t-Test
Overall hosp.	Yes	Yes	No	No	Yes	t-Test
Comm. med.	Yes	Yes	Not Tested	No	No	Mann-Whit. U
Nurse comm.	Yes	Yes	No	No	Yes	t-Test
Doctor comm.	Yes	Yes	Not Tested	No	No	Mann-Whit. U
Cleanliness	Yes	Yes	Yes	No	Yes	t-Test
Care trans.	Yes	Yes	No	No	Yes	t-Test
Discharge info.	Yes	Yes	Not Tested	No	No	Mann-Whit. U
Quietness	Yes	Yes	Yes	No	Yes	t-Test
Rec. hosp.	Yes	Yes	No	No	Yes	t-Test

Group statistics for *t* test 1 are displayed in Table 15. The mean HCAHPS scores are reasonably close between the LEED-certified and non-LEED-certified organizations for each of the dimensions. Alternatively, the standard deviation for the HCAHPS dimensions *staff responsiveness*, *overall hospital*, and *recommend hospital* are considerably different with greater variability present in the non-LEED-certified sample.

Table 15

Group Statistics for t Test 1

Dimension	LEED-certified	N	*M*	SD	Std. Error Mean
Staff respons.	Yes	22	86.73	2.55	0.54
	No	3401	85.73	4.28	0.07
Overall hosp.	Yes	22	90.27	1.42	0.30
	No	3401	88.50	3.34	0.06
Nurse comm.	Yes	22	92.32	1.46	0.31
	No	3401	91.64	2.46	0.04
Cleanliness	Yes	22	89.05	2.65	0.56
	No	3401	88.02	3.81	0.07
Care trans.	Yes	22	82.86	1.58	0.34
	No	3401	81.84	2.83	0.05
Quietness	Yes	22	85.14	4.14	0.88
	No	3401	82.33	5.11	0.09
Rec. hosp.	Yes	22	90.68	2.10	0.45
	No	3401	88.02	4.40	0.08

t test 1 compared the LEED-certified and non-LEED-certified mean HCAHPS scores for seven dimensions. Table 16 displays the outcomes from *t* test 1 and shows that the mean HCAHPS scores for *overall hospital*, *nurse communication*, *care transition*, *quietness*, and *recommend hospital* were significantly different between the LEED-certified and non-LEED-certified hospitals ($p < .05$).

Table 16

Results of t Test 1

		Levene's test		*t* test for equality of means		
Dimension	Equality of variance	F	Sig.	t	df	Sig.
Staff respons.	Yes	4.82	0.03[a]	1.09	3421	0.28
	No			1.81	21.77	0.08
Overall hosp.	Yes	9.85	0.00[a]	2.49	3421	0.01
	No			5.75	22.52	0.00*
Nurse comm.	Yes	4.53	0.03[a]	1.29	3421	0.20
	No			2.16	21.78	0.04*
Cleanliness	Yes	3.19	0.07[b]	1.27	3421	0.21
	No			1.81	21.57	0.08
Care trans.	Yes	5.21	0.02[a]	1.69	3421	0.09
	No			3.00	21.88	0.01*
Quietness	Yes	1.30	0.26[b]	2.57	3421	0.01*
	No			3.16	21.42	0.00
Rec. hosp.	Yes	8.85	0.00[a]	2.84	3421	0.00
	No			5.86	22.21	0.00*

[a] = Equal variance not assumed; [b] = Equal variance assumed; * = $p < .05$; Sig. = Significance. 2-tailed

t test 2 compared the mean scores of seven HCAHPS dimensions between 22 LEED-certified hospitals and the purposive sample of 22 non-LEED-certified hospitals. The group statistics for *t* test 2 are provided in Table 17. Similar to *t* test 1, the group statistics for *t* test 2 showed that the mean HCAHPS scores between the LEED-certified and non-LEED-certified hospitals were relatively close, with the non-LEED-certified hospitals displaying greater variation than the LEED-certified hospitals for each HCAHPS dimension.

Table 17

Group Statistics for t Test 2

Dimension	LEED certified	N	*M*	SD	Std. Error Mean
Staff respons.	Yes	22	86.73	2.55	0.54
	No	22	85.05	4.29	0.92
Overall hosp.	Yes	22	90.27	1.42	0.30
	No	22	88.50	3.10	0.66
Nurse comm.	Yes	22	92.32	1.46	0.31
	No	22	91.41	2.32	0.50
Cleanliness	Yes	22	89.05	2.65	0.56
	No	22	87.55	4.26	0.91
Care trans.	Yes	22	82.86	1.58	0.34
	No	22	81.73	2.57	0.55
Quietness	Yes	22	85.14	4.14	0.88
	No	22	82.41	4.82	1.03
Rec. hosp.	Yes	22	90.68	2.10	0.45
	No	22	87.77	4.12	0.88

The outcomes for *t* test 2 are displayed in Table 17. Significant differences in mean HCAHPS ratings between LEED-certified and non-LEED-certified hospitals occurred within the *overall hospital* and *recommend hospital* dimensions. This result differed from the *t* test 1 outcome in that *t* test 2 did not generate statistically significance differences in mean HCAHPS ratings for the *nurse communication, care transition*, and *quietness* dimensions.

Table 18

Results of t Test 2

		Levene's test		*t* test for equality of means		
Dimension	Equality of variance	F	Sig.	t	df	Sig.
Staff respons.	Yes	4.73	0.04[a]	1.58	42	0.12
	No			1.58	34.17	0.12
Overall hosp.	Yes	8.49	0.01[a]	2.44	42	0.02
	No			2.44	29.46	0.02*
Nurse comm.	Yes	2.04	0.16[b]	1.55	42	0.13
	No			1.55	35.35	0.13
Cleanliness	Yes	2.13	0.15[b]	1.40	42	0.17
	No			1.40	35.09	0.17
Care trans.	Yes	4.59	0.04[a]	1.77	42	0.08
	No			1.77	34.95	0.09
Quietness	Yes	0.76	0.39[b]	2.01	42	0.05
	No			2.01	41.08	0.05
Rec. hosp.	Yes	6.36	0.02[a]	2.95	42	0.01
	No			2.95	31.25	0.01*

[a] = Equal variance not assumed; [b] = Equal variance assumed; * = $p < .05$; Sig. = Significance. 2-tailed

Two Mann-Whitney U tests were required to evaluate if there were differences in the median HCAHPS ratings for *communication about medicines*, *doctor communication*, and *discharge information*. Mann-Whitney U test 1 evaluated if a difference in median HCAHPS ratings existed for the three dimensions between the 22 LEED-certified hospitals and the 3,401 non-LEED-certified hospitals in the United States. Mann-Whitney U test 2 determined if a difference in median HCAHPS ratings existed for the three dimensions between the 22 LEED-certified hospitals and the 22 non-LEED-certified hospitals chosen through purposive sampling. The Mann-Whitney U test relies on the assumption that the distribution of scores for both groups of the independent variable are similar. Figure 5 displays the distribution comparison for Mann-Whitney U test 1, and Figure 6 displays the distribution comparison for Mann Whitney U test 2. The LEED-certified and non-LEED certified distributions for the three HCAHPS dimensions in both Figures 5 and 6 are not similar. Therefore, the Mann-Whitney U test could not be used to evaluate if differences existed between the median ratings for the LEED-certified and non-LEED-certified HCAHPS dimensions *communication about medicines*, *doctor communication*, and *discharge information*. No other nonparametric tests were available to test differences in median scores when the samples have different sample sizes and dissimilar distributions.

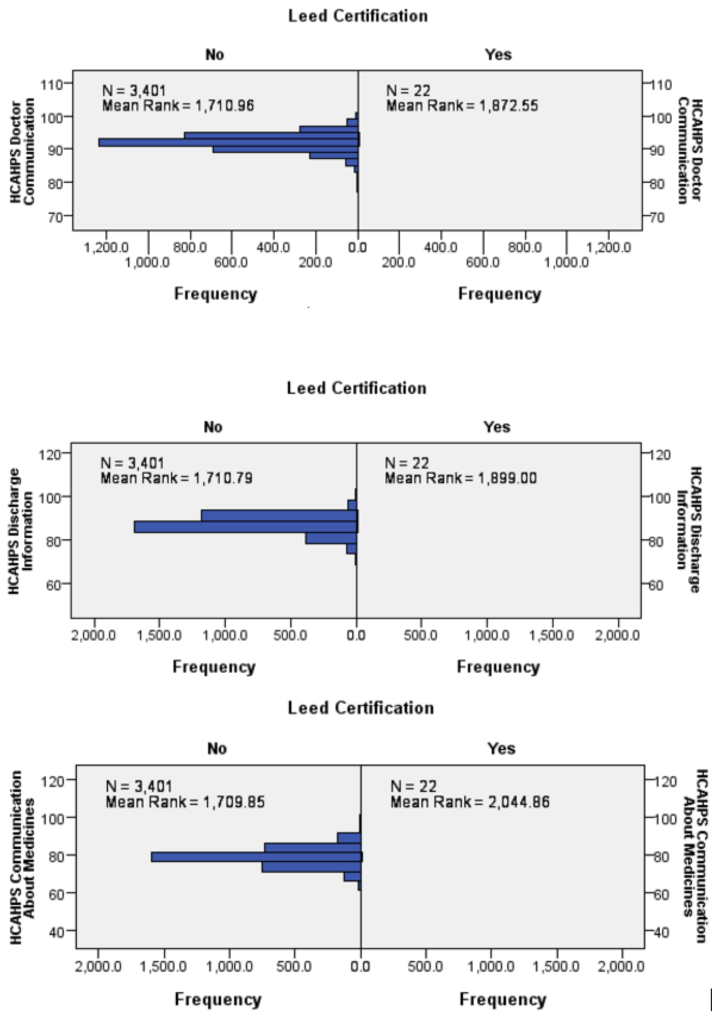

Figure 5. Summary of Mann-Whitney U test 1 distribution analysis.

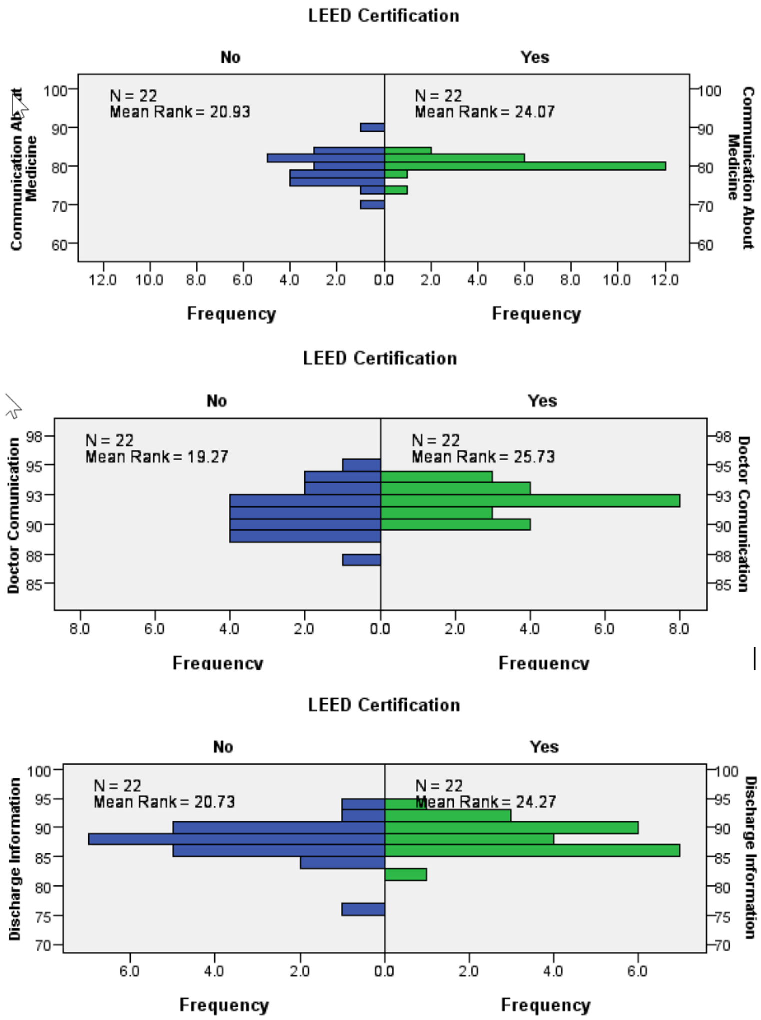

Figure 6. Summary of Mann-Whitney U test 2 distribution analysis.

Summary

Three research questions formed the foundation of this quantitative, retrospective study. The null hypothesis for RQ1 was retained, and the alternative hypothesis rejected; no differences in mean HCAHPS overall hospital scores among successively higher LEED rating levels for LEED-certified hospitals in the United States was identified using ANOVA analysis. The null hypothesis for RQ2 was also retained, and its alternative hypothesis rejected as I was not able confirm an association between LEED certification and overall hospital HCAHPS ratings for hospitals located in the United States while controlling for bed size, years LEED-certified, geographic region, and ownership type. The outcome for RQ2 was validated using a progressive series of statistical tests, including scatterplots, Pearson correlation, and regression analysis.

RQ3's null hypothesis stipulated that there were no differences in mean HCAHPS ratings for the survey's 10 dimensions between LEED-certified and non-LEED-certified hospitals in the United States. Two independent samples *t* tests were used to evaluate the seven HCAHPS dimensions that met the *t* test assumptions. The outcome of *t* test 1 demonstrated statistically significant differences in the HCAHPS rating dimensions *overall hospital*, *nurse communication*, *care transition*, *quietness*, and *recommend hospital* between LEED-certified and non-LEED-certified hospitals. The results from *t* test 2 only indicated statistically significant differences between LEED-certified and non-LEED-certified hospitals for the *overall hospital* and *recommend hospital* HCAHPS dimensions. I was unable to analyze differences between LEED-certified and non-LEED-certified hospitals for the HCAHPS dimensions *communication about medicines*, *doctor communication*, and *discharge information* since these data sets did not meet the *t* test or Mann-Whitney U test assumptions. To summarize, the null hypothesis for RQ3 was rejected and the alternative hypothesis accepted for the HCAHPS rating dimensions *overall hospital*, *nurse communication*, *care transition*, *quietness*, and *recommend hospital* while the null hypothesis was retained and the alternative hypothesis rejected for the remaining HCAHPS dimensions.

Section 3 offered a detailed statistical analysis of the study's three research questions. In Section 4, I will interpret the findings in relation to existing literature and in the context of the theoretical framework. Limitations of the study, recommendations for further research, and implications for professional practice and social change will also be provided.

Section 4: Application to Professional Practice and Implications for Social Change

Introduction

In this study, I used secondary quantitative data from the USGBC's LEED certification database and the CMS HCAHPS hospital survey to evaluate if hospitals with progressively higher LEED certification levels had better overall hospital ratings, to determine if there was an association between LEED-certification points and HCAHPS overall hospital ratings, and to establish if there were differences in HCAHPS ratings between LEED-certified and non-LEED-certified hospitals. The initial LEED-certified data set contained 81 hospitals. However, after data cleansing, only 22 hospitals were used in this study. The data analysis showed that no statistically significant difference existed between HCAHPS overall hospital scores among different LEED certification levels and that there was no association between LEED certification and HCAHPS overall hospital ratings. Alternatively, the data showed statistically significant rating differences between LEED-certified and non-LEED-certified hospitals for certain HCAHPS dimensions.

Interpretation of the Findings

Hospitals face a pressing financial and social need to improve energy efficiency, reduce costs, and decrease carbon footprints without generating adverse care delivery consequences. The primary purpose of this study was to better understand how LEED sustainability initiatives influence patient satisfaction, as measured by HCAHPS ratings. A review of the literature found that extensive energy usage in healthcare systems is unsustainable (Sagha Zadeh et al., 2016); that elements of the physical environment, such as heat consistency and lighting, impact patient experiences (American Society for Healthcare Engineering, 2016); and that patient perceptions of care quality were associated with architectural features that improved feelings of patient inclusion in the care process (Jacobs, 2016).

The findings of this study were in part novel because I was unable to locate research that involved the examination of whether higher LEED certification levels produce greater patient satisfaction or if LEED certification could be used to predict HCAHPS ratings. In this study, an ANOVA of mean HCAHPS overall hospital ratings for 22 LEED-certified hospitals found no statistical difference across different levels of LEED certification. This finding could be an artifact of the point-based LEED certification process wherein greater levels of certification are awarded based on the accumulation of LEED credits that would not necessarily be noticed by patients. For example, many of the LEED certification checklist items—like rainwater management, heat island reduction, light pollution reduction, and advanced energy metering—are not within the range of a patient's observation and cannot be directly or indirectly measured with the HCAHPS survey instrument.

Scatterplots of the independent (LEED certification points) and dependent (HCAHPS overall hospital rating) variables and control (number of years LEED-certified, number of beds) and dependent (HCAHPS overall hospital rating) variables indicated no association among these variable groupings. Similarly, a Pearson correlation conducted with the same variable groupings revealed no statistically significant relationship ($p > .05$ for all cases). A final examination of association was made using regression analysis. Two regression models were developed; the first model contained just the independent and dependent variables, and the second model included the independent, control (number of years LEED certified, number of beds, geographic region, and ownership type), and dependent variables. Both regression models failed to reach significance ($p > .05$), implying that the independent and control variables offered no explanatory or predictive power for the dependent variable.

The results of the scatterplots, Pearson correlation, and regression analyses reinforce the idea that HCAHPS overall hospital scores cannot be explained either by LEED certification points alone or in combination with number of years LEED certified, number of beds, geographic region, and ownership type. Two intersecting circumstances could substantiate this phenomenon. First, patients may assign substantially more importance to clinical variables, such as interaction with clinical staff, ease of medication administration, pain management, and treatment outcomes, than environmental variables when completing HCAHPS surveys. Second, patients may interpret the HCAHPS overall hospital rating solely in terms of their clinical experiences. These observations do not necessarily differ from the literature regarding environmental influences on patient satisfaction because much of the previous research has been focused on improvements in specific HCAHPS dimensions, like quietness and cleanliness (Fornwalt & Riddell, 2014; Hedges et al., 2019; Siddiqui et al., 2015; Walker & Karl, 2019) rather than the broader HCAHPS overall hospital rating. The lack of research exploring LEED or environmental influences on the HCAHPS overall hospital rating presents an obstacle for comparing and interpreting the results of this study.

The *t* test analysis that compared HCAHPS ratings across the survey's 10 dimensions demonstrated statistically significant differences in the *overall hospital*, *nurse communication*, *care transition*, *quietness*, and *recommend hospital* components between the LEED-certified and non-LEED-certified hospitals investigated in this study. There are tangential similarities between elements of this finding and those in the literature. For instance, Kutney-Lee et al.'s (2009) study found statistically relevant associations between small patient-to-nurse ratios in hospitals and high overall rating of hospital, definite recommendation, and satisfaction with discharge communication scores on the HCAHPS survey. Accordingly, LEED-driven facility design innovations that foster favorable patient-to-caregiver ratios could strengthen communication lines between nurses and patients and positively influence other HCAHPS survey dimensions. This logic stream aids in explaining how LEED-certified organizations could have garnered higher *nurse communication*, *care transition*, *overall hospital*, and *recommend hospital* ratings than non-LEED-certified hospitals in this study.

Hospitals are awarded acoustic environment LEED credits in two categories: sound isolation and room noise (USGBC, 2020). Of the 22 LEED-certified hospitals, three organizations received two LEED credits, two organizations received one LEED credit, and the remaining 17 hospitals received no LEED credits in the acoustic environment category (USGBC, 2020). Even though there was a statistically significant difference in quietness between LEED-certified and non-LEED-certified hospitals in this study, the majority of the LEED-certified hospitals did not receive any LEED credits for acoustic performance, which implies that these hospitals could have implemented sound control measures outside the LEED certification process that produced the finding.

No statistically significant difference was found in HCAHPS ratings between LEED-certified and non-LEED-certified hospitals for *staffing responsiveness* and *cleanliness*. Potential explanations for this outcome include the fact that LEED certification does not necessarily produce architectural changes in healthcare organizations that noticeably improve speed and accuracy of staff responses, and LEED certification alone does not promote ongoing cleanliness in hospital environments. The similarities in ratings between LEED-certified and non-LEED-certified hospitals for these dimensions suggest that common methods are used for responding to patient requests for help and for implementing and executing environmental cleaning and decontamination processes. However, because no other research exists that has studied LEED's impact on *staff responsiveness* and *cleanliness*, it is not possible to compare or confirm my findings.

Analysis of the Findings in the Context of the Theoretical Framework

Complex systems theory describes a type of system that contains numerous, interrelated components and relationships that interact with one another and produce emergent behaviors and patterns that could not be predicted from an examination of its individual elements. Kannampallil et al. (2011) explained that healthcare organizations contain complex systems and Ramaswamy et al. (2018) pointed out that quality improvement interventions produce complex nonlinear consequences. Complex systems also display dynamic emergence between cause and effect linkages, which may only be viewed in retrospect (Ramaswamy et al., 2018). This study's findings support the underpinnings of complexity found in healthcare organizations and healthcare system improvement efforts.

Interpreting the results of this study in terms of complex systems theory's characterizations leads to two observations. Due to the inherent complexity of healthcare systems, it is not possible to predict the array of interactions from an intervention aimed at an element of the system. The counterintuitive and negative findings in this research study provide suitable examples. In this study, progressive levels of LEED certification did not produce commensurate increases in HCAHPS overall hospital ratings, and there was no relationship between LEED certification points and HCAHPS overall hospital ratings even though several elements of the LEED certification framework, such as air control quality, places of respite, acoustic performance, quality views, interior lighting, thermal comfort, and furniture and medical furnishings would seem to directly and positively influence the patient experience. Since the HCAHPS survey was created to measure patient satisfaction with care and not the influence of LEED on patient satisfaction, it is likely that HCAHPS survey results are not appropriate for measuring the complex, systemic interactions among LEED certification, patient care, and other intervening elements of a hospital system.

A central tenet of complex systems theory is that a change in one element of a system produces inconsistent outcomes in other system components (Plsek & Greenhalgh, 2001). In this study, different levels of LEED certification did not generate statistically significant changes in the HCAHPS overall hospital rating across the certification types. However, LEED-certified hospitals realized higher ratings in *nurse communication*, *care transition*, *overall hospital*, *quietness*, and *recommend hospital* HCAHPS dimensions than their non-LEED-certified counterparts, illustrating the principle of unpredictable behavioral outcomes in complex systems.

Limitations of the Study

Although this study offered unique and valuable insight into LEED's influence on HCAHPS ratings, there are several limitations that should be considered. The small number of LEED-certified hospitals in the United States that participated in the HCAHPS survey process prevented randomization during sample selection, which greatly restricts generalization (external validity) of the study's results. Additionally, the small sample size of 22 LEED-certified hospitals was not sufficient to represent the 3,423 hospitals in the United States, contributing to an inability to generalize the study's results to different types of hospitals, hospitals in diverse geographic locations, or hospitals of different size.

Next, I relied on secondary data available from the USGBC, CMS, and American Hospital Directory to complete this study. Since I had no independent means for validating the quality and accuracy of the source data, I could not be certain that the data sets correctly represented the data advertised by their respective organizations. Data incorrectly coded by the collecting organizations could lead to skewed research results.

The absence of similar studies in the literature inhibits validation of this study's results. For instance, I could not locate any existing research that analyzed how different levels of LEED certification impacted HCAHPS ratings. One reason for insufficient research studies in the literature could be that LEED adoption among healthcare organizations, while beginning to increase, has not been as rapid or pervasive as in other industries. In fact, Sagha Zadeh et al. (2016) emphasized this particular challenge in their research.

Finally, this study did not explain the why behind the findings. Since quantitative secondary data was the only source of data for this study, qualitative opinions and experiences from patients and hospital leaders were not available, which could have provided insight into the research results and increased the value of the study.

Recommendations for Further Research

This cross-sectional, quantitative study provided valuable insight into LEED and its influence on HCAHPS ratings; however, further research is necessary to expand on and supplement its findings. Although the HCAHPS instrument is well-recognized and widely utilized in the United States, it does not provide sufficient information across the array of hospital experiences to adequately measure environmental influences on patient perceptions. If the rate of LEED adoption in hospitals is projected to increase over time, then it is certainly worth the effort to research, develop, test, and implement a survey instrument that is valid and reliable and that is capable of capturing LEED's influence on patient satisfaction.

A longitudinal investigation of LEED's influence on patient satisfaction ratings using a survey instrument specifically designed for this purpose would provide valuable information on whether patient perceptions changed over time as a result of greater integration of LEED and its concepts within hospital environments. A longitudinal study of LEED's nascent foray into different types of hospital organizations (government-owned, public, private), beginning with initial implementation and annually thereafter, would assist healthcare leaders in understanding if LEED adoption affected diverse hospital types differently over time.

Finally, I recommend that researchers replicate this study once a greater number of hospitals become LEED-certified. The results from the small sample size in this study may not reflect the same outcomes when a more robust sample of LEED-certified hospitals is examined. Additional research using a greater number of hospitals and a targeted, LEED-facing patient satisfaction measurement instrument is needed to confirm or refine the results of this study.

Implications for Professional Practice and Social Change

Professional Practice

Healthcare administrators have legal, fiduciary, and moral obligations to ensure the delivery of efficient, safe, and high-quality care. In their leadership, management, and problem-solving roles, healthcare administrators must embrace evidence-based process improvements that preserve scarce financial resources and improve sustainable operations while simultaneously preventing adverse impacts on patients and their families. The results of this study provide healthcare leaders with empirical evidence of LEED’s influence on patient satisfaction assessed through the evaluation of changes in HCAHPS survey ratings. Outcomes from this study show that healthcare administrators could embark on a LEED certification implementation effort or obtain higher LEED certification levels without adversely influencing HCAHPS overall hospital scores. Moreover, this study demonstrated that achieving LEED certification actually resulted in beneficial impact on patient perceptions of *nurse communication*, *care transition*, *overall hospital*, *quietness*, and *recommend hospital* HCAHPS dimensions.

Healthcare professionals should use this study as a baseline for understanding the relationship between LEED certification and patient satisfaction ratings and as a template for conducting further study. Comparing and contrasting outcomes from this study with findings from other studies would stimulate dialogue among healthcare administrators and their clinical counterparts about the systemic influence of LEED across the healthcare enterprise. These evidence-based discussions are an important focal point for healthcare organizations pursuing greater sustainability, reduced natural resource consumption, and improved waste stream management within the context of patient care delivery.

Positive Social Change

Positive social change is a concept wherein a change in an organization, system, environment, or relationship betters a person, institution, or society. As U.S. hospital leaders explore sustainability opportunities to reduce carbon footprints, energy and resource consumption, and waste generation, they must simultaneously consider how a path towards sustainability impacts their patients. This study and its findings contribute to positive social change by arming healthcare leaders with exploratory information about how LEED sustainability certification influences patient perceptions measured through the HCAHPS survey process.

Thought leaders and policymakers in hospital environments can leverage the information from this study when deciding whether to adopt an initial LEED certification project or gain higher levels of LEED certification. This study's outcomes should improve healthcare leaders' comfort levels for implementing LEED without creating an adverse impact on HCAHPS patient satisfaction results. Increasing the rate of LEED adoption across U.S. hospitals engenders positive and lasting social change through greater environmental sustainability, lower energy costs, and reduced community pollution levels.

The findings from this study also contribute to positive social change by exposing the idea that HCAHPS may not be the best tool for measuring LEED's impact on patient perceptions. This *new gap* in the research provides an opportunity for healthcare administrators to explore other means of assessing environmental impacts on hospital stakeholders and for tailoring data collection tools suitable for measuring these influences.

Conclusion

The persistent rise in the cost of delivering healthcare in the United States has created a burden on patients, their families, and communities and taxed the economic viability of local, state, and federal governments (Anderlini, 2018). Energy and water usage, building temperature control, waste stream management, lighting, and pollution abatement activities contribute to the cost of hospital operations, which flows through to patients and insurers. Hospital administrators and leaders can use the LEED framework for designing, constructing, and maintaining eco-friendly and energy-efficient hospitals. However, before embarking on a LEED sustainability implementation project, hospital leaders should understand if such an endeavor would impact patient perceptions and

HCAHPS ratings, which are embedded in the CMS Hospital Value-Based Purchasing Program for provider reimbursement.

A review of the literature found that hospitals are one of the most energy-intensive enterprises, (U.S. Department of Energy, 2009); that healthcare administrators have historically prioritized patient health, safety, and quality over sustainable building projects (Sagha Zadeh et al., 2016); and that LEED's influence on patient satisfaction in American hospitals is underresearched. This study examined the influence of LEED certification on HCAHPS survey ratings and contributed to closing the related gap in the literature. Data from the USGBC, CMS, and American Hospital Directory were collected and analyzed using ANOVA, Pearson correlation, regression, and *t* tests. Results from these statistical analyses showed that different levels of LEED certification produced no statistically significant change in HCAHPS overall hospital rating, that there was no relationship between LEED certification points and HCAHPS overall hospital rating, and that LEED-certified hospitals exhibited higher HCAHPS ratings for certain dimensions of the HCAHPS survey than non-LEED-certified hospitals. Healthcare administrators and leaders can use the results of this unique study to better inform LEED implementation decision-making and as a template for future research directed at confirming or expanding the outcomes of this study.

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Appendix: Descriptive Statistics of LEED-Certified Hospitals

Descriptive Characteristics	N	Min	Max	*M*	SD
Years LEED Certified:					
All	22	1.2	6.1	3.3	1.4
Certified	6	1.8	4.6	3.6	1.0
Silver	11	1.2	4.2	2.9	1.2
Gold	5	2.3	6.1	4.1	1.9
Number of Beds:					
All	22	0	777.0	236.9	244.8
Certified	6	22.0	305.0	116.9	116.0
Silver	11	0	716.0	230.6	241.3
Gold	5	100.0	777.0	394.8	141.0
HCAHPS Overall Hospital:					
All	22	88.0	93.0	90.3	1.4
Certified	6	89.0	93.0	90.3	.6
Silver	11	88.0	93.0	90.6	.4
Gold	5	88.0	92.0	89.6	.7
HCAHPS Recommend Hospital:					
All	22	86.0	94.0	90.7	2.1
Certified	6	86.0	94.0	90.5	1.1
Silver	11	88.0	94.0	90.9	.6
Gold	5	88.0	94.0	90.4	1.0
HCAHPS Staff Responsiveness:					
All	22	83.0	92.0	86.7	2.5
Certified	6	85.0	91.0	88.0	1.0
Silver	11	83.0	92.0	86.2	.9
Gold	5	85.0	88.0	86.4	.5
HCAHPS Communication Medicines:					
All	22	73.0	83.0	80.0	2.1
Certified	6	79.0	82.0	80.2	.5
Silver	11	73.0	82.0	79.6	.8
Gold	5	79.0	83.0	80.8	.9
HCAHPS Nurse Communication:					
All	22	89.0	95.0	92.3	1.5
Certified	6	91.0	94.0	92.5	.4
Silver	11	89.0	95.0	92.4	.5
Gold	5	90.0	94.0	92.0	.7
HCAHPS Doctor Communication:					
All	22	90.0	94.0	92.0	1.3
Certified	6	91.0	93.0	92.1	.3
Silver	11	90.0	94.0	92.0	.4
Gold	5	90.0	94.0	91.6	.7
HCAHPS Cleanliness:					
All	22	84.0	94.0	89.1	2.6
Certified	6	86.0	92.0	89.2	.9
Silver	11	87.0	94.0	89.6	.7
Gold	5	84.0	93.0	87.6	1.6

HCAHPS Care Transition:					
All	22	79.0	86.0	82.9	1.6
Certified	6	82.0	84.0	82.8	.4
Silver	11	79.0	86.0	83.1	.6
Gold	5	81.0	84.0	82.4	.7
HCAHPS Discharge Information:					
All	22	81.0	93.0	87.8	2.7
Certified	6	85.0	91.0	89.2	.9
Silver	11	81.0	93.0	87.1	1.0
Gold	5	86.0	89.0	87.8	.6
HCAHPS Quietness:					
All	22	77.0	91.0	85.1	4.1
Certified	6	78.0	90.0	85.3	1.7
Silver	11	77.0	91.0	85.9	1.3
Gold	5	78.0	87.0	83.2	1.7