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# A Study of Student Comfort and Satisfaction within Green Residence Halls

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# A STUDY OF STUDENT COMFORT AND SATISFACTION WITHIN GREEN RESIDENCE HALLS

by

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# ABSTRACT

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This research contributes to a better understanding of whether green university residential halls benefit students by creating better occupant comfort and satisfaction. Residential halls were considered green by this thesis if they achieved LEED certification. This study addresses Indoor Environmental Quality (IEQ) in relation to comfort and satisfaction among the college students living in residential halls. The present study surveyed Purdue University students living in a conventional residence hall (First Street Towers) compared with students living in a LEED Gold certified residence hall (Third Street Suites) regarding the comfort and satisfaction provided by their residence halls. A Building Use Studies (BUS) survey was utilized to measure IEQ factors on a seven-point Likert scale; the survey also provided an area for respondents' qualitative input. The results obtained from these descriptive statistics indicated that the Third Street Suites (LEED Gold certified) residence hall showed slightly higher mean satisfaction scores for *location*, *noise*, *temperature*, *air quality* and *overall comfort*; however, inferential statistics found no significant difference in the overall student comfort or satisfaction with the two residential halls. Although the results of this study concluded no significant impact, further studies could be conducted to measure other quantitative factors regarding comfort and satisfaction. Continued research of this kind could guide universities to build dormitories that better match students' IEQ needs and expectations.

# CHAPTER 1. INTRODUCTION

Sustainability has become a common topic of discussion in the construction industry, and green buildings are notable focus of today's society (Zuo & Zhao, 2014). The terms sustainability and green buildings have become interchangeable in sustainability research throughout the years (Zuo & Zhao, 2014). Alborz and Berardi (2015) and Princeton Review (2017) argue that nowadays, green buildings impact higher education; there are upwards of 200 colleges and universities with one or more green buildings. Moreover, most higher education institutions have implemented some form of sustainable practice, whether it be creating new agendas or simply adopting sustainable principles (Alborz & Berardi, 2015).

Various rating systems have been developed to measure whether a building is "green." For example, the United Kingdom (U.K.)-based Building Research Establishment (BRE) announced the Building Research Establishment Environmental Assessment Method (BREEAM) in 1990, the first assessment of its kind (Gou, Z., Prasad, D., & Lau, S. S., 2013). BREEAM is designed to manage and mitigate potential client risk by demonstrating sustainability performance through the building life cycle (Better with BREEAM, 2018). Other nations soon followed suit and created their own green assessment tools. The United States Green Building Council (USGBC) created the Leadership in Energy and Environmental Design (LEED), largely modeled after the BREEAM program (Gou et al., 2013). These rating systems provide their own specific requirements and a total point value required for the desired certification. As higher education campuses continue to increase the green building infrastructure, it is still uncertain whether or not green building design takes into account students' comfort and satisfaction.

## 1.1 Research Question

Do green buildings impact college student occupants' comfort and satisfaction in residence halls?

## 1.2 Scope

This thesis research surveyed college students living in Third Street Suites (TSS; LEED Certified) & First Street Towers (FST; conventional) residential halls at Purdue University in West Lafayette, Indiana. The survey sought input from students who lived in the specified residential halls to determine if green building played a role in occupant comfort and satisfaction. Students' responses were then compiled and analyzed to compare the two residential halls.

## 1.3 Significance

This research intended to obtain a better understanding of whether green residential halls benefit students by improving occupant comfort compared to that of students living in non-green residential halls. As stated by Nakisa Alborz and Umberto Berardi, "academic institutions are in a unique position to promote sustainability, as they have the ability and responsibility to change attitudes through education and awareness programs" (2015, p.25). If green buildings become standardized within campus construction, better indoor environmental quality can be achieved, which will influence sustainability in the construction industry. If green buildings can be shown to provide better comfort and satisfaction for students, this evidence can offer a potential catalyst to expand green building into academic buildings. This expansion could not only be beneficial to students, but also help universities promote green initiatives and potentially justify fully-green college campuses. Universities could see a return on their green investments as early as seven years after construction ("Benefits of Green Building," 2016).

## 1.4 Assumptions

Assumptions are intrinsic to research, and the following assumptions are identified as part of this research:

- Participants taking the survey responded in an honest manner to the survey questions.
- Participants responded to all survey questions and returned the surveys in a timely manner.
- Participants completed the survey in one sitting; therefore, their responses are not influenced by outside sources.
- Survey required approximately 5 to 10 minutes to complete, depending on the depth of responses.
- Submitted responses provided adequate data to complete the study.
- Survey was distributed to Residence Education Coordinators (RECs), who passed them along to each Resident Assistant (RA), who then administered the surveys to their student residents.

## 1.5 Limitations

Limitations are intrinsic to research, and the following limitations are identified as part of this research:

- The ways in which hall-specific amenities have affected student comfort and satisfaction with their residence hall cannot be controlled.
- Survey was only available for two weeks.
- REC and RA student survey distribution was limited to e-mail.

- The researcher cannot control if the survey participants experienced habituation bias or sponsor bias while responding to the survey. These biases could influence the survey results.

## 1.6 Delimitations

Delimitations are intrinsic to research, and the following delimitations are identified as part of this research:

- Only one LEED-Certified and one conventional building will be assessed via students currently living in First Street Towers & Third Street Suites residential halls at Purdue University's Main Campus (West Lafayette, Indiana).
- Only LEED standards of Indoor Environmental Quality were used in this study.
- The survey instrument used was a pre-established survey, the Building Use Studies (BUS) Survey.

## 1.7 Definitions

Comfort and Satisfaction:

> "Meeting or exceeding the expectations or needs in thermal comfort, acoustic comfort, temperature comfort, lighting comfort and overall health." (The WELL Building Standard v1 w/ October 2016 agenda, 2016)

Conventional Building (uncertified):

> A building that did not seek any LEED certification requirements

Ethnocentrism

> "characterized by or based on the attitude that one's own group is superior" (Merriam-Webster, n.d.)

Green Building:

> "the planning, design, construction, and operations of buildings with several central, foremost considerations: energy use, water use, indoor environmental quality, material section and the building's effects on its site." (Kriss, 2014)

Indoor Environmental Quality (IEQ):

> "Quality of a building's environment in relation to the health and well-being of those who occupy space within it. IEQ is determined by many factors, including lighting, air quality, and damp conditions." (CDC, 2017)

LEED for NC & MR– Leadership for Energy and Environmental Design for New Construction and Major Renovation:

> "…rating system for buildings that was designed to guide and distinguish high performance buildings that have less of an impact on the environment, are healthier for those who work and/or live in the building, and are more profitable than their conventional counterparts." (USGBC, 2009)

Sustainability:

> "Sustainability is the scope, quality, richness, and benignity of human culture, the biosphere and the economic life we make from them, and the distribution of those benefits, both now and over time." (Daly, 1996).

## 1.8 Summary

This chapter provides an overview of the research conducted by the current study. It has provided insight on the scope, significance, research question, as well as the limitations and delimitations that influenced the research. The next chapter will define IEQ in regards to sustainability and green building, and explain how IEQ was measured for this research.

# CHAPTER 2. REVIEW OF RELEVANT LITERATURE

## 2.1 Introduction

This chapter details the relevant literature pertaining to this thesis research. The focus of the current study is green building design, Leadership in Energy and Environmental Design (LEED), indoor environmental quality (IEQ), and IEQ measurement of occupant comfort and satisfaction. This chapter will seek to provide an overview of the methods and principles used throughout the methods portion of this thesis.

## 2.2 Green Building

Given the popularity of sustainable buildings due to reports of irreversible climate change, as well as ever-increasing energy costs (Warrick & Mooney, 2014), societal interest in green buildings has grown exponentially (Zuo & Zhao, 2014). Buildings classified as "green" typically follow building assessment guidelines such as LEED, Well Building Standard, or Living Building Challenge, all of which assess building factors including water, energy, environmental quality, and comfort. These assessment tools allow buildings to achieve a specific rating or certification related to their sustainability status.

Green assessment guidelines were first developed in the early 1990s in the U.K. by the Building Research Establishment, also known as BREEAM. After years of development, other nations around the world followed suit by creating their own various forms of green assessment tools. Leadership in Energy & Environmental Design (LEED) was developed in 1993 by the United States Green Building Council (USGBC) (Gou et al., 2013). In the following years Japan created the Comprehensive Assessment System for Building Environmental Efficiency

(CASBEE), China created the Green Building Label (GBL), and Hong Kong developed its own Hong Kong Building Environmental Assessment Methods (HK-BEAM) (Gou et al., 2013).

This research measures how LEED standards for green building affect the comfort and satisfaction of college student residents. Robichaud and Anantatmula (2010) asserted that green buildings focus on the following four pillars: minimizing impact on the environment, return on investment to both the developers and the local community, enhancing the health conditions of green building occupants, and consideration of the building life cycle during the planning and development process (p. 49). Green buildings are primarily designed and built based on the local climate and current assessment guidelines. Green buildings also typically use resources such as land, water, and energy more efficiently than conventional buildings, as well as improve overall student health (Kats, 2003). As green building development grows, so does the research conducted to develop new tools and revamp old ones to accommodate the changing climate conditions, economic development, and geographic conditions (Zuo & Zhao, 2014).

### 2.3 Benefits of Green Building

When dealing with the social aspects of green buildings, the focus on green building tends to be on the quality of living, occupant health and safety, and future professional development opportunities (Zuo & Zhao, 2014). Zuo and Zhao (2014) suggested that the cost benefits associated with green buildings are energy efficiency, water efficiency, and a smaller carbon footprint (Zuo & Zhao, 2014**)**. Green buildings have been shown to be more cost-effective regarding upfront investments, increase in value by 4 percent on average, and reduce day-to-day maintenance costs by up to 20 percent on an annual basis (McGraw-Hill, 2012).

Green design can earn up to ten times the initial investment required for green buildings, and features the financial benefits of lowered energy, water, waste, environmental, and emission

costs (Kats, 2003). Kats (2003) also noted that green building projects are most cost-effective when green design is incorporated into the early stages of the design process.

A case study by Ries et al. (2006) examined the benefits of green buildings by conducting a Post Occupant Evaluation (POE) survey to research the connection between green features and business performance. (Ries et al., 2006). Their study focused on a new LEED Silver certified office building compared to an older conventional office building. The results showed employees' superior IEQ in the LEED building than the conventional office building, and the authors suggested that the green building increased employee productivity (Ries et al., 2006).

According to Zuo and Zhao (2014), a common approach to analyze the characteristics of green buildings versus conventional buildings is to compare water efficiency, energy efficiency, indoor environmental quality, thermal comfort, and occupants' health and productivity (Zuo & Zhao, 2014).

## 2.4 LEED

LEED was created by the USGBC in 1993 by Rick Fedrizzi, David Gottfried, and Mike Italiano. **(**USGBC, 2017**).** USGBC is a non-profit organization that promotes sustainability in buildings, designs, and construction (USGBC, 2017**).** LEED has evolved from a single standard for new construction to six standards encompassing all aspects of the construction process (LEED, 2017). LEED was designed to achieve the following tasks:

- "Define "green building" by establishing a common standard of measurement;
- Promote integrated, whole-building design practices;
- Recognize environmental leadership in the building industry;
- Stimulate green competition;
- Raise consumer awareness of green building benefits; and

- Transform the buildings market." (LEED, 2017)

LEED has become the international standard for over 90,800 projects in various countries and territories around the world (USGBC, 2017). LEED has become integrated into new and existing construction, healthcare, schools, retail, and many other aspects of construction (Kajikawa, Y., Inoue, T., & Goh, T., 2011).

The LEED rating system is voluntary, and it is the principle standard by which green construction continues to outpace non-green construction growth in the U.S. By 2018, green construction is projected to contribute over 1.1 million jobs and $75.6 billion in U.S. wages alone (USGBC, 2017). The system evaluates environmental performance from the pre-design phase of construction to building occupancy (USGBC, 2009). The process must be requested by the owner and then initiated by a LEED-Accredited Professional. Buildings must follow environmental laws as a prerequisite of the LEED process. Once the building certification is achieved, the owners are required to share water and energy data for five years after occupancy. Certification completion can take up to 2 or 3 years, depending on the size of the building. The LEED evaluation also provides a definitive standard for what is considered sustainability in design, construction, and operations (USGBC, 2009). LEED buildings are classified as one of four levels: Certified, Silver, Gold, or Platinum. The Platinum level, the highest LEED achievement, requires 80 points or above. Table 2.1 indicates the points required for each category.

Table 2.1 LEED Point Scale

| Level | *Points* |
|---|---|
| Certified | 40-49 |
| Silver | 50-59 |
| Gold | 60-79 |
| Platinum | 80 and above |

LEED covers seven evaluation categories within its rating certification, and each category is allotted a certain amount of points (see Supplemental Information #3). One of the seven categories is Indoor Environmental Quality (IEQ). The IEQ point system, according to LEED BD+C: New Construction v3 – LEED (2009), is shown in Table 2.2.

Table 2.2 LEED Certification

Indoor Environmental Quality Credits

| Credit | Name | Required | Credit | Name | Required |
|---|---|---|---|---|---|
| 1 | Outdoor Air Delivery Monitoring | 1 | 5 | Indoor Chemical & Pollutant Source | 1 |
| 2 | Increased Ventilation | 1 | 6.1 | Controllability of Systems – Lighting | 1 |
| 3.1 | IAQ Management Plan – During Construction | 1 | 6.2 | Controllability of Systems – Thermal Comfort | 1 |
| 3.2 | IAQ Management Plan – Before Occupancy | 1 | 7.1 | Thermal Comfort – Design | 1 |
| 4.1 | Low-Emitting Materials – Adhesive & Sealants | 1 | 7.2 | Thermal Comfort – Verification | |
| 4.2 | Low-Emitting Materials – Paints and Coatings | 1 | 8.1 | Daylight & Views – Daylight | 1 |
| 4.3 | Low-Emitting Materials – Floor Systems | 1 | 8.2 | Daylight & Views – Views | 1 |
| 4.4 | Low-Emitting Materials – Composite Wood & Agrifiber | 1 | | | |

Despite LEED's international recognition and prestige, the certification process features documented issues. The LEED process is complicated and expensive. LEED makes no distinction for building location, allocates equal points to buildings built in cold and warm climates, and disregards building neighborhood and region (Environment & Ecology, 2018). LEED has been

criticized as a system oriented towards accumulating points rather than improving the environment (Environment & Ecology, 2018).

### 2.5 LEED's Indoor Environmental Quality (IEQ)

Indoor Environmental Quality is an important component of the LEED certification process. According to LEED for New Construction handbook (USGBC, 2009), the intent of the IEQ standards "is to establish minimum indoor air quality (IAQ) performance to enhance the indoor air quality of buildings, thus contributing to the comfort and well-being of the occupants" (USGBC, 2009, p. 70). IEQ is a component of both green buildings and conventional buildings; however, various research indicates that green buildings provide better IEQ than conventional, uncertified buildings. IAQ is one of the ultimate goals of the IEQ guidelines. Young Lee and Denise Guerin (2010) conducted a study on how the IAQ, thermal, and lighting quality of five LEED-certified office types affected employee environment satisfaction and job performance (Lee & Guerin, 2010). They found increased IAQ and job performance among employees with enclosed, private offices compared to those in high and low cubicles. They also found that occupants from four of the offices reported higher satisfaction regarding lighting and visual comfort (Lee & Guerin, 2010).

The goal of another study, by Sergio Altomonte and Stefano Schiavon (2013), was to determine if LEED buildings provided higher, lower, or equal IEQ satisfaction compared to uncertified buildings. Altomonte and Schiavon found that LEED building occupants showed equal satisfaction with the overall building and with their workspace as the occupants of conventional buildings (Altomonte & Schiavon, 2013).

These previous studies suggest that LEED buildings generally have a higher IEQ than conventional, uncertified buildings. The impact of IEQ on user satisfaction has also been the focus of several studies, which are discussed in the following paragraphs.

Mahbob, Kamaruzzaman, Salleh, and Sulaiman (2011) performed a correlation study regarding IEQ and productivity in the workplace by using articles, books, and journals to discuss how components of IEQ relate to each other. They conducted five case studies on a variety of office buildings, restaurants, and residential buildings. They found that IEQ affected workers' physical and psychological health. They also noted that acoustics and lighting ranked the lowest of the IEQ parameters (Mahbob et al., 2011).

Frontczak and Wargocki (2011) studied how IEQ parameters and building features affect occupant satisfaction. They analyzed 52,980 occupants in 351 office buildings over a 10-year span using a Center for Built Environment (CBE) POE survey. Their findings concluded that space, noise, and visual privacy were most important in regards to workplace satisfaction, and space was the most important factor. The study also found that there was higher satisfaction among people sitting closer to a window in green buildings than their colleagues, and the highest dissatisfaction with IEQ parameters were reported for temperature, noise, and air quality (Frontczak & Wargocki, 2011).

### 2.6 Comfort & Satisfaction Among College Students

Numerous IEQ studies have investigated how IEQ affects LEED and non-LEED office building workplaces (Lee and Guerin, 2010). Fewer studies have examined higher education residence halls by focusing on LEED's IEQ factors related to comfort and satisfaction.

Amole (2008) conducted a study in Nigeria on 20 residential halls from four universities and how IEQ factors predicted satisfaction among the student residents. 1124 students responded to

the printed questionnaire via stratified sampling procedure. The "study conceptualized residential satisfaction as influenced by objective and subjective measures of housing attributes and the demographic characteristics of the students" (p. 78). Amole (2008) found that student housing performed below average compared to the users' evaluations, which implied "the residences did not match the aspirations and expectations of the students" (p. 84). This study also suggest that *social density* and *privacy* are variables which predict occupant satisfaction (Amole, 2008).

Higher education residence hall research by Alborz and Berardi (2015) measured if green buildings performed as expected by conducting a post-occupancy evaluation (POE). The study featured 593 students' feedback, most often dissatisfaction regarding their lack of control over changing the indoor temperature. They also interview designers, facilities managers, and owners (Alborz & Berardi, 2015). Their conclusions suggested that LEEDs rating system could promote skewed savings expectations; their study demonstrated variations in energy, water consumption, and indoor air quality. They also noted that "LEED labelling" (level of certification achieved) does not capture the reality of occupant behavior (Alborz & Berardi, 2015). Abbaszadeh, Zagreus, Lehrer, and Huizenga (2006) conducted a study to compare green office buildings to conventional office buildings. Abbaszadeh et al. (2006) found that occupants of green buildings reported being satisfied with thermal comfort and air quality in their workspace, while these occupants' satisfaction with lighting and noise quality were comparable to those of non-green buildings (Abbaszadeh et al., 2006). Both of the previously mentioned studies demonstrated different outcomes when comparing green buildings to non-green buildings. These studies and their findings can give some insight on what to expect from college students' IEQ comfort and satisfaction. As colleges continue to grow and evolve, they are going above and beyond to attract and recruit students to attend their universities (Rathemacher et. al, 2011).

Universities are revamping campus housing to be more accommodating to green standards (Princeton Review, 2017). For example, Duncan College at Rico University in Houston, Texas features a reduced energy and water consumption of 25-30 percent, complemented by a green roof to reduce heating and cooling costs. Pitzer College in Claremont California conducted a Residential Life Project with the goal to become the first college with all LEED Gold-certified residential housing (Minors, 2010). From 2011-2016, Purdue University constructed one green residential hall, Third Street Suites (rated LEED Gold), along with several other green academic buildings.

Building occupant comfort can be broken down to individual components. The Wellness Standards for Buildings, or Well Building Standard, was a seven-year process that merges design, construction, health, and well interventions ("WELL Building Standard," 2016). It is intended to "harness the built environment as a vehicle to support human health, well-being and comfort" ("WELL Building Standard," 2016, p.1) The Well Building Standard definition of comfort is to "provide productive, distraction-free, and comfortable environments" ("WELL Building Standard," 2016, p. 118). Their *comfort* category includes thermal comfort, olfactory comfort (reduction of strong odors within the building), visual and physical ergonomics, sound-reducing surfaces (absorptive ceilings and wall surfaces), sound barriers, individual thermal control, and radiant thermal control ("WELL Building Standard," 2016).

In terms of satisfaction regarding building occupants, a study by Vaez, Kristenson, and Laflamme (2004) compared health statuses and quality of life assessments. Their study was based on 1997 students attending Sweden's Linkoping University and the population of Ostergoland (947 respondents), both males and females from the ages of 20-34. Respondents were assessed on a 10-point scale (1 = worst, 10 = best) and a 5-point scale (excellent, very good, good, fair, poor).

Vaez et al. concluded that undergraduate students reported a lower quality of life—which included life satisfaction, self-esteem, health and functionality—than their working counterparts. (Vaez et al., 2004). The study concluded that the lower ratings could stem from students' living and studying conditions and possible emotional problems (e.g. current financial situation, academics, and career planning) (Vaez et al., 2004). Paul and Taylor (2007) performed a comparison study of one green office building and two uncertified office buildings to test the IEQ perceptions of comfort and satisfaction. Their study used a questionnaire of four sections that asked occupants to rate their workplace environment's "aesthetics, serenity, lighting, acoustics, ventilation, temperature, humidity, and overall satisfaction" (p.1). Their findings confirmed that thermal comfort does influence overall satisfaction with the workplace environment; ultimately, however, the green buildings did not provide a better IEQ than the uncertified buildings (Paul and Taylor, 2007). Arslan and Akkass (2013) conducted a study in Turkey involving 1260 students who completed questionnaires and interviews to determine their satisfaction with the quality of college life (social, academic, service satisfaction, life satisfaction, and identification). Their findings showed that the social satisfaction of the students tested was low, but their social satisfaction had the highest impact on the students' quality of college life. Their findings also suggested that university administration should focus on increasing their social services to increase the satisfaction of their students (Arslan & Akkass, 2013). An Administrative focus on social services could benefit new construction design and consider occupant satisfaction during the design phase. These studies may help universities better understand student comfort and satisfaction in order to help facilitate design, layout, and site planning so that money and resources can be allocated more efficiently.

## 2.7 Survey Research

Surveys can be used to elicit quality data from a large or small sample relatively quickly (Check & Schutt, 2012). Survey research can be used to gather both qualitative and quantitative data. Survey research can be defined as "the collection of information from a sample of individuals through their responses to questions" (Check & Schutt, 2012, p. 160). Surveys have recently evolved into more rigorous processes, as stated by Julie Ponto, with “scientifically tested strategies detailing who to include what and how to distribute, and when to initiate the survey and follow up with nonresponders” to ensure quality research outcomes (Ponto, 2015, p. 169).

There are some advantages and disadvantages to the use of the survey as a research methodology. Surveys are cost-effective and flexible. Survey costs are lower than paper or phone distributions, even with added incentives for respondents. Due to survey flexibility and versatility, they can be taken and given anywhere, and feature the following options face-to-face, online, email, social media, paper, and telephone. Surveys can be customized to provide a wide range of questions to gather data. Surveys can also cover a large group or events that produce data on real world observations and can be generalized to a population (Kelly, 2003).

Some disadvantages to using a survey is that questions can be misinterpreted by respondents, thus creating unclear data. Surveys could also lack the detail or depth needed to study a specific topic (Kelly, 2003). Customized surveys can lead respondents to a certain response, which will result in a source of error. Another form of error is known as bias. As defined by Fowler (2014), bias is “some systematic way the people responding to a survey are different from the target population as whole” (p. 10). There are various forms of biases. A respondent could give the same answer to questions that sound similar, which is known as habituation bias (Sarniak, 2015). Sponsor bias is when respondents know or suspect they know who is giving the survey, and their feelings about the sponsor may change their responses (Sarniak, 2015).

There is also the issue of non-response, when there is "failure to collect data from a higher percentage of those selected to be in the sample" (Fowler, 2014, p. 49). The response rate of a survey typically determines non-response. Response rate is found by dividing the number of people who took the survey by the selected sample population. As stated by Baruch and Holtom (2009), "response rate" is an important, sometimes crucial factor in assessing the value of research findings (p. 1140). There is, however, as Fowler (2014) states, "… no-agreed upon standard for a minimum acceptable response rate" (p. 51). Mitigation strategies to reduce non-response depend on the survey method. Some examples of those strategies include: a survey layout that is easy to understand with simple tasks, reminders that are preferably sent out 10 days after the initial survey, and a letter mailed to the respondents emphasizing the importance of a higher response rate (Fowler, 2014). These strategies are most beneficial when using mail or email as the survey approach.

## 2.8 Summary

This chapter presented the components of green building, LEED, and IEQ that are pertinent to the present research. IEQ provides many integral components that form what is known as comfort and satisfaction. The focus of this specific thesis pertains to college students' overall comfort and satisfaction. However, a basic understanding of LEED assessment tools and IEQ are needed to assess comfort and satisfaction. The research methodology for the present research is discussed further in the next chapter.

# CHAPTER 3. METHODOLOGY

## 3.1 Conceptual Framework

Current research regarding indoor environmental quality (IEQ) has developed methods to measure IEQ. These methods consist of various customized occupant surveys created by The Center for the Built Environment (CBE) and the Building Use Studies (BUS). This research will use a survey approach via the Building Use Studies (BUS) occupant survey (see Appendix B) as the testing instrument. This research focused on comparing the impressions of LEED-certified (Third Street Suites) and conventional (First Street Towers) residence halls within Purdue University. This survey was distributed to the Residential Education Coordinators (RECs) of each residence hall, who forwarded the survey information to their Resident Assistants (RAs), who then forwarded the survey to their student residents. After the data was collected, all responses were compiled into an excel file to be analyzed using SPSS and compared to the U.K.'s BUS database. Descriptive and inferential statistics, as well as qualitative data, was used to compare the residence hall student occupants' perceptions of IEQ.

## 3.2 Research Question

Do green buildings impact the comfort and satisfaction of college student occupants in residence halls?

## 3.3 Research Context, Sampling & Population

Both samples for this research were taken from Purdue University. Purdue University is located in the small college town of West Lafayette, IN. Purdue is an institution with a total population of approximately 40,451 students (Purdue University Office of Admissions, 2017). Of

that total, 30,043 are undergraduate students; 58% are male and 42% are female. See Table 3.1 for undergraduate enrollment by college.

Table 3.1 Undergraduate Enrollment

| College | *% of Students* | *College* | *% of Students* |
|---|---|---|---|
| Engineering | 29% | Management | 6% |
| Health & Human Sciences | 11% | Exploratory Studies | 11% |
| Science | 13% | Education | 2% |
| Technology | 10% | Pharmacy | 4% |
| Liberal Arts | 6% | Veterinary Medicine | Less than 1% |
| Agriculture | 8% | | |

Purdue has a total of eighteen residential halls, with single rooms, semi-suites, suites, and family-style apartments. Fourteen of the residence halls are co-ed, and the remaining four being are male-only or female-only. Of the eighteen residential halls, Third Street Suites is the only LEED residence hall on campus. The present research analyzed one conventional, non-LEED certified hall (First Street Towers) and one LEED Gold certified residence hall (Third Street Suites). In the present research, uncertified is defined as a building that did not seek LEED certification. These specific halls were chosen because Third Street Suites (TSS) is the only LEED Gold Certified residence hall on Purdue's campus, and First Street Towers (FST) is the only single-room residence hall on Purdue's campus. Both halls were recently constructed and service mainly

undergraduate students. See Figure 3.1 for the locations of the residence halls FST (orange), TSS (red), and the Purdue Recreational Sports Center (green).

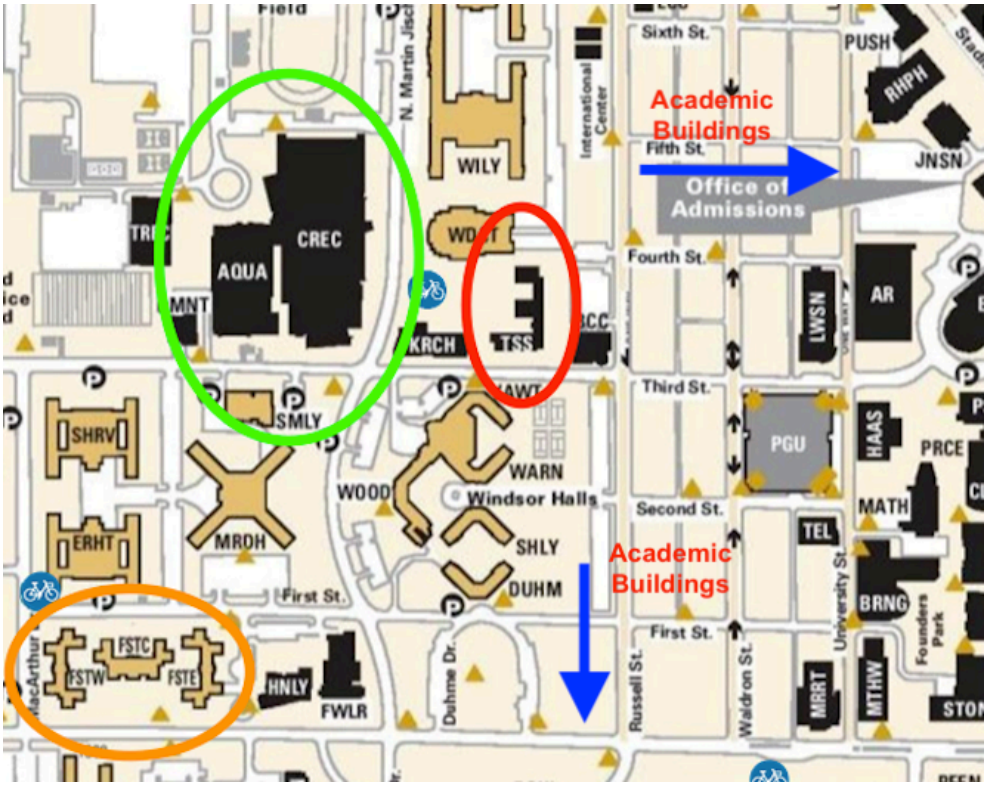


Figure 3.1 Purdue University Map (obtained from Purdue University Residences)

First Street Towers (Non-LEED certified): The first survey sample was from students living in First Street Towers (FST). FST began construction in June 2007. FST opened its doors in July 2009 and can house up to 522 students. FST is a single-occupant room residential hall, with units that are 157 sq. ft., and feature private bathrooms (see Figure 3.2). The current room and board rate for this hall with a 13-meal weekly plan is $14,054 per academic year. Other amenities include two TV lounges with coffee bars on each floor, a music room, and a recreational lounge with billiards and ping pong.

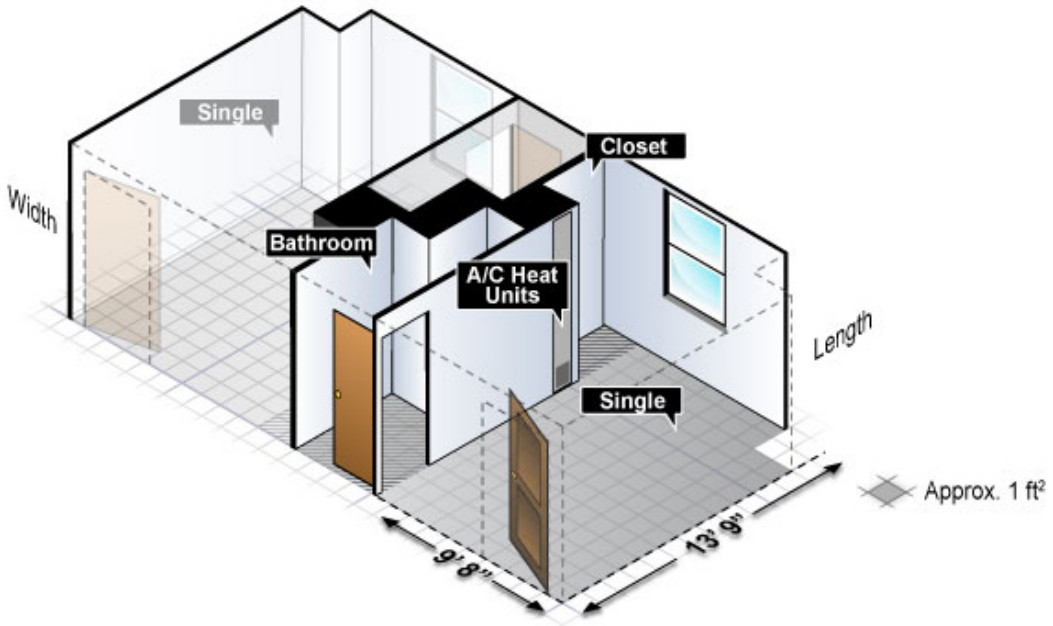


Figure 3.2 FST: Single Room Floor Plan **(**obtained from Purdue University Residences)

Third Street Towers (LEED Gold certified): The second sample surveyed students living in Third Street Suites (TSS). Third Street Suites was constructed from 2012-2014. Students can choose to live in 425 sq. ft., 4-person semi-suites or 1020 sq. ft., 4-person suites. Each unit has two, two-person bedrooms, a shared bathroom, a room storage closet, dual sinks (see Figures 3.3 and 3.4). Residents also have access to a Starbucks and 3rd Street Market on the building's first floor. Other amenities include kitchenettes, TV lounges, laundry rooms, and a large multi-purpose/classroom space.

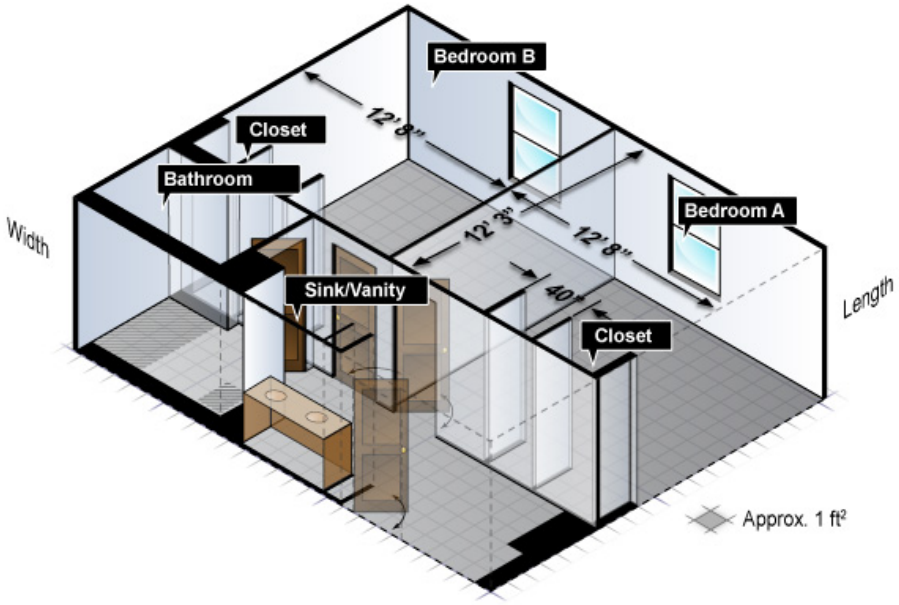


Figure 3.3 TSS: Semi-Suite Floor Plan (obtained from Purdue University Residences)

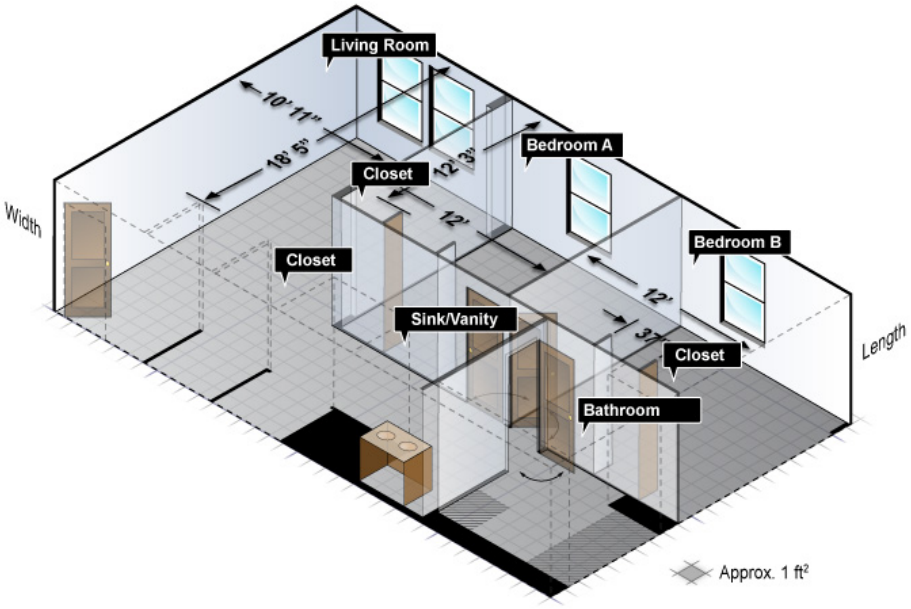


Figure 3.4 TSS: Suite Floor Plan (obtained from Purdue University Residences)

TSS can house up to 304 students during the school year and has a current room and board rate of $11,288 per academic year, including a 13-meal weekly plan.

In summary, Table 3.2 provides the specifications of the two buildings that the present research will compare. Third Street Suites (LEED certified) is configured for four-resident units, while First Street (non-LEED certified) is configured for single rooms with private bathrooms. TSS houses less students than FST and costs less per year.

Table 3.2 Residential Hall Specifications

| Hall | *P* | *Cost w/Meal* | *LEED* | *Date Opened* | *SQFT/Room* | *Single* | *4 Person* |
|---|---|---|---|---|---|---|---|
| Third Street | 304 | 11,288 | X | 2014 | 425/1020 | | X |
| First Street | 522 | 14,054 | | 2009 | 157 | X | |

### 3.3.1 Third Street Suites (TSS) LEED Certification

TSS scored a total of 66 out of 110 points according to the LEED scorecard and achieved a Gold Certification in 2016. See Table 3.3 for the TSS LEED scorecard breakdown.

Table 3.3 LEED Scorecard (USGBC, 2017)

| | *Points* | *Points Possible* | *%* |
|---|---|---|---|
| Regional Priority Credits | 4 | 4 | 100% |
| Sustainable Sites | 22 | 27 | 84% |
| Innovation | 5 | 6 | 83% |
| Water Efficiency | 8 | 10 | 80% |
| Indoor Environmental Quality | 10 | 15 | 66% |
| Material & Resources | 6 | 14 | 43% |
| Energy & Atmosphere | 11 | 35 | 31% |

TSS scored 10 out of 15 points possible in the category of indoor environmental quality (IEQ), which is the focus of this research. TSS received all possible points for low-emitting material (LEM) categories and thermal comfort. Refer to Table 3.4 for the TSS IEQ score breakdown.

Table 3.4 IEQ Score Results (USGBC, 2017)

| | *Points* | *Points Possible* |
|---|---|---|
| Outdoor Delivery Monitoring | 1 | 1 |
| Increased Ventilation | 0 | 1 |
| IAQ Management – During Construction | 1 | 1 |
| IAQ Management – Before Occupancy | 0 | 1 |
| LEM – Adhesives & Sealants | 1 | 1 |
| LEM – Paints & Coatings | 1 | 1 |
| LEM – Flooring Systems | 1 | 1 |
| LEM – Composite Wood & Agrifiber | 1 | 1 |
| Indoor Chemical & Pollutant | 1 | 1 |
| Controllability of Systems - Lighting | 0 | 1 |
| Controllability of Systems – Thermal Comfort | 1 | 1 |
| Thermal Comfort - Design | 1 | 1 |
| Thermal Comfort - Verification | 0 | 1 |
| Daylight & Views - Daylight | 0 | 1 |
| Daylight & Views - Views | 1 | 1 |

### 3.3.2 Defining Ideal Sample Size

The combined population of both residence halls was 826 (522 in FST and 304 in TSS). Based on an ideal response rate of 10 percent, a power analysis was conducted using SAS software. The results indicate that with a 10 percent response rate (n total = 83; per group n = 41) and

significance level of 0.05, the power is 0.847, which is above the usual minimum accepted $\beta \geq 0.80$ threshold for research (Bausell & Li, 2002).

### 3.4 Survey Instrument

The data instrument used was the Building Use Studies (BUS) Occupant Survey. This survey was chosen because it has been developed specifically for user satisfaction and has been previously used in studies analyzing offices and residential buildings (see Chapter 2). This survey asks respondents 38 questions in the form of a seven-point Likert scale and includes commentary space for the respondent to include qualitative information regarding each component. The survey is three pages long and intended to measure students' comfort and satisfaction within their current residence halls. The instrument also gathers background information on each occupant. See Figure 3.5 for the printed survey version and Figure 3.6 for the online survey version (see Appendix B for the full survey).

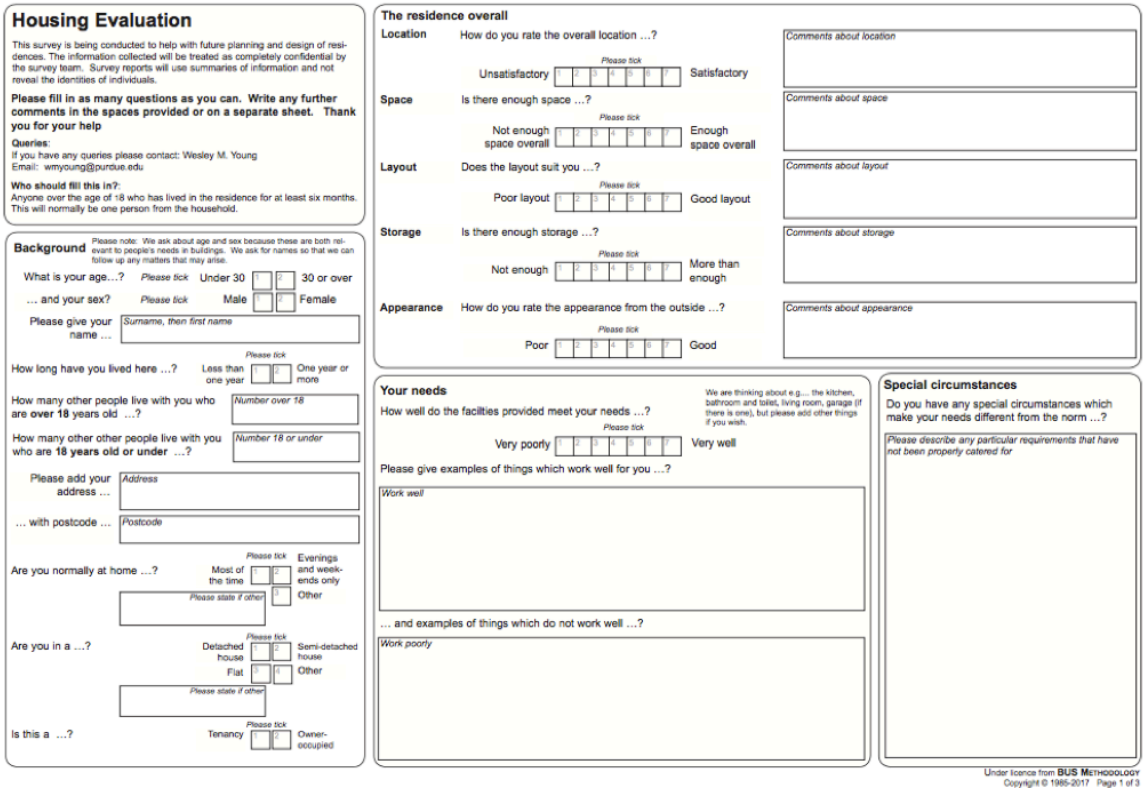


Figure 3.5 BUS SURVEY (First Page)

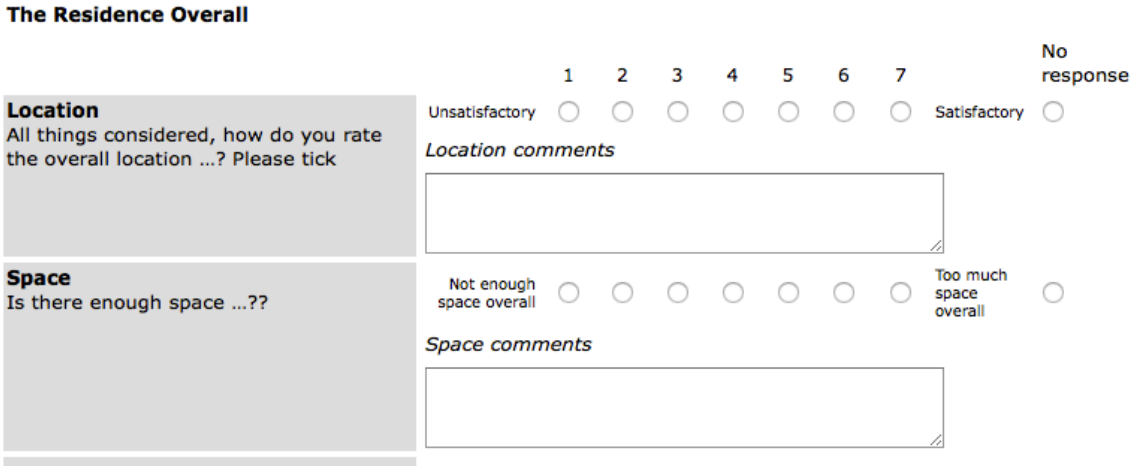


Figure 3.6 BUS SURVEY (Online)

The levels measured by the BUS survey regarding users' satisfaction are:

- Comfort of Temperature during Fall/Spring
- Noise
    - Noise overall
    - Noise between rooms
    - Noise from neighbors
    - Other outside noise
- Lighting
    - Lighting overall
    - Natural light
    - Artificial light
- Overall comfort
- Design
- Health

The BUS survey was created in 1985 to assess the comfort and satisfaction of building occupants. It was created by Sheena Wilson and Alan Hedge as part of an office environment survey, is currently copyrighted by Building Use Studies, and curated by ARUP ("BUS Methodology: The BUS methodology process", 2017). The BUS survey was used to analyze 4300 office workers in fifty U.K. buildings. The purpose of the BUS survey is to gather feedback from building users. The BUS Survey can be utilized to measure comfort and satisfaction among building occupants in relation to IEQ. It is beneficial to survey the actual occupants of a building because they are the residents who encounter any building issues that arise.

### 3.4.1 Previous Studies Using BUS Survey

Gou et al. (2013) conducted a study in 14 Chinese office buildings to measure if green building users “were more satisfied and comfortable than non-green building users" (Gou et al., 2013, p. # 156).. Of the 14 office buildings, 5 were Green Building Label (GBL) certified, 4 were LEED certified, and the remaining 5 were uncertified conventional buildings. Gou et al. found that some green buildings showed higher satisfaction and comfort, while others achieved lower satisfaction and comfort compared to non-green buildings (Gou et al., 2013). Their findings also suggest “green building users were more forgiving of their building, which has important implications for green building design and evaluation” (Gou et al., 2013, p. 160).

Deuble and Dear (2012) studied two academic buildings using Building Use Studies (BUS) and the New Ecological Paradigm (NEP), the latter of which is an environment attitudes questionnaire. The two academic buildings consisted of a Mixed-Mode (MM) building, which was able to switch to air conditioning via building management sensor, and a Natural Ventilation (NV) building with occupant-operated windows and no central heat or air conditioning. Since “NV consumed less energy, it is considered “greener” than the MM building” (p. 23). Both buildings’ total population was around 200 occupants, including academic and administration staff as well as graduate students from various disciplines (Deuble and Dear, 2012). A hard copy of both questionnaires were delivered to occupants of each building. 163 were distributed to MM and 120 were distributed to the occupants of NV. They received 86 responses from MM (53% response rate) and 69 from NV (57% response rate). Deuble and Dear (2012) found that occupant satisfaction was positively associated with environmental beliefs. The study also suggested that “green building users are more forgiving of their building, consistent with the hypothesis that ‘green’ buildings work best with ‘green’ occupants” (Deuble and Dear, 2012, p. 26).

In another study using the Building Use Studies occupant survey, conducted by Adrian Leaman and Bill Bordass (2007), the focus was a mix of 177 uncertified and green buildings in the U.K. Their findings suggested "that occupants of green buildings tend to be more tolerant" (Leaman & Bordass., 2007, p. 671). of issues when rating green buildings than the occupants of uncertified buildings (Leaman & Bordass, 2007).

An interesting factor regarding the previous studies is they all found that green building users to be more tolerant of their buildings. This factor is known as the occupants' "forgiveness," "which shows occupants' capability of extending their comfort zone by overlooking inadequacies of their ambient environments" (Gou et al., 2013, p. 157).

### 3.4.2 Reliability

The BUS survey is designed to collect occupant feedback on building performance on a case-by-case basis. The questionnaire is suitable and has been previously used for both residential and commercial office space users (Adrian Leaman, Building Use Studies internal, supplied by author**).** The instrument produces benchmarked statistics and is used by advanced design practices and research organizations.

When BUS questions have been adapted, constant tests have been run to test the validity and reliability of the surveys. Gary Row tested the reliability of BUS by testing 728 people in 12 U.K offices. The test focused on repeated winter and summer surveys using a t-test (Row et al., 2002). Gary et al. concluded that the BUS survey is a reliable instrument to measure IAQ in office buildings (Gary et al., 2002), which is one of the IEQ factors.

In addition to these previous studies, Parkinson et al. conducted an exploratory factor analysis and a McDonald's omega test, both of which is used to measure survey reliability (Parkinson et al., 2017). Their study focused on a building performance evaluation (BPE) program,

which studied over 100 newly-constructed and refurbished buildings (48 of which were non-domestic). Their study noted omega statistics for the overall test within the BUS survey had values over 0.9, and they concluded that the BUS survey can be considered a reliable instrument to provide a measurement for occupant satisfaction (Parkinson et al., 2017).

Licensing was introduced to the BUS survey in 1988 with the intent to allow for proper benchmark management and to prohibit researchers from using the survey incorrectly and without permission (Adrian Leaman, Building Use Studies internal, supplied by author). Licensing for the BUS survey was obtained by the researcher from Adrian Leaman, the creator of the BUS survey (see Appendix C).

### 3.5 Data Collection

The data collection was performed online, beginning March 20th 2017, which was Monday after the students' spring break. IRB Exemption category two #170201877 was obtained prior to conducting the survey (see Appendix A). Research clearance was given by the Associate Director of Residential Learning to proceed with the research. With this clearance, the researcher was able to contact the RECs of both residential halls. Introduction meetings were conducted with the RECs in order to establish a point of contact and get the confirmation that RECs would assist in survey distribution to RAs via email on Monday, March 20th, 2017.

Once RAs received the email containing the survey information (including the research purpose and context) and a link to the online survey (see Appendix D) from their REC, RAs were requested to forward the survey information to their individual residents via email. The estimated time required to complete the survey was 5 to 10 minutes and the survey had to be taken in one sitting. Students were given two weeks to complete the survey.

### 3.5.1 Data Collection Method Revisions

Due to a low response rate after the first week, on March 27th, RECs were asked to resend the survey information to RAs to repeat the distribution process, which was to serve as a reminder to the students. The researcher also asked if surveys could be distributed to the students in person in order to elicit a better response rate. The survey was distributed in First Street Towers (FST) on a table in the center tower lobby. However, the survey was not distributed in Third Street Suites (TSS) due to the REC of TSS stating that students were being over surveyed at that time.

## 3.6 Data Analysis Strategy

The data was collected and compiled into a single excel file. The data was then analyzed using two methods. The first method required sending the excel file to the U.K. to be analyzed and compared to the BUS database. Results were then sent back, including descriptive statistics, graphs, and benchmarking information on how each category placed in the overall BUS database. The benchmark results provided interesting information, but was not the main focus of this research; therefore, the benchmark results will not be presented in the following chapter (see Supplemental Information #1 & #2).

The second method involved gathering the results collected in the excel spreadsheet to compile the descriptive and qualitative information. This descriptive data was the basis of the comparison of the two data sets. The qualitative data provided input regarding occupants' comfort and satisfaction regarding the tested hypothesis. Themes emerged from the dataset as well. The excel spreadsheet was also used to process the data through the Statistical Package for Social Sciences (SPSS) to test the inferential statistics, which allowed for a statistical comparison of the two buildings based on the sampled population.

### 3.6.1 Descriptive Statistics

The collected data was analyzed to provide the following demographic data for each sample: gender, how long occupants have lived in either resident hall, and how often occupants reside in their room. Each demographic was isolated by resident hall. The descriptive data results also provided the average, median, and standard deviation of the categories tested for each residential hall. The categories are as follows: *Location, Space, Layout; Storage; Appearance; Needs; Temp in Winter: Hot/Cold, Stable/Varies, Overall; Air in Winter: Still/Drafty, Dry/Humid, Fresh/Stuffy, Odorless/Smelly; Temp in Summer: Hot/Cold, Stable/Varies, Overall; Air in Summer: Still/Drafty, Dry/Humid, Fresh/Stuffy, Odorless/Smelly; Noise: Overall, From Outside, From Neighbors (between walls), Other People; Lighting: Overall, Artificial, Natural; Comfort: Overall; Health; Control of Heat, Cooling, Ventilation; Light and Noise.*

### 3.6.2 Qualitative Data

The collected data was used to report how many occupants chose to respond to each open-ended question, and to find the most frequent themes among occupants' responses to each category. For example, comments such as "I am pleased with my living space," "good amount of space," and "there is an ideal amount of space" suggest a common theme of an ideal amount of space. These themes will be presented in tables for each category and each residence hall to complement the quantitative dataset.

### 3.6.3 Inferential Testing

The following categories will be tested using a two-sample t-test: *overall comfort* and *overall satisfaction*. These individual categories align with the objective of this research: to determine occupants' overall comfort and satisfaction with the two residential buildings. Prior to performing

the two-sample t-test, Levene's Test of Equality of Variances was conducted at a 0.05 significance level. After assessing the equal variance of each sample, a two-sided t-test between residence halls and using a significance level of 0.05 was performed using the following hypothesis:

Ho: $\mu 1 - \mu 2 = 0$, Ha: $\mu 1 - \mu 2 < 0$

where $\mu 1$ = FST (Non-LEED) and $\mu 2$ = TSS (LEED Gold). Therefore, for Ho, there is no difference between the two buildings, and for Ha, TSS (LEED Gold) is better than FST (Non-LEED).

Each category (*overall comfort* and *overall satisfaction*) will be tested using the same hypothesis and significance level for each category. *Overall comfort* will be measured by the overall comfort question on the BUS survey. This question specifically focuses on occupants' rating of their overall comfort in their residence hall. *Overall satisfaction* will be measured using data from the following 18 categories (*Location Space, Layout, Storage, Appearance, Needs, Overall Temp in Winter, Overall Air in Winter, Overall temperature in Summer, Overall Air in Summer, Noise Overall, Lighting Overall, Health, Control of Heating, Cooling, Ventilation, Lighting, and Noise*). These individual categories were chosen because they are all factors of determining an individual's building satisfaction. These categories can also be combined using a t-test given that each category had an identical Likert scale incorporated into the BUS survey.

The results from these tests will measure how students rate their comfort and satisfaction in their current residential hall and provide insight on whether the LEED building differs from the conventional building in its impact on occupant comfort and satisfaction, therefore answering the present study's main research question.

## 3.7 Research Bias

As mentioned in Chapter 2, survey research is subject to some potential biases. The researcher has identified the following biases as potential issues that the present study could be subject to:

- Habituation Bias – students taking the survey who are not mentally engaged, resulting in selecting the same response to similar questions.
- Sponsor Bias – students marking higher scores because they received the survey from their RA.
    - Because a hard copy of the survey was distributed only in FST due to residential learning issues, this could be seen as another form of potential sponsor bias as well.
- Students who have lived in either FST or TSS for longer periods of time could be biased due to their increased sense of community within their residential hall.
- Ethnocentrism - FST is known as the higher end residential hall on campus, and the FST residents could have reported more comfort and satisfaction due to paying for a higher standard of campus living.

## 3.8 Summary

This chapter has introduced the survey methodology that was applied in this thesis. It has presented the Building Use Studies (BUS) as the measuring instrument and the possible research biases of the survey respondents. Moreover, the chapter introduced the data analysis strategies (descriptive, qualitative, and inferential) used to analyze the collected data.

# CHAPTER 4. RESULTS

## 4.1 Sample Demographics

The survey was distributed in March 2017, during the first week after Purdue University students' spring break. Students initially had until the end of the week to submit their responses. Due to a low response rate at the conclusion of the first week, the survey was distributed again at the beginning of the following week. The survey was distributed in person during the final days of the data collection period to the students in First Street Towers (FST). Permission to distribute the surveys in person to Third Street Suites (TSS) students was denied, due to Purdue University residential learning stating that the students were being over surveyed at that time. Table 4.1 shows the total number of student responses from each residential hall following the two data collection methods, as well the final survey response rates. There were 17 total respondents from TSS (5.59% response rate) and 32 (6.13% response rate) from FST.

Table 4.1 Total Survey Respondent Sample Breakdown

Total Sample Breakdown

| Hall | Male | Female | N | P | RR |
|---|---|---|---|---|---|
| Third Street | 10 | 7 | 17 | 304 | 5.59% |
| First Street | 16 | 16 | 32 | 522 | 6.13% |
| Total | 26 | 23 | 49 | 826 | 5.93% |

(Note: N = number of respondents, P = possible respondents, RR = response rate)

The data shown in Table 4.2 represents how long the respondents had lived in their residence halls. Both residence halls were split between students who lived there for more than one year and

those who lived for less than one year. There were eleven students total who did not answer the question.

Table 4.2 How Long Students Had Lived in the Residence Hall

How Long Students Had Lived in the Residence Hall

| | More Than a Year | Less Than a Year | N.R. |
|---|---|---|---|
| Third Street (n= 17) | 5 | 5 | 7 |
| First Street (n=32) | 14 | 14 | 4 |

(Note: NR = no response)

Table 4.3 shows which style room the respondents lived in. Most TSS respondents lived in suite style rooms, and two TSS respondents lived in semi-suite units. All FST rooms were private, single rooms. There were two respondents who did not answer the question.

Table 4.3 Room Type

Room Type

| | Suite | Semi-Suite | Single | N.R. |
|---|---|---|---|---|
| Third Street (n=17) | 14 | 2 | - | 1 |
| First Street (n=32) | - | - | 31 | 1 |

(Note: NR = no response)

Table 4.4 shows how often respondents were in their residences. Most students in both residence halls reported that they were in their dorms most of the time. Some reported that they were only there during the evenings and weekends, and one student did not respond to the question.

Table 4.4 Frequency in Residence Hall

Frequency in Residence Hall

| | Most of the Time | Evening/Weekends Only | Other | N.R. |
|---|---|---|---|---|
| Third Street (n=17) | 9 | 7 | 1 | - |
| First Street (n=32) | 23 | 9 | - | - |

(Note: NR = no response)

## 4.2 Descriptive Statistics and Qualitative Input

This section presents the descriptive statistics (mean, median, and standard deviation) for the BUS survey categories for each residence hall, as well as the optional qualitative input supplied by survey participants for each category.

### 4.2.1 Residence Overall

Table 4.5 shows the average, standard deviation, and median results for both residential halls regarding respondents' impressions of their building residences overall. This includes information regarding its location, space, layout, storage, and appearance. TSS respondents reported a higher mean score for *location* (Mean = 6.58) than FST respondents (Mean = 5.85). FST respondents had a higher residential satisfaction in *space*, *layout*, *storage,* and *appearance* than TSS respondents. TSS location showed the lowest standard deviation of all tested overall residence categories

(SD=0.50), compared to the FST location score (SD=1.45). This may indicate that TSS occupants prefer the location of their residence hall more so than FST occupants. FST scores also showed a higher standard deviation in all overall residence categories except layout (SD=1.35). Despite the low FST standard deviation, there is still insufficient indication of disagreement between the occupants.

Table 4.5 Residence Overall

Residence Overall

| | Third Street Suites | | | | | First Street Towers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R | N.R. | Mean | Median | Std. Dev. | R | N.R. | Mean | Median | Std. Dev. |
| Location | 17 | | 6.58 | 7 | .50 | 32 | | 5.85 | 6 | 1.45 |
| Space | 17 | | 4.41 | 4 | 1.17 | 32 | | 5.40 | 6 | 1.36 |
| Layout | 17 | | 5.64 | 6 | 1.57 | 32 | | 5.90 | 6.5 | 1.35 |
| Storage | 17 | | 3.88 | 4 | 1.53 | 32 | | 4.65 | 5 | 1.65 |
| Appearance | 17 | | 6.17 | 6 | 1.01 | 30 | 2 | 6.4 | 7 | 1.32 |

(Note: R = number of respondents; N.R. = no response)

The qualitative comments presented in Table 4.6 show that respondents found the *location* of TSS and FST to be convenient and close to campus. In terms of *space,* TSS respondents commented on there being an ideal amount of space; FST respondents noted that their *space* and *storage* was limited.

Table 4.6 Overall Residence Qualitative Feedback

Overall Residential Qualitative Feedback (Themes)

| Third Street Suites (n=8) | First Street Towers (n=9) |
|---|---|
| Convenient, close to campus (n=3) | Close to campus (n=3) \| Others (n=5) |
| Great amount of space (n=3) | Small but enough (n=4) \| Others (n=2) |
| No emerging theme (n=6) | No emerging theme (n=5) |
| No emerging theme (n=5) | Closets too small (n=3) \| Other (n=1) |
| No emerging theme (n=2) | No emerging theme (n=3) |

(Note: N = number of respondents)

### 4.2.2 Needs Results

Table 4.7 shows the average, standard deviation, and median results for both residential halls regarding respondent's *needs* satisfaction. TSS respondents (Mean = 6.125) show that their *needs* were better met than FST respondents (Mean = 5.64). TSS occupants' needs (SD=1.01) showed less standard deviation than FST occupants' needs (SD=1.47). This indicates that FST occupants were in less agreement on the satisfaction of their *needs* compared to TSS occupants.

Table 4.7 Needs

Needs

| | Third Street Suites | | | | | First Street Towers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R | N.R. | Mean | Median | Std. Dev. | R | N.R. | Mean | Median | Std. Dev. |
| Needs | 16 | 1 | 6.125 | 7 | 1.01 | 31 | 1 | 5.64 | 6 | 1.47 |

(Note: R = number of respondents; N.R. = no response)

Table 4.8 presents the findings for qualitative inputs from respondents regarding their needs. For qualitative comments regarding respondents' *needs* that were met, TSS respondents

commented on their living area space; FST respondents commented on their study spaces. Regarding respondents *needs* that weren't met, TSS respondents mentioned light sensor issues; FST respondents noted that their elevator was often out of order.

Table 4.8 Needs – Qualitative Feedback

Needs – Qualitative Feedback (Themes)

| | Third Street Suites (n=13) | First Street Towers (n=22) |
|---|---|---|
| Needs | Worked Well: Living room areas (n=5)\| Others = (n=8)<br>Worked Poorly: Others(n=11) | Worked Well: Study areas (n=5) Others = (n=17)<br>Worked Poorly: Elevator always broken (n=17) \|Others = (n=12) |

(Note: N= number of respondents)

### 4.2.3 Temperature Comfort Results

Tables 4.9 and 4.10 show the average, standard deviation, and median results for both residential halls regarding how respondents' *air quality and temperature* comforts were met during the spring and fall months. TSS respondents' spring temperature satisfaction overall (Mean = 5.92) and fall temperature satisfaction overall (Mean = 5.75) was higher than FST respondents (Mean = 5.33) and (Mean = 5.23). Both residence halls showed similar standard deviation of their spring satisfaction, and FST (SD=1.41) was slightly higher than TSS (SD=1.38). Both residential halls also showed similar standard deviation with their fall satisfaction; however, TSS (SD=1.29) showed a slightly higher standard deviation than FST (SD=1.24). This indicates that both residential halls have similar occupant agreement with both their fall and spring temperature comfort.

Table 4.9 Temperature Comfort in Spring

Comfort in Spring

| | Third Street Suites | | | | | First Street Towers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R | N.R. | Mean | Median | Std. Dev. | R | N.R. | Mean | Median | Std. Dev. |
| **Temp in Spring** | | | | | | | | | | |
| Uncomfortable | 14 | 3 | 5.64 | 6.5 | 1.69 | 32 | 1 | 5.93 | 6 | 1.52 |
| Too Hot | 15 | 2 | 4.14 | 4 | .66 | 30 | 2 | 4.03 | 4 | .96 |
| Stable | 16 | 1 | 3.4 | 3 | 2.02 | 30 | 2 | 2.73 | 2.5 | 1.79 |
| **Air in Spring** | | | | | | | | | | |
| Still | 14 | 3 | 3.61 | 4 | .086 | 28 | 4 | 3.28 | 4 | 1.24 |
| Dry | 14 | 3 | 3.53 | 4 | 1.39 | 27 | 5 | 3.84 | 4 | 1.43 |
| Fresh | 14 | 3 | 3.07 | 3 | 1.25 | 28 | 4 | 3.25 | 3.5 | 1.57 |
| Odorless | 14 | 3 | 2.84 | 2 | 1.72 | 28 | 4 | 2.64 | 2 | 1.52 |
| **Conditions in Spring** | | | | | | | | | | |
| Satisfactory Overall | 13 | 4 | 5.92 | 6 | 1.38 | 27 | 5 | 5.33 | 6 | 1.41 |

(Note: R = number of respondents; N.R. = no response)

Table 4.10 Temperature Comfort in Fall

Comfort in Fall

| | Third Street Suites | | | | | First Street Towers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R | N.R. | Mean | Median | Std. Dev. | R | N.R. | Mean | Median | Std. Dev. |
| **Temp in Fall** | | | | | | | | | | |
| Uncomfortable | 16 | 1 | 5.87 | 6 | 1.45 | 26 | 6 | 5.57 | 6 | 1.47 |
| Too Hot | 16 | 1 | 4.68 | 4 | 1.07 | 26 | 6 | 4.19 | 4 | 0.89 |
| Stable | 16 | 1 | 3.06 | 2 | 2.11 | 26 | 6 | 3.07 | 3 | 1.59 |
| **Air in Fall** | | | | | | | | | | |
| Still | 15 | 2 | 3.6 | 4 | .98 | 26 | 6 | 3.76 | 4 | 1.01 |
| Dry | 15 | 2 | 3.26 | 4 | 1.03 | 26 | 6 | 3.88 | 4 | 1.23 |
| Fresh | 15 | 2 | 2.93 | 3 | 1.22 | 26 | 6 | 3.24 | 4 | 1.45 |
| Odorless | 15 | 2 | 2.53 | 2 | 1.18 | 26 | 6 | 2.96 | 3 | 1.48 |
| **Conditions in Fall** | | | | | | | | | | |
| Satisfactory Overall | 16 | 1 | 5.75 | 6 | 1.29 | 26 | 6 | 5.23 | 5 | 1.24 |

(Note: R = number of respondents; N.R. = no response)

The qualitative comments presented in Table 4.11 regarding respondents' *comfort* show that TSS respondents noted their rooms were too hot or too cold, and that they had no control over the temperature. FST respondents noted a lack of ventilation in their rooms.

Table 4.11 Temperature Comfort – Qualitative Feedback

Temperature Comfort – Qualitative Feedback (Themes)

| | Third Street Suites (n=9) | First Street Towers (n=7) |
|---|---|---|
| Spring | Rooms too hot (n=2) \| Others (n=6) | No emerging theme (n=4) |
| Fall | Too cold, no control over temperature (n=2) \| Others (n=5) | No ventilation (n=4)<br>Other (n=1) |

(Note: n = number of respondents)

### 4.2.4 Noise Results

Table 4.12 shows the average, standard deviation, and median results for both residential halls regarding how respondents' noise satisfaction was met. TSS respondents' overall noise satisfaction (Mean = 4.82) was lower than FST respondents (Mean = 4.96). FST also shows a higher level of noise from neighbors (Mean = 4.09) compared to TSS (Mean = 3.70). The overall TSS (SD=2.18) noise score showed an extremely high standard deviation compared to FST (SD=1.64). This indicates that TSS occupants had little to no agreement on their noise satisfaction.

Table 4.12 Noise

Noise

| | Third Street Suites | | | | | First Street Towers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R | N.R. | Mean | Median | Std. Dev. | R | N.R. | Mean | Median | Std. Dev. |
| Noise Overall | 17 | | 4.82 | 5 | 2.18 | 31 | 1 | 4.96 | 5 | 1.64 |
| People Rooms | 17 | | 4.58 | 4 | 1.58 | 31 | 1 | 4.12 | 4 | 1.52 |
| From Neighbors | 17 | | 3.70 | 4 | 1.31 | 32 | | 4.09 | 4 | 1.51 |
| Noise from Outside | 17 | | 4.17 | 4 | 1.28 | 32 | | 4 | 4 | 1.36 |

(Note: R = number of respondents; N.R. = no response)

The qualitative comments presented in Table 4.13 regarding *noise* show that both TSS and FST respondents commented on their walls being too thin and outside noise from neighbors. TSS respondents also noted outside construction noise.

Table 4.13 Noise – Qualitative Feedback

Noise – Qualitative Feedback (Themes)

| | Third Street Suites (n=10) | First Street Towers (n=7) |
|---|---|---|
| Noise | Thin walls and outside noise (n=4)<br>Others (n=6) | Thin walls, noise from people (n=5)<br>Others (n=2) |

(Note: n = number of respondents)

### 4.2.5 Lighting Results

Table 4.14 shows the average, standard deviation, and median results for both residential halls regarding how respondents' lighting satisfaction. TSS respondents' (Mean = 5.11) overall lighting satisfaction was slightly lower than FST respondents (Mean = 5.31). FST (SD=1.73) showed a higher standard deviation compared to TSS (SD=1.57). This indicates that FST occupants had less agreement on their overall lighting satisfaction; however, TSS had more agreement on their artificial lighting (SD=0.80).

Table 4.14 Lighting

Light

| | Third Street Suites | | | | | First Street Towers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R | N.R. | Mean | Median | Std. Dev. | R | N.R. | Mean | Median | Std. Dev. |
| Light Overall | 17 | | 5.11 | 6 | 1.57 | 32 | | 5.31 | 5.5 | 1.73 |
| Natural Light | 17 | | 3.88 | 4 | 1.11 | 32 | | 3.96 | 4 | 1.33 |
| Artificial Light | 17 | | 4.17 | 4 | 0.80 | 32 | | 4.46 | 4.5 | 1.43 |

(Note: R = number of respondents; N.R. = no response)

The qualitative comments presented in Table 4.15 regarding *light* show that TSS respondents reported issues related to their automatic light sensors.

Table 4.15 Lighting – Qualitative Feedback

Light – Qualitative Feedback (Themes)

| | Third Street Suites (n=9) | First Street Towers (n=3) |
|---|---|---|
| Light | Automatic light issues (n=4)<br>Others (n=5) | No emerging theme (n=3) |

(Note: n = number of respondents)

### 4.2.6 Overall Comfort Results

Table 4.16 shows the average, standard deviation, and median results for both residential halls regarding respondents' *overall comfort*. TSS respondents' (Mean = 6.11) overall comfort was higher than FST respondents (Mean = 5.83). The FST (SD=1.42) standard deviation was nearly twice as high as TSS (SD=.85). This indicates that FST had less agreement, while TSS showed more agreement with their overall comfort.

Table 4.16 Overall Comfort

Overall Comfort

| | Third Street Suites | | | | | First Street Towers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R | N.R. | Mean | Median | Std. Dev. | R | N.R. | Mean | Median | Std. Dev. |
| Overall Comfort | 17 | 0 | 6.11 | 6 | 0.85 | 31 | 1 | 5.83 | 6 | 1.48 |

(Note: R = number of respondents; N.R. = no response)

The qualitative comments presented in Table 4.17 show no emerging themes. Only three respondents provided input.

Table 4.17 Overall Comfort – Qualitative Feedback

Overall Comfort – Qualitative Feedback (Themes)

| | Third Street Suites (n=1) | First Street Towers (n=2) |
|---|---|---|
| Light | No emerging theme (n=1) | No emerging theme (n=2) |

### 4.2.7 Health Results

Table 4.18 shows the average, standard deviation, and median results for both residential halls regarding respondents' *health*. TSS respondents' (Mean = 5.11) health satisfaction was roughly the same as FST respondents (Mean = 5.13). TSS (SD=1.49) showed a higher standard deviation compared to FST (SD=1.35). Despite the higher TSS standard deviation, both residential halls had similar agreement on their health satisfaction. This also corresponds with their mean score satisfaction.

Table 4.18 Health

Health

| | Third Street Suites | | | | | First Street Towers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R | N.R. | Mean | Median | Std. Dev. | R | N.R. | Mean | Median | Std. Dev. |
| Health | 17 | | 5.11 | 5 | 1.49 | 30 | 2 | 5.13 | 5 | 1.35 |

(Note: R = number of respondents; N.R. = no response)

The qualitative comments presented in Table 4.19 regarding *health* show that TSS respondents commented on a lack of air flow. FST respondents reported no apparent themes.

Table 4.19 Health – Qualitative Feedback

Health – Qualitative Feedback (Themes)

| | Third Street Suites (n=8) | First Street Towers (n=2) |
|---|---|---|
| Health | Lack of air flow causing sickness (n=3)<br>Others (n=5) | No emerging theme (n=2) |

### 4.2.8 Personal Control Results

Table 4.20 shows the average, standard deviation, and median results for both residential halls regarding occupant satisfaction with their *personal control* over their surroundings. TSS respondents reported less personal control over heating (Mean =5.66) than FST respondents (Mean = 6.09). However, TSS respondents reported more control over their heating than cooling, ventilation, light, or noise. FST respondents reported more personal control over heating and cooling. FST (SD=2.01) showed the highest standard deviation in the ventilation category compared to TSS (SD=1.70). This indicates that FST occupants showed less agreement on their ventilation control. No qualitative comments were given for this category.

Table 4.20 Personal Control

Personal Control

| | Third Street Suites | | | | | First Street Towers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R | N.R. | Mean | Median | Std. Dev. | R | N.R. | Mean | Median | Std. Dev. |
| Heating | 15 | 2 | 5.66 | 6 | 1.44 | 32 | | 6.09 | 7 | 1.53 |
| Cooling | 16 | 1 | 5.37 | 5.5 | 1.74 | 32 | | 6.06 | 7 | 1.58 |
| Ventilation | 16 | 1 | 4.12 | 4 | 1.70 | 30 | 2 | 5 | 5 | 2.01 |
| Light | 16 | 1 | 4.87 | 5 | 1.62 | 32 | | 5.78 | 7 | 1.71 |
| Noise | 16 | 1 | 3.31 | 3 | 1.92 | 31 | 1 | 3.70 | 4 | 1.77 |

(Note: R = number of respondents; N.R. = no response)

## 4.3 Inferential Results

This section presents inferential statistics on two categories—*overall comfort* and *overall satisfaction*—via a two-sided t-test using the following hypothesis:

Ho: $\mu 1 - \mu 2 = 0$, Ha: $\mu 1 - \mu 2 < 0$.

Where $\mu 1$ = FST (Non-LEED) and $\mu 2$ = TSS (LEED Gold). For Ho, there is no difference between the two buildings. For Ha, TSS (LEED Gold) is higher than FST (Non-LEED).

### 4.3.1 Overall Comfort Results

Table 4.21 shows results for the overall comfort of all survey respondents. Levene's test for equality was performed prior to conducting a t-test, which showed that equal variance could be assumed for both samples. The two-sided t-test result was $\alpha = 0.481 > .05$, which is higher than the threshold used for the significance level ($\alpha = 0.05$). The results indicate that we cannot accept the alternative hypothesis and must remain with the null hypothesis: there is no difference in the overall comfort of both residence halls.

Table 4.21 Overall Comfort

| | | LEVENE TEST FOR EQUALITY | T-TEST FOR EQUALITY OF MEANS | | | | |
|---|---|---|---|---|---|---|---|
| | | Sig. | T | Sig (2-talied) | Sig (1-tailed) | Mean difference | Std. Error Difference |
| OVERALL COMFORT | Equal variance assumed | .155 | -.710 | .481 | .240 | -.279 | .393 |

### 4.3.2 Overall Satisfaction Results

Table 4.22 shows results for overall satisfaction for both residence halls. Levene's test for equality was performed prior to conducting a t-test, which showed that equal variance could be assumed for both samples. Overall satisfaction was measured by including the following categories: *Location*, *Space, Layout, Storage, Appearance, Needs, Overall Temp in Winter, Overall Air in Winter, Overall temperature in Summer, Overall Air in Summer, Noise Overall, Lighting Overall, Health, Control of Heating, Cooling, Ventilation, Lighting, and Noise*. The two-sided t-test result was $\alpha = 0.474 > .05$, which is higher than the threshold used for the significance level ($\alpha = 0.05$). The results indicate that we cannot accept the alternative hypothesis and must remain with the null hypothesis: there is no difference in overall satisfaction with both residence halls.

Table 4.22 Overall Satisfaction

| | | LEVENE TEST FOR EQUALITY | T-TEST FOR EQUALITY OF MEANS | | | | |
|---|---|---|---|---|---|---|---|
| | | Sig. | T | Sig (2-talied) | Sig (1-tailed) | Mean difference | Std. Error Difference |
| OVERALL SATISFACTION | Equal variance assumed | .746 | .722 | .474 | .237 | .2140 | .2965 |

## 4.4 Summary

This chapter presented the descriptive, qualitative, and inferential data results collected from the BUS survey. It has also provided a brief analysis of the results, along with the frequent themes obtained from respondents' qualitative input.

# CHAPTER 5. DISCUSSION & CONCLUSION

## 5.1 Discussion

The results presented in Chapter 4 of this thesis indicated that LEED does not play an important role in determining overall student comfort and satisfaction (via the thirty-six categories tested) with Third Street Suites (TSS) and First Street Towers (FST). the author expected LEED Gold Certified TSS to have shown more statistical significance in the categories tested. However, this was not the case.

Previous literature reported similar results as the current study. Alborz and Berandi (2015) found that green building users were dissatisfied with their lack of personal control regarding the indoor temperature. The current study's results included similar findings. TSS occupants were dissatisfied with their limited personal control over heating and cooling compared to FST respondents. Abbaszadeh et al. (2006) found that green building occupants showed higher satisfaction with their thermal comfort and air quality. Similarly, TSS occupants reported higher satisfaction with their temperature comfort and air quality than FST respondents.

Other research results contradict the findings of the current study. Frontczak and Wargocki (2011) reported that green building users were dissatisfied with their building's temperature, air quality, and noise. These findings differ from TSS occupants, who were more satisfied with their overall building temperature and air quality than FST respondents. TSS also reported lower satisfaction with lighting, which differs from Lee and Guerin (2010), who found that green building occupants were more satisfied with light and visual comfort.

When testing for a significant difference between TSS and FST, this research concluded that there was no significant difference between the occupants' overall comfort and satisfaction with the two residential halls. This conclusion differs from Sergio and Stefano (2013), who

reported that green building occupants were equally satisfied with their overall building as conventional building occupants.

## 5.2 Limitations

Some limitations were encountered while conducing this research, mainly during the data collection phase. Time constraints were a major factor, due to the International Review Board (IRB) certification taking longer than anticipated. Certification was completed a couple of days before the students' spring break; therefore, testing had to be delayed another week.

Another limitation was that the researcher could neither ensure that each RA received the BUS survey email from their RECs, nor that each student resident received the BUS survey email from their RAs. These two factors alone could have significantly impacted the total response rate for both halls, which in turn could have influenced the significance tested for *overall comfort* and *overall satisfaction* categories due to the low response rate.

Another limitation was that the survey was distributed via email to both residential halls, but was only distributed in person to FST residents. This was due to an unforeseen circumstance in which Purdue University's Residential Learning stated that they didn't want the students being over surveyed, thus denying the researcher access to distribute the survey in person to TSS students. Recruiting additional TSS respondents could have impacted the data and resulted in a more even number of respondents.

Lastly, there was an error with the online survey regarding the "design" measure; unfortunately, this was not caught until after the students had already submitted their responses. Accordingly, overall satisfaction was measured using only the 18 categories selected. These factors could have influenced the data results.

## 5.3 Lessons Learned

This section is intended to alert future researchers on how to best handle the research process. The following suggestions were drawn from scenarios encountered throughout this research experience:

- Choosing a topic: When choosing to do research on a specific topic, be sure to be interested in the chosen topic. Consider the time and work that need to be allotted to complete the task. If while researching a topic you cannot find evidence to support or oppose the topic, do not hesitate to select a new topic. Being indecisive and uninterested in the chosen topic will make the thesis writing much more difficult.
- Committee Selection: An important component of the thesis process is the guidance and support you will receive from your committee team. A great way to ensure a solid team is to interview potential committee members. The interviews can be used to gauge how well you would work with each faculty member, as well as how each potential member would work with each other. Also, be sure to understand the expectations that each potential committee member has for you as well as him/herself during your thesis process. It will be extremely beneficial to have a clear understanding of what your committee expects from you and what you expect from them early on. The committee team should assist you in establishing a realistic timeline, including deadlines that must be met each semester. Remain actively involved with your committee team to ensure that such deadlines are met. The key during this process is to be proactive.

- IRB approval: If planning to use human subjects for research, approval from the International Review Board (IRB) must be obtained before proceeding with data collection. Finalize the IRB paperwork well in advance. This is very important, as unforeseen delays can push back the established timeline for your testing, data collection, and analysis. Since graduate students are typically working within the same timeframe, everyone tends to submit applications for IRB approval around the same time (thus prolonging the process). The key to avoiding long waiting periods is to set up a meeting with an IRB reviewer. Ask them to walk through and finalize the paperwork with you. Once that process is complete, submit the paperwork to the same reviewer. This will drastically shorten the process.
- Research Methodology: When focusing on the thesis proposal, be sure to structure the methodology of the research. This structure will serve as the guideline for remainder of the research and written requirements. Ensure the methodology testing method used is sound; a less-than-sound methodology can negate your entire research if caught too late. When focusing on the final defense, be sure your committee team has approved the written portion of your research and your committee chair has given approval to move forward with the final defense. No new methodology should be stated during the final defense presentation. All of the information presented during the final defense should be reflected in the written document.
- Lastly, and probably the most important, make sure writing a thesis is something of personal value. Writing a thesis is hard work and time consuming for the researcher as well as the faculty committee.

## 5.3 Conclusions

This research intended to obtain a better understanding of whether green residential halls benefited students by creating better occupant comfort and satisfaction when compared to students living in non-green residential halls. This study was conducted using a Building Use Studies (BUS) survey to test the student residents' overall comfort and overall satisfaction relating to factors of indoor environmental quality (IEQ). The descriptive statistics presented in this study showed that LEED Gold certified Third Street Suites (TSS) had higher mean satisfaction scores in the following categories: *location*, *temperature, air quality, needs* and *overall comfort*. The results also presented that the conventional First Street Towers (FST) building had higher mean satisfaction scores for *space*, *layout*, *storage*, *appearance*, *noise*, *lighting,* and *personal control*. Both residential halls showed equal satisfaction regarding *health*. However, using inferential statistics (a t-test), there was no significant difference between the two residential halls regarding *overall comfort* and *overall satisfaction*.

The results of this research were both similar to and different than previous literature. Similar literature showed that green building occupants were dissatisfied with their *personal control* over temperature, but reported higher satisfaction with *temperature comfort,* and *air quality*. Previous literature findings showed that green building users were dissatisfied with *temperature*, *noise,* and *air quality,* and satisfied with *lighting* and *visual comfort*. This was not the case for TSS respondents, who reported higher satisfaction regarding *temperature,* and *air quality,* and showed dissatisfaction with *lighting.*

Further studies could continue this research by applying the same methods, comparing different residential halls, and focusing on a larger response rate. A larger response rate could possibly result in a more precise difference between the two residential hall types. Further research could also focus on students who have lived in both residence halls; this would allow for a true

comparison of opinions between the two halls. A long-term study could also be conducted to assess students' impressions of all residence halls on a university campus to anticipate the potential variations. This could provide further insight on whether green buildings can improve students' overall comfort and overall satisfaction, In addition to other factors that may be associated with the results.

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# APPENDIX A: IRB APPROVAL LETTER

PURDUE
UNIVERSITY

HUMAN RESEARCH PROTECTION PROGRAM
INSTITUTIONAL REVIEW BOARDS

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| | |
|---|---|
| **To:** | KIRK ALTER<br>KNOY 433 |
| **From:** | JEANNIE DICLEMENTI, Chair<br>Social Science IRB |
| **Date:** | 03/09/2017 |
| **Committee Action:** | **Determined Exempt, Category (2)** |
| **IRB Action Date:** | 03/09/2017 |
| **IRB Protocol #:** | 1702018771 |
| **Study Title:** | Examining Occupant Comfort and Satisfaction of College Students Within Green Residences |

The Institutional Review Board (IRB) has reviewed the above-referenced study application and has determined that it meets the criteria for exemption under 45 CFR 46.101(b).

Before making changes to the study procedures, please submit an Amendment to ensure that the regulatory status of the study has not changed. Changes in key research personnel should also be submitted to the IRB.

Please retain a copy of this letter for your regulatory records. We appreciate your commitment towards ensuring the ethical conduct of human subject research and wish you well with this study.

Ernest C. Young Hall, 10th Floor - 155 S. Grant St. - West Lafayette, IN 47907-2114 - (765) 494-5942 - Fax: (765) 494-9911

# APPENDIX B: BUS SURVEY

## Housing Evaluation

This survey is being conducted to help with future planning and design of residences. The information collected will be treated as completely confidential by the survey team. Survey reports will use summaries of information and not reveal the identities of individuals.

**Please fill in as many questions as you can. Write any further comments in the spaces provided or on a separate sheet. Thank you for your help**

**Queries**:
If you have any queries please contact: Wesley M. Young
Email: wmyoung@purdue.edu

**Who should fill this in?**:
Anyone over the age of 18 who has lived in the residence for at least six months. This will normally be one person from the household.

## Background

Are you ...? *Please tick* Male [1] [2] Female

How long have you lived here ...? *Please tick* Less than one year [1] [2] One year or more

Please add your address ... *Please tick* First Street Towers [1] [2] Third Street Suites

Are you normally at home ...? *Please tick* Most of the time [1] [2] Evenings and weekends only [3] Other

*Please state if other*

Are you in a ...? *Please tick* Suite [1] [2] Semi-suite Single [3] [4] Other

*Please state if Other*

## The residence overall

**Location** How do you rate the overall location ...?

*Please tick* Unsatisfactory [1] [2] [3] [4] [5] [6] [7] Satisfactory

*Comments about location*

**Space** Is there enough space ...?

*Please tick* Not enough space overall [1] [2] [3] [4] [5] [6] [7] Enough space overall

*Comments about space*

**Layout** Does the layout suit you ...?

*Please tick* Poor layout [1] [2] [3] [4] [5] [6] [7] Good layout

*Comments about layout*

**Storage** Is there enough storage ...?

*Please tick* Not enough [1] [2] [3] [4] [5] [6] [7] More than enough

*Comments about storage*

**Appearance** How do you rate the appearance from the outside ...?

*Please tick* Poor [1] [2] [3] [4] [5] [6] [7] Good

*Comments about appearance*

## Your needs

How well do the facilties provided meet your needs ...?

We are thinking about e.g.... the kitchen, bathroom and toilet, living room, garage (if there is one), but please add other things if you wish.

*Please tick* Very poorly [1] [2] [3] [4] [5] [6] [7] Very well

Please give examples of things which work well for you ...?

*Work well*

... and examples of things which do not work well ...?

*Work poorly*

## Special circumstances

Do you have any special circumstances which make your needs different from the norm ...?

*Please describe any particular requirements that have not been properly catered for*

 

## Comfort

This section asks how comfortable you find the building in both the fall semester and the spring semesters.

How would you describe typical conditions in the SPRING semester?
If you have not lived here in spring then please leave these questions blank and just complete the questions on Fall conditions.

**Temperature in spring** *Please tick your rating on each scale*

| | | |
|---|---|---|
| Uncomfortable | 1 2 3 4 5 6 7 | Comfortable |
| Too hot | 1 2 3 4 5 6 7 | Too cold |
| Stable | 1 2 3 4 5 6 7 | Varies during the day |

**Air in spring**

| | | |
|---|---|---|
| Still | 1 2 3 4 5 6 7 | Draughty |
| Dry | 1 2 3 4 5 6 7 | Humid |
| Fresh | 1 2 3 4 5 6 7 | Stuffy |
| Odourless | 1 2 3 4 5 6 7 | Smelly |

**Conditions in spring**

| | | |
|---|---|---|
| Unsatisfactory overall | 1 2 3 4 5 6 7 | Satisfactory overall |

How would you describe typical conditions the in FALL semester?
If you have not lived here in the fall then please leave these questions blank and just complete the questions on Spring conditions.

**Temperature in fall** *Please tick your rating on each scale*

| | | |
|---|---|---|
| Uncomfortable | 1 2 3 4 5 6 7 | Comfortable |
| Too hot | 1 2 3 4 5 6 7 | Too cold |
| Stable | 1 2 3 4 5 6 7 | Varies during the day |

**Air in fall**

| | | |
|---|---|---|
| Still | 1 2 3 4 5 6 7 | Draughty |
| Dry | 1 2 3 4 5 6 7 | Humid |
| Fresh | 1 2 3 4 5 6 7 | Stuffy |
| Odourless | 1 2 3 4 5 6 7 | Smelly |

**Conditions in fall**

| | | |
|---|---|---|
| Unsatisfactory overall | 1 2 3 4 5 6 7 | Satisfactory overall |

*Comments about heating*

*Comments about cooling and/or ventilation*

## Noise

How would you describe the effects of noise ...?
*This question refers to conditions all year round*

*Please tick your rating on each scale*

| | | | |
|---|---|---|---|
| Noise overall | Unsatisfactory | 1 2 3 4 5 6 7 | Satisfactory |
| Noise from people between rooms | Too little | 1 2 3 4 5 6 7 | Too much |
| Noise from neighbours | Too little | 1 2 3 4 5 6 7 | Too much |
| Other noise from outside | Too little | 1 2 3 4 5 6 7 | Too much |

*Comments about noise and its sources*

## Lighting

How would you describe the quality of the lighting ...?
*This question refers to conditions all year round*

*Please tick your rating on each scale*

| | | | |
|---|---|---|---|
| Lighting overall | Unsatisfactory | 1 2 3 4 5 6 7 | Satisfactory |
| Natural light | Too little | 1 2 3 4 5 6 7 | Too much |
| Artificial light | Too little | 1 2 3 4 5 6 7 | Too much |

*Comments about lighting conditions*

## Overall comfort

All things considered, how do you rate the comfort of the residence's environment overall ?

*Please tick*

Unsatisfactory 1 2 3 4 5 6 7 Satisfactory

*Comments about comfort*

## Health

Do you feel that the building affects your health by making you feel less healthy or more healthy?

*Please try to evaluate this building with respect to your experience of using buildings in general.*

*Please tick*

Less healthy 1 2 3 4 5 6 7 More healthy

*Comments about health*

## Personal control

How much control do you personally have over the following ...?

**Importance of control**
*Please tick if important to you*

*Please tick each scale*

| | | | | |
|---|---|---|---|---|
| Heating | No control | 1 2 3 4 5 6 7 | Full control | 1 |
| Cooling | No control | 1 2 3 4 5 6 7 | Full control | 1 |
| Ventilation | No control | 1 2 3 4 5 6 7 | Full control | 1 |
| Lighting | No control | 1 2 3 4 5 6 7 | Full control | 1 |
| Noise | No control | 1 2 3 4 5 6 7 | Full control | 1 |

*Comments about personal control*

## Design overall

All things considered, how do you rate the design overall...?

*Please tick*

Unsatisfactory 1 2 3 4 5 6 7 Satisfactory

*Comments about design overall*

## Environmental design features

*If you have anything to add about the energy and water-saving features of your home please put them here.*

*Comments about energy or water-saving design features*

## Anything else ...?

*If you have anything else to add which is relevant to the topics raised please put it here.*

*Other comments*

## Lifestyle

Has living here changed your lifestyle …?

*Please tick*

Yes 1 2 No

If yes, please give examples of lifestyle changes …

*Work*

*Leisure*

*Diet*

*Travel*

*Anything else?*

## Utilities costs

How do your utilities costs (for heating, electricity and water) compare with your previous accommodation…?

*Please tick*

| | | | |
|---|---|---|---|
| **Heating** | Much lower | 1 2 3 4 5 6 7 | Much higher |
| **Electricity** | Much lower | 1 2 3 4 5 6 7 | Much higher |
| **Water** | Much lower | 1 2 3 4 5 6 7 | Much higher |

Please give examples of how you have changed your use of heating/cooling, lighting, appliances and water since coming here …

*Heating/cooling*

*Lighting*

*Appliances*

*Water*

*Anything else?*

**Thank you for your help**

If you have any more comments on the topics raised, please add them on a separate sheet.

**Please return the filled-in questionnaire to Wesley M. Young or as otherwise requested.**

 

# APPENDIX C: BUS LICENSE

**Definitions**

**Questionnaire:** The work produced by the Licensor

**Territory** :

USA

**Period** :

One year

**Term:** The full term of copyright and all renewals and extensions.

**Rights**: The non-exclusive right by licence, to utilise the questionnaire in the agreed material format for the purposes defined.

**Study building** : The building/s to which the licence applies, normally named in Further Details below.

**Further Details**

BUS project reference: 1435

For graduate study of:

First Street Towers - 1250 First Street West Lafayette, IN 47906

Third Street Suites - 1196 Third Street West Lafayette, IN 47907

**Invoices** : Free licence by arrangement with BUS Methodology and the Usable Buildings Trust

## Licence agreement

21/12/16

This is a questionnaire licence agreement between:

Adrian Leaman, Usable Buildings Trust — *The Licensor*

and:

Wesley M Young, Purdue University — *The Licensee*

concerning the method/s:

**BUS Methodology Domestic version Standard 2016**

The licensors as owners of the copyright of the title agree to grant the rights to the licensee subject to these terms and conditions.

1. The licensor as beneficial owner grants the licensee rights throughout the territory for the period.
2. The licensor warrants that they are the sole owners of the rights and have full power to enter the agreement.
3. The licensee undertakes that the following copyright notice is prominently displayed on all pages of the questionnaire and prominently in the report of survey, especially within data tables:

**© Copyright: BUS Methodology 2016 Used under licence.**

4. If a survey is undertaken, the licensee undertakes to lodge the data file of the survey with BUS Methodology subject to full confidentiality in agreed computer file format..

5. If a survey is undertaken. and data are supplied as in 4., BUS Methdology undertakes to supply the licensee with data analysis in the current formats.

6. If a survey is undertaken, the licensee undertakes to conduct the survey using agreed ethical principles such as those of the Market Research Society.

7. The licensee undertakes not to change any questionnaire or other formats without prior agreement of BUS Methodology.

8. The licensee undertakes not to publish or circulate details of questionnaires or benchmarks without prior agreement of BUS Methodology.

9. The licensor undertakes never to reveal details of individuals or to release details of building names without prior agreement of the licensee.

10. The licensor undertakes not to grant more than one licence for a particular study building during a defined period.

11. If a translation is undertaken, the licensee undertakes to carry out the translation under supervision from the licensor and to release the resulting translation file to BUS Methodology.

Signed: Adrian Leaman

Digitally signed by Adrian Leaman
DN: cn=Adrian Leaman, o, ou, email=adrianleaman@usablebuildings.co.uk, c=GB
Date: 2016.12.21 09:03:10 Z

Adrian Leaman, Usable Buildings Trust

Signed: Wesley Young

Wesley M Young, Purdue University

# APPENDIX D: RECRUITMENT FLYER

**Greetings**:
My name is Wesley Young. I am graduate student in the School of Construction Management. This survey is intended to help with ongoing thesis research and your help would be much appreciated. If you have any questions regarding the survey, please contact me at *wmyoung@purdue.edu.*

**Purpose of Research:**
You have been invited to participate in a research study designed to assess the effects of occupant comfort and satisfaction among college students living in residential halls. The goal of this survey is to get feedback from college students on their perception of their overall comfort and satisfaction in their current residential hall.

**Instructions:**
If you agree to participate in the study, please answer all question as accurately as possible. This will ensure reliable data

- You can **ignore the utilities** section since it does not apply

**Duration:**
The survey will take you about 5-8 minutes (pending on your responses)

**Confidentiality:**
This voluntary survey is being conducted to help with future planning and design of residences. Your responses and participation are completely anonymous and confidential. All data obtained during the survey will be destroyed once data collection is complete. You will NOT have to disclose any personally identifying information (e.g. name, student identification number). Survey reports will use summaries of information and not reveal the identities of individuals.

**Voluntary Nature of Participation**
Your participation is strictly voluntary. You may refuse to participate or discontinue at any time without penalty. You may also decline to answer any question that makes you feel uncomfortable.

**Link to Survey (Click the link to participate)**
**http://www.usablebuildings.co.uk/Q1435/DomesticStandard.html**

Thanks for your help!

Wesley Young
MS Candidate
Construction Management