A Research Protocol for a Field Study of Behavior, Comfort, and Energy Consumption in Student Residence Halls

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Abstract:
A research protocol was developed for a field study of occupant behavior, thermal comfort, and energy consumption in two residence halls, one old and one new, at the University of Oregon in Eugene, Oregon. Three methodologies were used in the investigation: an online occupant survey, data logging of thermal conditions within the buildings, and the collection of electrical utility data. In response to university concerns, the study protocol was carefully devised to prevent intrusive contact between the investigator and the student residents as well as to limit the number of times that housing staff would need to provide access to the buildings. Data collection over a three-week period, beginning in late October 2009, indicates that the procedure outlined can be effectively utilized to investigate residence hall living environments with little disruption to student and staff routines.

Keywords:
Residence Halls, thermal comfort, energy consumption, behavior

Introduction

Student housing on college campuses began as early as the 12th century in France, England, and Germany.[i] Over the centuries various terms have been used to describe these living environments: hostel, hall, college, halls of residence, and dormitory are, perhaps, the most common.[ii] More recently the term "residence hall" has come to symbolize institutional housing that satisfies student needs for affordable, comfortable, and safe accommodation, and contributes in a positive way to academic and personal development.[iii] Consequently, the term "dormitory" has fallen out of favor because it has come to symbolize an antiquated idea of institutional housing in which students merely sleep and store their belongings.

Student housing has been an integral component of American higher education since the founding of the first colonial colleges.[iv] However, it was in the years after World War II that colleges dramatically increased their student housing stock in response to increased enrollments and the availability of federally subsidized construction loan programs.[v]

Indeed, the majority of student housing at colleges and universities dates from the 1950s and 1960s. At that time, the priority was to economically house as many students as possible. These buildings have functioned as the workhorses of student housing ever since. Within the past decade, however, a new breed of residence hall has emerged that directly responds to increased student expectations and institutional commitments to student needs and environment concerns.

New residence halls differ substantially from their predecessors due, in part, to their advanced environmental systems, energy efficiency, and greater opportunities for occupant control. However, studies of other building types, such as offices, have found that occupants appear less willing to take action to adjust their comfort in the presence of sophisticated systems that regulate environmental conditions.[vi] Furthermore, many institutions have been unable to build or renovate residence halls at a pace that satisfies the student demand for newer housing. As a result, students attending the same institution are often housed in vastly different living environments.

Objective

A large number of residence hall studies were completed in the 1960s and 1970s. Much of this research focused on social interaction, academic achievement, room layouts (suites vs. doubles), and building types (towers vs. low-rise). Robert Sommer, the noted psychology researcher, speculated that the widespread use of college dormitories for research studies is due to the large number of study subjects in close proximity to academic researchers.[vii] However, institutions now appear determined to dispel the notion that college students living in residence halls should be "easy targets" for research samples. This may help to explain why fewer studies have focused on residence hall environments in recent years.

Nevertheless, there is a lack of residence hall research related to occupant comfort, energy consumption, and the role of building age on occupant behavior. Therefore, the primary objective of this research project is to address these gaps in the existing body of residence hall research.

Despite the procedural challenges inherent in conducting research in residence halls, information related to behavior, comfort, and energy usage in these buildings could assist institutions in providing superior campus housing that improves student satisfaction, productivity, achievement, and health in addition to reducing energy costs, waste, and environmental impact.

Approach

The field study focused on two residence halls at the University of Oregon in Eugene, Oregon: Riley Hall was built in 1963 and the Living and Learning Center (LLC) South was built in 2006. The intent was to investigate occupant behavior and physical conditions related to comfort and energy consumption in two residence halls of different vintages. The buildings were specifically chosen for their similar size, number of occupants, and numbers of double and single bedrooms (Table 1).

	Riley Hall	LLC South
Age (year built)	47 (1963)	4 (2006)
Gross Sq. Ft.	42,719	48,748
Net Assignable Sq. Ft.	22,355	26,280
Bldg. Efficiency	0.52	0.54
Occupancy	143 (56 male, 44 female)	165 (41 male, 59 female)
Number Double Rooms	70	77
Number Single Rooms	10	11

Table 1: Building Comparison.

Riley Hall is located five blocks from the campus and was originally built by a local hospital to house nursing students (Fig. 1). The university purchased the building in 1987 and it is scheduled to be demolished in 2013 in accordance with the Housing Strategic Plan.[viii] The three-story building is located on a corner lot along a busy arterial road. The hall is rectangular in plan with student rooms predominantly oriented north and south. Student rooms are small: 163 square feet for doubles and 88 square feet for singles. Bedrooms have operable windows and simple, numbered thermostat controls. The building is not air-conditioned. Corridors are long and narrow (approximately four feet wide). An open courtyard provides natural light and ventilation to parts of the upper floor corridors. Student rooms occupy the 2nd and 3rd floors. The ground floor is predominantly lounge space. The entire building is card-access only.

Figure 1: Riley Hall Residence Hall.

LLC South is located on campus near other existing residence halls (Fig. 2). It comprises one half of a larger complex. The LLC Complex was the first new residence hall built on the campus in 43 years. The four-story building is "C" shaped in plan with student rooms predominantly facing north and south. Student rooms are large: 215 square feet for doubles and 139 square feet for singles. Bedrooms have operable windows and electronic thermostats. The building is not air-conditioned. Corridors are broad and well lit. The ground floor includes lounge spaces, a performance space, a small number of student rooms, and an apartment for housing staff. Several ground-floor public spaces are open and accessible to the entire university population, but the student room areas are card-access only.

Figure 2: LLC South Residence Hall.

Methodology

Three research methods were utilized in this field study investigation: occupant surveying, thermal data logging, and electrical utility data collection. A *dominant-less dominant design*, as described by Groat and Wang,[ix] was developed in which the survey data assumes a *dominant* role and the thermal and utility data assume *less-dominant, or supporting,* roles. Using a combination of research methods is common in field studies and helps to balance the strengths and weaknesses inherent in individual data collection strategies.

Occupant Survey

Surveys have been widely used as research instruments in studies of thermal comfort, energy consumption, and residence halls. Several recent studies by Petersen et al.[x] and Devlin et al.[xi] have successfully utilized web-based survey methods in combination with incentives to encourage student participation. When compared to traditional paper surveys, online surveys offer researchers investigating residence halls several key advantages. First, they are less costly because no printing or mailing is necessary. Second, they do not have to be manually distributed to individual student rooms, which is time consuming. Third, they can be accessed and submitted at any time via the web, which eliminates the risk that students will misplace or forget to return their paper survey. Finally, they enable investigators to administer the survey without having to interact directly with the survey participants, which was a significant concern at the University of Oregon. For these reasons, a web-based survey was created and administered using Surveymonkey.com. Basic surveys created using the Surveymonkey website are free of charge, however a monthly subscription service was purchased for this study, which provided an expanded range of options (Fig. 3).

The survey was comprised of an introduction and consent page, an instructions page, 29 questions on 12 separate pages, an opportunity to be entered in an incentive prize drawing, and a concluding thank you page with contact information. The survey questions were divided into five sections, which asked students: their perceptions about their room; their routines and actions in their room; their perceptions and actions in common spaces such as lounges; their overall residence hall experience; and demographic information. The divisions helped to organize the question types and to give participants the sense that they were making progress toward finishing the survey.

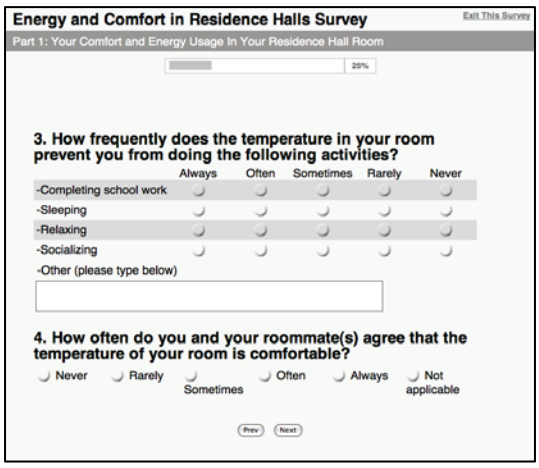

Figure 3: Page from Online Survey.

Survey questions were predominantly multiple-choice. 5-point Likert scales (for instance: never, rarely, sometimes, often always) were heavily used in sections 1-4 and enabled ordinal-level measurements. An "other" option was often included so that respondents could type-in additional information. Few entirely open-ended questions were given. Respondents were typically asked to comment on the one-month period that they had lived in the buildings since the beginning of the academic school year. This was important because accurately recalling experiences beyond recent memory can be challenging for survey takers and can produce inaccurate data for investigators.

Random sampling methods were not possible given the limitations imposed on this study by the university. Therefore, purposive sampling methods were used in the selection of survey subjects. All residents in each of the two buildings investigated were given an opportunity to complete the survey.

A survey pretest was conducted using 10 students who did not live in either of the two buildings being studied. Pretest respondents were given an opportunity at the end of the survey to provide suggestions for improvements to the survey organization and question wording. This feedback was used to modify the final version of the survey.

Printed fliers were the primary respondent recruitment method. Housing staff agreed to hang color fliers on bulletin boards, to distribute black and white fliers beneath student room doors, and to send one e-mail to the hall residents at the very beginning of the survey period.

The online survey ran for two weeks. A customized online URL weblink was created to enable respondents to easily access the survey page.

Thermal Data Logging

Six factors, or parameters, affect thermal comfort conditions in buildings: air temperature, relative humidity, air movement, radiant temperature, metabolic rate, and clothing insulation.[xii] Typically, thermal comfort field studies measure the first three factors with instruments and calculate the later three factors from measurements and questionnaire data. The six parameters are then compared with occupant responses to questions related to thermal comfort at the time the measurements were made. This procedure is effective when large numbers of occupants can be surveyed in a single space, for example in offices or school classrooms.

Because residence halls are compartmentalized into large numbers of bedrooms, they present unique challenges for thermal comfort research. Measuring separate student rooms would be prohibitively time consuming and intrusive to students' personal privacy. In addition, arranging separate meeting times with all building occupants given the access limitations was not logistically possible. Therefore, small HOBO U12 data logging devices were used to measure temperature and relative humidity conditions every two minutes over a three-week period in four representative rooms and one outdoor location in each residence hall. Within each of the buildings being studied, three Resident Assistants (RAs) volunteered to have the data loggers mounted in their rooms, one data logger was placed in a student lounge space, and one data logger was mounted to the outside of a window.

All data loggers were placed within protective cardstock boxes (Fig. 4), which obscured the data logging devices from view and included a label stating "Temperature Experiment in Progress. Please Do Not Distrurb." The investigator's contact information was also listed. The boxes were mounted to wall and window surfaces using 3M Command™ adhesive strips, which did not leave any residue when removed or damage painted surfaces.

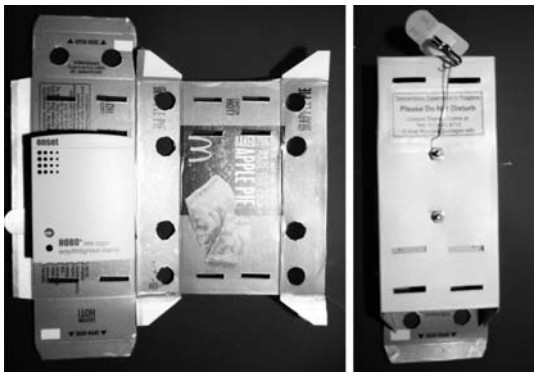

Figure 4: Protective Boxes for Data Loggers.

Electrical Utility Data

The residence halls being investigated used the same utilities: steam and electricity. However, submetered steam consumption for the newer building (LLC South) was not available. Therefore, the study looked only at electricity consumption in the buildings. Electricity meters record kilowatt-hours (kWh) of power usage and are read monthly.

Utility data was provided by the Department of Utilities and Energy Management rather than being collected directly. This arrangement posed significant limitations on the study because the only available data was collected by someone other than the investigator. In addition, the data revealed complexities within the building metering that were not anticipated by the university or the investigator during the planning stages of the study, which impacted the data analysis process toward the end of the study.

Data Collection Procedure

The data collection procedure was devised to accomplish the following objectives: to work within the limitations of a 10-week academic term; to limit intrusive contact with students living in residence halls; and to limit the amount of assistance and access that housing staff would need to provide during the study.

Several months before the survey and physical measurements began, a meeting was scheduled with the Interim Director of Housing to discuss the proposed research project in two residence halls. At a second meeting several weeks later, University Housing agreed to allow the study to take place in Riley Hall and the Living and LLC South building. Intrusive student contact and building access were to be minimized, but mounting data loggers in the building and conducting an occupant survey were approved.

One month before the study commenced, the final survey was submitted to the university as part of a required Human Subjects Protocol Application process. The application was approved in mid-October after several minor revisions were made.

The data logging commenced on Monday October 26, 2009. Five data loggers were mounted in each building. RA's provided access to the buildings and to specific rooms and supervised the mounting of the devices. The process took approximately 30 minutes in each building.

One week later, on Monday November 2, 2009, the online survey was launched. Fliers were given to housing staff several days prior to the launch for distribution under doors and posting on bulletin boards. In addition, an e-mail was sent by the housing staff on the day of the launch.

Later that week, during the second week of data logging, the devices in each space were checked. The procedure was to plug the data loggers into a laptop computer, download data logged to date, and check that the device was operating properly. Data logging was not interrupted while the devices were being checked. The process took approximately 30 minutes in each building.

On Monday November 16, 2009, two weeks after the initial launch, the online survey access was closed. The survey data was saved in spreadsheet format for future analysis.

The data loggers were removed from the buildings after the survey period ended. RA staff, once again, provided access to the buildings and specific rooms and supervised the collection of the data loggers. Each device was connected to a laptop computer and the data logged over the three-week period was saved in graph and spreadsheet formats for future analysis. The process took approximately 20 minutes in each building.

Survey respondents were given the opportunity to submit their e-mail address to be included in an incentive prize drawing for one of four $50.00 gift cards to the school bookstore. The four prizes were given to the housing staff to distribute to the student winners during the week after the survey ended.

Monthly utility data for 2009 was requested in October, but was not available from the university until mid-January 2010. The data was obtained from the University of Oregon Department of Utilities and Energy Management in the form of spreadsheets.

Conclusion

The research protocol described in this paper takes into account many of the challenges inherent in fieldwork within student housing facilities. The procedure was effectively implemented in two residence halls at the University of Oregon and could inform future studies in similar living environments. The lack of recent residence hall research may be due, in part, to the types of institutional concerns for student privacy and safety that were encountered in this research investigation. Nevertheless, carefully conceived research protocols may be one way to increase the number of studies being conducted in residence halls while providing assurance to institutions that intrusive contact between students and researchers can be minimized.

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