Effectiveness of design standards in improving residence hall usability and satisfaction

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ABSTRACT: "Universal design is a process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation" (Steinfeld and Maisel 2012). The designers of a university residence hall utilized a draft universal design standard during their design process. The Rehabilitation Engineering Research Center on Universal Design and the Built Environment (RERC-UD) conducted a post-occupancy evaluation to determine the effectiveness of the draft standards and help inform further standard development. In this study, researchers used more general concepts of "usability" and "satisfaction" to encompass the three desired outcomes of universal design. This post-occupancy evaluation used three methods of inquiry:

1. Guided Tours: A trained researcher escorted participants through the new residence hall and a comparison hall while participants rated usability of specific building features. This provided a controlled environment for a quantitative response format while providing open-ended response opportunities prompted by the real world immersion.

2. Online Survey: Residents of both buildings answered comparable questions about usability of specific building features and general satisfaction.

3. Archival Records: A researcher systematically examined work orders created by residents and staff about problems they were experiencing with both buildings.

The use of multiple methods of inquiry, though challenging, leads to increased confidence in the results. While each method yields unique information, the complimentary information found in the overlapping content areas provides a better understanding of the complex issues involved.

The results provided insight into how well the two buildings suit occupant's needs, identified which features were most closely related to resident satisfaction, and helped evaluate the effectiveness of specific universal design standards, as well as the value of utilizing such standards in practice. The findings show that participants rated the new residence hall as more usable and more satisfactory than the comparison hall. This paper will discuss the methodology and findings and identify further directions for this line of research.

KEYWORDS: Design standards, Residence hall, Usability, Satisfaction, Post-occupancy evaluation

1.0 INTRODUCTION

The primary role of architects is to design environments that are safe, usable, and meet the goals of all their target users. However, specific design decisions can create barriers for subsets of the population with unaddressed needs. Such groups include people with disabilities, caregivers, low-income people, children, and older people. These unintentional barriers could be anything from a door that is too heavy, to stairs and passageways that block access for wheelchair users and create difficulty for people with strollers and rolling luggage, to a poor room layout and numbering system that causes people to get lost. The Americans with Disabilities Act Standards for Accessible Design aims to eliminate fundamental access barriers for one special population, people with disabilities, but they do not address usability and convenience issues for the broader population. Further, while the standards provide minimum requirements to accommodate people with disabilities, they do not inform designers how to provide optimum conditions for even this group and have significant gaps, e.g. addressing cognitive disabilities. Building codes and standards focus primarily on access and egress, safety, and major health issues like sanitation. They do not address the full range of issues related to social integration, comfort, and wellness from a best practices perspective.

Built upon the foundation of accessibility, the concept of universal design addresses health, wellness, and social integration as well as higher levels of physical access, safety, and comfort provided by building

regulations. The eight Goals of Universal Design are Body Fit, Comfort, Awareness, Understanding, Wellness, Social integration, Personalization, and Cultural Appropriateness. Proponents of universal design argue that these goals are appropriate for all design projects, and architects and designers who attempt to achieve these goals will create environments that are healthier, friendlier, safer, and more usable for all people (Steinfeld and Maisel 2012). However, unlike minimum standards for accessible design, there is no single set of guidelines or standards to guide architects and designers on how to achieve the goals of universal design. While several organizations have developed informal checklists, many focus on the residential sector, and none reference evidence-based design criteria. In 2009, the Center for Inclusive Design and Environmental Access began assisting the Global Universal Design Commission to develop consensus standards for universal design of commercial buildings. The purpose of such standards is to bridge the knowledge gap by creating a single body of evidence-based universal design strategies. Experience, expert judgment, and evidence-based research informed development of the standards. Architects utilized a draft version of these standards to design a new 600-student residence hall on the State University of New York at Buffalo's campus. The standards include provisions for the design of the site, building entrances, common areas, interior circulation, restrooms, assembly spaces, sleeping rooms, workspaces, services, and policies. The post-occupancy evaluation conducted by the Rehabilitation Engineering Research Center on Universal Design (RERC-UD) presented in this paper demonstrates that user satisfaction and usability is significantly higher in this building than a comparison building designed without use of the standards. The results provide insight into how well the two buildings suit occupant's needs, identified which features were most closely related to resident satisfaction, and helped evaluate the effectiveness of specific universal design standards as well as the value of utilizing such standards in practice.

2.0 BACKGROUND

Residence halls are homes to a broad and diverse population including students with varying needs, abilities, and interests as well as university staff and visitors of all kinds. Residence halls include spaces for sleeping, eating, studying, meeting, teaching, and public programs. The wide variety of spaces and people makes residence halls an ideal environment in which to study universal design standards. While there have been post-occupancy evaluations conducted on how specific features of the residence hall environment affect student satisfaction and behavior, there are no studies that examine effect of a specific set of universal design strategies on a building's users.

Amole (2009) investigated the relationship between residential satisfaction and scale of the residential environment utilizing a survey about design, facilities, social interaction, place, maintenance, and management. Propst and Propst (1973) studied the impact of room layout on student satisfaction and behavior at the University of Massachusetts, Amherst. Van Der Ryn and Silverstein (1967) studied University of Berkeley student perception and satisfaction with their high-rise residence hall using factors such as temperature, light, and noise. None of the studies compared the effectiveness to a specific set of design guidelines. Further, no previous study has given attention to people with disabilities or any other group often overlooked in the design process.

In 2006, the University of Wisconsin-Whitewater (UWW) commenced planning a residence hall using universal design as a guiding framework (Watson, et. al 2013). However, since this was prior to development of the draft universal design standard, the designers of the UWW residence hall developed their own proprietary set of guidelines based on a document called the Principles of Universal Design (Center for Universal Design, 1997). In an article on the project, UWW acknowledged, "there are no specific standards for what [universal design] means in practice" (Watson, et. al 2013). The university's interest in universal design was to serve an increasing student population with disabilities. According to the article, the growing population of students with disabilities on campus is due to "better medicine, increased access to primary and secondary education, and the availability of adaptive technology and other resources" (Watson, et. al 2013). The university's primary goal was to eliminate barriers for students of a diverse population and to improve access, resulting in the retention of students with disabilities.

3.0 OBJECTIVES

The primary research question was to determine if a universally designed building provides a significantly better user experience than a similar building that was not. A related question was to determine if the draft universal design standards were effective in contributing to an improved experience. A third objective was to gather information to improve the draft standard and lay the foundation for a cost effective audit process. To

determine an answer to the primary research question, researchers conducted a post-occupancy evaluation of two residence halls. One residence hall incorporated many design strategies listed in the draft universal design standard. The comparison residence hall is comparable in size and student population, is generally compliant with accessibility regulations, but pre-dates the concept of universal design. The post-occupancy evaluation had three phases: a guided tour, an online survey, and a review of archival records.

4.0 METHODS

4.1. Guided tours

The guided tours consisted of a trained researcher who escorted 62 participants through the new residence hall and the comparison hall one-at-a-time. The researcher asked participants to perform various tasks using the building's features throughout the tour and to rate the ease or difficulty of such tasks. He or she also recorded the ratings of features on a seven-point Likert scale (from very easy to very difficult). The researcher also asked participants to explain the reason for their rating, recorded notes on existing conditions, and made comments based on his or her observations of task performance. The guided tour focused on usability and addressed a selected set of topics such as entry to the building, design of public areas, finding destinations, and using features and amenities in restrooms, hallways, kitchens, lounges, stairways, elevators, and sleeping rooms. Specific goals and strategies listed in the draft standard formed the basis for most questions. The structured interview and response format provided a controlled environment for a quantitative response format that an audit tool would need while providing open-ended response opportunities prompted by the real world immersion. Participants consisted of paid volunteers who did not live in either building, and who had a variety of physical and cognitive abilities and backgrounds, including 31 able-bodied people and 31 people with a mobility, cognitive, and/or visual impairment (split nearly evenly). The purpose of using non-residents was to avoid bias due to familiarity with the building and to allow researchers to gather information on the difficulty of finding destinations from a visitor's perspective, something that the draft universal design standards address.

4.2. Online survey

Residents of both buildings completed an online survey. The survey questions were similar to those used in the guided tour methodology in order to allow a comparison between the techniques, but the online survey also addressed satisfaction with building features and issues that required familiarity with the building to make meaningful judgments, e.g. thermal comfort. The online survey used a five-point Likert scale asking participants to rate their level of agreement with a positive statement about the building's features (from strongly disagree to strongly agree). While the guided tour questions focused primarily on the ease of use of completing tasks using the building's features, the online survey asked residents to evaluate specific features in their residence hall in terms of their satisfaction, safety, and comfort. The online survey addressed private areas within the halls (e.g., resident's rooms or suites), shared spaces (e.g. lounges, bathrooms, laundry areas), and public spaces (e.g., first floor lounges, eating areas, etc.). Specific goals and strategies listed in the draft standard formed the basis for most questions. The survey also included a set of more general evaluations of the residence halls, such as overall maintenance, safety, comfort, and satisfaction. To ensure survey availability to respondents with visual impairments, researchers ensured the hosting website was compatible with screen reader software and other accessibility standards.

4.3. Work orders

Researchers systematically analyzed building work orders for both residence halls. The purpose of the analysis was to determine if there were any issues not identified by either of the other two methods. The work orders consisted of written complaints by students and staff about various problems and issues within the buildings. This analogous assessment of the issues or concerns raised by the guided tours and the online survey provided researchers with the opportunity to explore new issues and to investigate known issues further. For example, the qualitative portion of the survey identified a problem with frequent tripping of circuit breakers, but researchers did not realize the extent of the problem until the work order analysis revealed that this issue accounted for 37% of all work orders. The work order results also provide insight into typical problems facing a new building, in contrast with an established building, which will aid in the refinement of the universal design standards for facilities management.

4.4. Presence or absence of universal design strategies

Finally, to determine if the draft universal design standards were effective in precipitating the user ratings, researchers had to determine which universal design strategies in the draft standard were included in both buildings. The draft universal design standards contain over 600 strategies and designers can choose which strategies they want to include to meet universal design goals. For example, the standards includes the goal,

“Doors are designed to facilitate understanding of their operation and are easy to use.” To achieve this goal, it lists strategies such as, “Frames and doors have contrasting color from adjacent walls,” “Push side and pull side are coded for ease of use,” and “clear width allows all personal wheeled mobility devices to pass through,” and others. The building may have used one or more of these strategies but all would affect ease of use. Thus, it is important to understand which strategies contributed to the ratings.

Researchers compiled a list of the universal design strategies to investigate in both buildings since it was possible that the non-universally designed building could have individual strategies consistent with the universal design standard. However, researchers discovered that some strategies were worded in such a way that they were open to interpretation making it difficult to determine which strategies actually existed in each building. To make this determination, a researcher and two colleagues completed an independent assessment of each building using a checklist of strategies. The level of agreement among the assessors was also determined for each item to ascertain the extent of consensus on the presence of each universal design feature. Researchers compared the assessors’ ratings for each building and developed a level of agreement score based on how far apart the assessors were on the five-point rating scale. If experts did not agree on the existence of the same strategy in both buildings, the strategy was not included in the analysis since the wording of the strategy was likely unclear. This analysis identified three categories of strategies: (1) strategies that were more prominent in the universally designed building, (2) strategies that were more prominent in the non-universally designed building, and (3) strategies that were of equal prominence in each building. Once the strategies list was reduced to only those where there was general agreement in the existence of a strategy in at least one building, researchers compared the average assessors’ rating for each strategy, for each building. Then, for each strategy, the researcher marked which building had the higher score, or if the scores were even.

5.0 RESULTS

5.1. Building comparisons

Researchers paired the guided tour items from each building. While there were items unique to each building, only those that are present in both buildings are included in this analysis. For example, each building had a restroom with door and toilet, thus researchers asked the same questions about these features in each building. Each building tour included a way-finding task, in which researchers instructed participants to find a room based on its room number. Conversely, only one building had a business center; thus, this analysis does not include any questions on the business center. Researchers designed the tour for each building to be as similar as possible to facilitate these comparisons. Similarly, the online survey for each building was nearly identical save word substitutions to match each building’s internal nomenclature (e.g. “floor lounge” substituted for “entertainment lounge”).

After pairing the questions, researchers computed average ratings for each item for each building. Analyses were also completed by gender and self-reported functional limitations, defined here as “disability.” Thus, for each question, in each building, there is an average rating for five samples: the total sample, all males, all females, all non-disabled people, and all people reporting at least one disability. The objective for each of these samples was to compare the two buildings. Researchers used a two-tailed paired samples t-test to compare the two buildings for the guided tour data, and a two-tailed independent samples t-test for the online survey building comparison.

The universally designed building rated significantly higher than the comparison building on 88 items (guided tour and online survey combined). The comparison building rated higher on only 5 items. There were no significant differences between the buildings for the remaining 41 items. These results indicate that the building designed to meet the draft universal design standards does in fact provide a better experience across many measures. Table 1 shows these results for the total sample, gender, and disability.

Table 1: Number of items with significant differences (p=0.05 or better) by gender, and ability level

	Items in Online Survey			Items in Guided Tour		
	UD Rated Higher	Non-UD Rated Higher	No Significant Difference	UD Rated Higher	Non-UD Rated Higher	No Significant Difference
Full Sample	**56**	**2**	**27**	**32**	**3**	**14**
Male	34	3	48	30	2	17
Female	55	1	29	25	5	19
Disability	20	1	64	25	3	21
No disability	56	2	27	27	6	15

The results were generally consistent by gender and ability level on the guided tour. However, in the online survey, questions answered by residents with a disability were less likely to result in a significant difference between buildings but this is possibly due to low sample size, since many residents did not have a disability. Another factor is the type of disability. In the online survey, researchers did not differentiate between individuals with a severe physical or sensory disability, (e.g. inability to walk or see) or a less severe cognitive disability (e.g. dyslexia). The online survey also indicated that there was a higher prevalence of significant differences among females. Since sample size is not the issue in this case, perhaps females are more sensitive to their living environments than males; however, exploring this finding requires further analysis. The open-ended responses in particular, may further explain this difference.

5.2. Effect of draft standards

To determine if there is a relationship between the number of universal design strategies incorporated in each building with the participant ratings for each item, a statistical analysis would be most conclusive but is not yet complete. However, researchers conducted a preliminary analysis to examine this issue. For this analysis, researchers identified the prominence of the strategies (universal design features) related to the items used in the guided tours and online survey – whether the strategies were implemented and to what degree. All items in which there was a significant difference in results between buildings were ranked and compared to the prominence of universal design features. While this preliminary analysis cannot definitively prove a relationship between the number of standards used and the ratings for each question, it provides an indication that one may exist, and confirms the value in additional statistical analysis, which will be complete soon.

Table 2 provides an analysis of the degree of presence of universal design strategies in comparison to the ratings from the online survey and the guided tours. Researchers identified 225 instances where a particular strategy incorporated in the building also corresponded to an online survey item. There were 408 such instances corresponding to a guided tour item. Note that many strategies may apply to a single item in the survey or tours, and many items use the same strategies as other items. For example, a restroom could incorporate many universally designed strategies, and some strategies such as those relating to the door could apply to other spaces. Thus, for each item in the survey or tour, the number of strategies incorporated into each building can be computed on an item-by-item basis as a percentage of possible strategies that were adopted. For example, one item may have 20 related strategies. If only 5 of those are incorporated in a building, it can be represented by a percentage of 25%. Alternatively, if 15 are incorporated, it can be represented as 75%. The researchers computed the presence of universal design strategies using the process described in the methods section and then calculated the incorporation rate for each item in the survey or tour. Overall, 41% was the mean “incorporation rate.” Table 2 compares the user ratings of items above or below that level. The table shows that at least twice as many items above that level had significantly higher participant ratings in the universally designed building. Therefore, there appears to be a strong relationship between the presence of universally designed features and a positive user experience.

Table 2: Number of items with significant differences (p=0.05 or better) by presence of universal design strategy

	Items in Online Survey			Items in Guided Tour		
Frequency of UD Strategies	UD Rated Higher	Non-UD Rated Higher	No Significant Difference	UD Rated Higher	Non-UD Rated Higher	No Significant Difference
% higher than mean	15	0	4	19	2	6
% lower than mean	9	1	11	6	1	7

CONCLUSION

The universally designed building provided a better user experience than the comparison building on many measures, which confirms the hypothesis that universal design provides a better user experience for all in terms of usability and satisfaction. It appears that it is possible to establish a relationship between the use of specific universal design strategies and user ratings. Such a relationship would be useful for providing guidance in prioritizing strategies, especially in terms of developing a certification program based on the universal design standards (e.g. LEED).

The research collected much more data than is presented here and further analyses are ongoing. In particular, an item-by-item analysis is necessary to identify the value of each guideline and strategy. The details of the open-ended responses and work orders will also provide information useful for clarifying the results of the online surveys and guided tours. Future articles will focus on further comparisons between different user groups. For example, the finding that women rated the universally designed building higher than the comparison building on many items more often than men do, suggests that further investigation of gender differences would be valuable as well.

The multi-methods approach proved to be very informative. Information from one method often provided clarification of results from another method. For example, an analysis of building work orders provided an explanation for unexpected conflicts between guided tour results and online survey results. Furthermore, results from the use of multiple methods revealed the importance of studying usability in relationship to other design goals such as sustainable design. It also led the research team to rethink the standards to make the strategies clearer and easier to identify. Future research should focus on analysis of the relationship between specific universal design strategies and user ratings. Such attention will provide the guidance necessary to inform improvements to the universal design standards.

In conclusion, this research will provide insight into the value of universal design standards and certification programs for improving the quality of the built environment for all people.

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