



# Rethinking the environmental and experiential categories of sustainable building design, a conjoint analysis



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## ARTICLE INFO

### Article history:

Received 12 September 2015

Received in revised form

18 December 2015

Accepted 19 December 2015

Available online 22 December 2015

### Keywords:

Green building

LEED

Choice Based Conjoint

Environmental categories of design

Experiential categories of design

## ABSTRACT

Although extensive research has investigated the benefits of green buildings very little is known about user perception and satisfaction. Most of the studies involving users in green buildings are in the form of post-occupancy evaluations that gather satisfaction scores and qualitative feedback from building occupants. However it is difficult to generalize these individual case studies to a wider discussion of preferences for green building attributes. The current research uses a more generalizable technique to examine occupants' experiences in green buildings. This study identifies the relative importance of environmental and experiential design categories by occupants based on lived experiences in the space. The article provides the results of a Choice-Based Conjoint (CBC) study that compares responses from green and non-green building occupants. The results provide novel insights into the degree of importance of experiential categories of design, such as social territories, visual, and non-visual aesthetics, compared with environmental categories of design, such as energy efficiency, water savings, and indoor environmental quality. The article contributes to the green building design literature by evaluating green buildings from a new perspective that is based on users' preferences. This perspective can be influential in developing green building rating systems for enhancing green building performance.

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## 1. Introduction

There are a number of benefits that are attributed to green building design, including saving energy and water, preserving natural resources, and promoting a healthy indoor environment [1–3]. It has been found that green buildings do payoff as real estate investment [4], and outperform conventional buildings in operational and environmental aspects of design [5]. Yet, there is less evidence that these green buildings promote better social and cultural dimensions, and evidence suggests green buildings do not provide occupants with better experiences and higher levels of satisfaction than conventional buildings [6]. For example, the Leadership in Energy and Environmental Design (LEED) certification does not have a significant influence on occupant satisfaction with indoor environmental quality [7] and occupant surveys in the

United Kingdom found that green buildings are “repeating past mistakes by creating unneeded and wasteful complexity, which can undermine their whole purpose” [8] (p. 22). This imbalance between the environmental performance and quality of experience offered for building occupants may, at least in part, be explained by the use of green building rating systems.

Green building rating systems evaluate green buildings based on environmental categories related to the impact of a building on the environment. The predominant green building rating systems—LEED in North America and BREEAM in the United Kingdom—use five main environmental categories of credits: sustainable site, water efficiency, energy efficiency, materials and resources; and indoor environmental quality [9]. In contrast, building occupants evaluate buildings based on their experiences in these buildings. According to Doxtater [10], human experiences in buildings can be categorized into five categories of experience: task performance, way-finding, visual and non-visual aesthetics, social territories, and cultural expression.

Yet in this contrast lies a fundamental challenge for building designers. While certification systems tend to focus on the design and construction of new buildings, building occupancy plays a

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major role in the ongoing building performance [11]. For a building to be sustainable it must consider not just the design of the building, but also the ongoing consideration of environmental, social, and economic dimensions. Therefore users' preferences and behaviors, which are drawn from their perceptions and experiences in buildings, can also be important determinants of sustainable building performance. The present study uses an experimental design approach, Choice-Based Conjoint (CBC) analysis, to identify the relative importance of three experiential categories (social territories, visual aesthetics, and non-visual aesthetics) and three environmental categories of design (water efficiency, energy savings, and indoor environmental quality) for users of green buildings and non-green buildings. Choice Based Conjoint (CBC) analysis is widely used in the fields of marketing, economics, and decision-making as it reveals the preferences of customers for certain products, designs, and/or prices based on the responses of sample participants.

The current study contributes to both the theoretical and practical understanding of green building design. Theoretically, it reveals an important dimension of design related to the actual use of a building and its influence on the ongoing environmental performance of the building. Practically, the current study provides evidence that could be used in the revision of green building rating systems. The study identifies some quality of experience dimensions and their importance to laypeople, which could be integrated into the credit system. Improving the quality of experience for laypersons will support the ongoing performance of green buildings after certification.

### 1.1. Green building design

“Green building” is a term that encompasses the strategies, techniques, and construction materials that are resource-efficient with fewer adverse effects on the environment than conventional building strategies, techniques, and materials [12]. The main drivers of building green currently involve selecting and designing buildings on a sustainable site while maximizing savings of energy, water, and natural resources to lower the impact of buildings on the environment [13]. Green building rating systems are meant to measure and evaluate the levels of adherence to the principles of sustainability, alleviate the environmental burden of these buildings, and label it accordingly. Sustainability rating tools are particularly important in distinguishing the level of sustainability in buildings [14]. Green building rating programs were developed to encourage building professionals to adopt a higher level of sustainability in building design, construction, and operations by promoting and making possible a better integration of environmental concerns with cost and other traditional decision criteria [15] (p. 1).

### 1.2. Categorizing user's perceptions and experiences in buildings

While not always considered in building design, the evaluative judgments of laypeople's individual experiences in the built environment are an important consideration for the assessment of a building [16,17]. According to Doxtater [10], occupants' experiences can be categorized into five categories of experience: *Way-finding* – finding one's way in a setting and the sources of potential way-finding problems; *Visual and Non-visual Aesthetics* – environmental impressions involving an inherent or personally developed response to natural and architectural forms that are perceptually pleasurable or unpleasurable; *Task Performance* – how the efficiency of physical tasks depends upon the environment as a “tool;” *Social Territories* – environmental activities that maintain social identities and organization of individuals and/or groups; *Cultural*

*Expression* – how people attach and use associational/symbolic meaning in a setting. Including historical references, artwork, organizational or professional themes, and ritual-like activities [10].

In the present research, two of Doxtater's categories of human experience in buildings are considered to be influential in the case of green buildings: *social territories* and *visual and non-visual aesthetics*. These two categories are crucial for the satisfaction of building users. First, territoriality refers to how people use space to communicate ownership or occupancy of areas and possessions [18]. Users' social territory, or the behavior of establishing them (territoriality), is an important determinant factor in users comfort in a physical space. Second, visual and non-visual aesthetics establish a connection between people and place. Occupants show a preference for buildings that have higher quality aesthetics [19] and building aesthetics form a mental image that produces happiness and comfort for laypersons. In the current study, we divided this into two categories or design factors: visual aesthetics are those architectural design features such as visual pattern, texture, and color which are generally created by the architect; and non-visual aesthetics include factors such as sound, aroma, warmth, and coolness [10], which are generally controlled by the design of the engineering systems and building technology. Devising this category is meant to reflect the distinction between architectural design and engineering systems design in sustainable buildings. These kinds of experiential factors have also been raised as important issues for users' experiences in previous studies [e.g. Refs. [10,20–22]].

## 2. Methodology

Most of the research into the performance of green buildings involves post-occupancy evaluations based on users judgment [1,7,23–26]. However, this approach makes it difficult to generalize the outcomes because each study is specific to a few case studies. The present study uses an experimental design approach that offers greater potential for generalization of the results because the sample is drawn from a more general population of building occupants. Choice Based Conjoint (CBC) is primarily used to evaluate multi-attribute decision-making and reveals the preferences of customers for certain products, designs and/or prices. Multi-attribute decision-making recognizes that most objects are composed of a bundle of attributes that have different levels of importance to the decision maker [27]. Decision makers employ rules to help them make decisions by placing greater or lesser importance of the attributes that are seen to make up the object. Based on their individual responses, a utility value is derived which represents the importance that respondents place on a particular attribute relative to other attributes in the design set [28]. Choice-based conjoint analysis is an effective method for analyzing choices in complex decision-making situations. It has been used to weight the relative importance of characteristics in green versus non-green developments in Hong Kong [29], to identify the preferences of older people for environmental attributes of local parks in the UK to inform better park design [30], and to measure the willingness to choose green options when commuting to work [31].

Generally, conjoint experiments examine the structure of consumer preferences, such that when a consumer is forced to trade-off between attributes, his or her choices can be broken down into a combination of part-worth utilities provided by the different attributes of the products [31]. In the current study, CBC was used to determine the relative importance of three experiential categories of design (social territories, visual aesthetics, and non-visual aesthetics) and three environmental categories (water efficiency, energy efficiency, and indoor environmental quality) to occupants

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