Journal of Scientific Research & Reports
9(1): 1-6, 2016; Article no.JSRR.20106
ISSN: 2320-0227

SCIENCEDOMAIN *international*
www.sciencedomain.org

Climate Change and Green Hotel Efforts: Evaluating Successful Green Hotel Interior Design

Yen-Cheng Chen[1], Hsin-I Chen[1*], Pei-Ling Tsui[2,3] and Ching-Sung Lee[4]

[1]Department of Applied Science of Living, Chinese Cultural University, Taiwan.
[2]Department of Hospitality Management, National Taitung College, Taiwan.
[3]Graduate Institute of Technological and Vocational Education, National Taipei University of Technology, Taiwan.
[4]Department of Restaurant, Hotel and Institutional Management, Fu Jen Catholic University, Taiwan.

Authors' contributions

This work was carried out in collaboration between all authors. Author YCC designed the study, and supervised the running of the project, and revised the manuscript for important intellectual content. Author HIC managed the literature searches, analyses of the study and author PLT performed the statistical analysis. Author CSL managed the analyses of the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2016/20106
Editor(s):
(1) Shangyao Yan, Convener of Civil and Hydraulic Engr Program, NSC, National Central University, Taiwan.
Reviewers:
(1) Ding Ding, Shandong Jianzhu University, China.
(2) Surabhi Srivastava, University of Kota, Rajasthan, India.
Complete Peer review History: http://sciencedomain.org/review-history/11430

Original Research Article

Received 11th July 2015
Accepted 26th August 2015
Published 16th September 2015

ABSTRACT

The recent development of green building and green operations have reached hotel industry, that more and more travelers demand hotels to make green policies. In response, hoteliers devoted their resources into making hotels greener. This study intends to provide an FAHP evaluation model for hoteliers while designing green hotel interiors. Delphi method was applied before FAHP to build the hierarchy. FAHP calculated criteria priorities which can be directly interpreted as the priorities when designing. The result of this study will help hoteliers make their decision under limited budgets and resources. At the same time, we wish to call more attention to green hotel efforts.

Keywords: Climate change; green hotel; FAHP.

**Corresponding author: Email: chen2907@ms53.hinet.net;*

1. INTRODUCTION

The demand for green operation is a long-term trend and not just a brief fever and marketing gimmicks, started in the 1970s [1]. The demands and prices for food, water and energy rise as the world population rises. Meanwhile, the increased production of food and energy leads to the rapid increase in carbon dioxide emissions and climate change. In response, people are forced to take various measures for the purpose of long-term sustainability. Building more power-efficient homes and buildings is considered one of the major acts to achieve this goal. In 2000, a typical office building in U.S. consumed over 300 kilowatt-hours per square meter annually (kWh/m2/yr). In 2011, a high-performance office building consumes only 100 kWh/m2/yr [2]. The number even goes down to 50 kWh/m2/yr for high performance buildings in Germany. Water consumption can also be reduced by 50% if high-efficient toilet and urinal were installed. Another 50% reduction (totally 75% reduction combined) can be achieved by introducing rainwater and greywater recycling system [2].

The increased environmental awareness is poised to have a significant impact on hotel selection. Forty three million U. S. travelers have expressed their concern for the environment [3], which means that travelers will begin to pay attention to hotels that have environmental policies in place. The types of environmental policies hotels have, or the measures they have taken to reduce their impact on the environment, may become factors for travelers when choosing which hotels to stay in [4].

Business travelers are becoming greener, and baby boomerslead their Generation Y counterparts in environmentally sensitive behavior while traveling. According to a survey commissioned by Deloitte, 34% of business travelers now seek out hotels that are environmentally friendly, and 38% have researched green lodging facilities either online or by asking friends and relatives. The survey polled a sample of 1,155 business travelers. Twenty-eight percent of these travelers said they would be willing to pay 10% more to stay in a green lodging facility. In addition to considering a hotel's green practices before booking, the survey showed business travelers routinely practiced energy conservation: 69% said they always turn off the lights, and 31% always adjust the heat/air conditioner when leaving the room [5].

A survey of 1,300 U.S. travelers by TripAdvisor.com shows that nearly two-thirds of travelers, 62 percent, often or always consider the environment when choosing hotels, transportation and meals, and 69 percent said they plan to make even more eco-friendly choices in the next 12 months [6].

The survey also shows that hotels could do a better job of publicizing their green efforts. 64 percent of respondents said that they rarely or never feel informed about whether hotels are truly eco-friendly. A whopping 93 percent don't take it upon themselves to confirm hotels' green practices [6]. That's an opportunity for hoteliers and other travel operators to marketing on their green efforts. Among some other findings of the survey, 84 percent of the respondents did not believe that eco-friendly choices have an impact on comfort or luxury. These travelers already practice some of the most common, easiest to follow green habits in hotels: turning off lights when not in the room (88 percent), reusing towels and linens (78 percent) and recycling material such as plastics and papers (58 percent). However, charging more because of these green measures seems to be not viable. Only 17 percent of travelers said they would be willing to pay $25 more for eco-features, while 58 percent said that they would either not pay more or expect to pay less.

Hotels that voluntarily provide environmentally friendly attributes are oftentimes referred to as either green hotels or environmentally friendly hotels. Some hotels may have many environmental attributes in place, while others may have just a few [4]. A study conducted by Virginia Polytechnic Institute and State University indicated that frequent travelers would stay in hotels with environmental strategies, but they would not be willing to pay a premium for those rooms [7].

As for the costs of hotel green measures, hoteliers can rest assured that no considerable costs will be yielded. The U.S. Green Building Council (USGBC) report documented that the minimal premium for building LEED-certified projects (Leadership in energy and environmental design), was only 1 to 2 percent for LEED-certified, LEED-Silver, and LEED-Gold buildings. Most critically, the report documented the declining cost of green design and construction over the past few years, which seemed to be associated with increased experience and

adapted supply chain in designing and constructing green buildings.

Aside from the financial incentives, studies also noted that green buildings seem to show noticeable improvements in the health and productivity of people working in them [1]. Beneficial features include better siting (e.g., avoiding locating air intakes next to outlets such as parking garages); better use of daylight (e.g., more natural light, better use of shade, less glare); improved thermal comfort and better ventilation; reducing use of toxic materials; and use of low-emission adhesives, sealants, paints, carpets, and other materials. The report noted that there have been thousands of studies finding significantly reduced illness symptoms, reduced absenteeism, and increases in perceived productivity, as compared to workers in buildings without green features [2,8,9].

Although there is a large entity of research available about green hotel design and its effects on customer hotel selection, there is very little emphasis on the priorities of these green factors when designing them. For one, we cannot assume unlimited budgets when designing green hotels. Second, for those hotels which are already existed and in operation, the costs of renovation might be much higher than building from scratch. Therefore, there is a good reason that the priorities among green factors are ranked for the highest cost-performance value. To achieve this goal, this study applies a combination of Delphi method and fuzzy analytic hierarchy process (FAHP) in different stages. In the following section, we will summarize our method and demonstrate the prioritizing results. Finally, the conclusion and some advices will be given in the last section.

2. METHODS

In this study, a total of nine selected hotel management professionals to fill in the questionnaire fuzzy method of Delphi, which contains the relevant members of the hotel management experts and scholars, and scholars in the field of green building experts and industry experts. We applied a two-stage evaluation process which combined Delphi method in the first stage and FAHP in the second stage. The purpose of applying Delphi method is to find suitable indicators of hotel green interior design. The FAHP is to utilize these indicators and prioritize them. The priorities of the indicators can provide a complete picture for hoteliers and decision makers of how will they prioritizing their green efforts subject to limited resources (e.g., budget, time). Here we will provide a brief introduction of the methods we applied in this study.

2.1 Delphi Method

The Delphi method is a structured communication technique, originally developed as a systematic, interactive forecasting method which relies on a panel of experts [10]. The experts answer questionnaires in two or more rounds. After each round, a facilitator provides an anonymous summary of the experts' forecasts from the previous round as well as the reasons they provided for their judgments. Thus, experts are encouraged to revise their earlier answers in light of the replies of other members of their panel. It is believed that during this process the range of the answers will decrease and the group will converge towards the "correct" answer. Finally, the process is stopped after a pre-defined stop criterion (e.g. number of rounds, achievement of consensus, stability of results) and the mean or median scores of the final rounds determine the results [11]. This study uses Delphi method to decide green hotel interior design indicators, which will be treated as the evaluating criteria of FAHP.

2.1.1 Analytic hierarchy process

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then.It has particular application in group decision making [12], and is used around the world in a wide variety of decision situations, in fields such as government [13], business [14], industry [15], healthcare [16], and education [17].

Rather than prescribing a "correct" decision, the AHP helps decision makers find one that best suits their goal and their understanding of the problem. It provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions.

Users of the AHP first decompose their decision problem into a hierarchy of more easily comprehended sub-problems, each of which can

be analyzed independently. The elements of the hierarchy can relate to any aspect of the decision problem—tangible or intangible, carefully measured or roughly estimated, well or poorly understood—anything at all that applies to the decision at hand. Therefore, Delphi method is an appropriate technique to build the hierarchy and its elements before advancing to the next stage.

Once the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them to one another two at a time, with respect to their impact on an element above them in the hierarchy. This process is also called pairwise comparison. In making the comparisons, the decision makers can use concrete data about the elements, but they typically use their judgments about the elements' relative meaning and importance. It is the essence of the AHP that human judgments, and not just the underlying information, can be used in performing the evaluations [18]. A problem of the ambiguity when people express their thoughts may hinder the precision of the comparison. This is the reason where fuzzy linguistic and fuzzy numbers are introduced in the AHP – to simulate the vagueness of human language and defuzzify it to a crisp number.

The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of the problem. A numerical weight or priority is derived for each element of the hierarchy, allowing diverse and often incommensurable elements to be compared to one another in a rational and consistent way. This capability distinguishes the AHP from other decision making techniques.

In the final step of the process, numerical priorities are calculated for each of the decision alternatives. These numbers represent the alternatives' relative ability to achieve the decision goal, so they allow a straightforward consideration of the various courses of action.

2.1.2 Fuzzy set theory

Zadeh (1965) introduced fuzzy setsas an extension of the classical notion of set whose elements have degrees of membership. The membership of elements in a set is evaluated in binary terms according to a bivalent condition in classical set theory, that is, an element either belongs or does not belong to the set. In contrast to classical set theory, fuzzy set theory permits the gradual assessment of the membership of elements in a set. Membership is described with a membership function valued in the real unit interval $[0,1]$. Fuzzy sets generalize classical sets, since the indicator functions of classical sets are special cases of the membership functions of fuzzy sets, if the latter only take values 0 or 1 (Dubois and Prade, 1988). In fuzzy set theory, classical bivalent sets are usually called crisp sets.

A fuzzy set can be represented as a pair(U, m)in which$U$is and set, and $m: U \to [0,1]$.For$x \in U$, the value $m(x)$ is called grade of membership of $x$in(U, m). The fuzzy set $(U, m)$is often denoted by $\{m(x_1)/x_1, \cdots, m(x_n)/x_n\}$ for a finite set $U = \{x_1, \cdots, x_n\}$. We call x is not included in the fuzzy set (U, m) if $m(x) = 0$, and fully included if $m(x) = 1$, and we call x a fuzzy member if $0 < m(x) < 1$. $m(x)$ is the membership function of the fuzzy set (U, m). A fuzzy number is a convex, normalized fuzzy set $\tilde{A} \subseteq \mathcal{R}$ whose membership function is at least segmentally continuous and has the functional value $\mu_A(x) =$ 1at exact one element.

3. RESULTS

We collected the pairwise comparison input from the invited experts in various fields. After the aggregation and defuzzify process, we can obtain a matrix containing crisp numbers, which will be used for the calculation of criteria priorities. By finding the eigenvector of this positive reciprocal pairwise comparison judgment matrix, we can obtain the priorities of these criteria. There are other methods to obtain the priorities of the criteria which are not applied in this study, because eigenvector method was proved to be an optimal method to obtain the priorities [19].

In Table 1 we can see that “sustainable site” was deemed the most important criteria of green hotel interior design. Experts suggested that this is the major demand of green hotel efforts – to create a sustainable site and reduce its impact to the environment. The second important main criterion is “special design”. Special design includes innovative design and regional specific design. Innovative design requires designers to create new and more efficient ways to achieve the goal of green hotel sites. Regional specific design asks designers to consider the differences in various regions (e.g. tropical and temperate climates). Indoor atmosphere is the third main criterion. While the green design focuses on sustainable design, it should also increase the habitability and comfort of the hotel interior

Table 1. Pairwise comparison results

Main criteria (Weight)	Sub-criteria	Priority
Sustainable site	Water use reduction and recycle	0.269
(0.339)	Energy use optimization	0.247
	Green power	0.271
	Air conditioning optimization	0.213
Material and resources	Recyclable storage and collection	0.378
(0.164)	Construction material	0.286
	Waste management	0.336
Indoor atmosphere	Air quality control	0.168
(0.223)	Low emitting material	0.154
	Thermal control	0.147
	Interior lighting	0.125
	Day light utilization	0.163
	Quality green view	0.171
	Acoustic performance	0.072
Special design	Innovative design	0.543
(0.274)	Regional specific design	0.457

Table 2. Overall priorities and rankings

Main criteria	Sub-criteria	Overall priority	Ranking
Special design	Innovative design	0.149	1
	Regional specific design	0.125	2
Sustainable site	Green power	0.092	3
	Water use reduction and recycle	0.091	4
	Energy use optimization	0.084	5
	Air conditioning optimization	0.072	6
Material and resources	Recyclable storage and collection	0.062	7
	Waste management	0.055	8
	Construction material	0.047	9
Indoor atmosphere	Quality green view	0.038	10
	Air quality control	0.037	11
	Day light utilization	0.036	12
	Low emitting material	0.034	13
	Thermal control	0.033	14
	Interior lighting	0.028	15
	Acoustic performance	0.016	16

(e.g. use of air conditioning). The last but not the least main criterion is “material and resources”. In construction or renovation, the choice of material will greatly shape the future sustainability of the building. Choosing environmental friendly materials may both reduce costs and increase the sustainability of the sites. Resource management and recycling are also essential to the hotel interior design. It will help the recycling process to be easier and more efficient. The overall priorities and sub-criteria rankings are summarized in Table 2 above.

4. CONCLUSION

The world is suffering from climate change and various pollution caused by industrial development and population growth. In response, people devote in green efforts such as build green. Green buildings are able to reduce energy and water consumption and help us make less impact to the environment. Hoteliers have noticed this trend and started to build green hotels as a marketing strategy. This study provides an evaluation model which was developed by applying Delphi method and FAHP for hoteliers and decisions makers. This evaluation model helps decision makers to understand the priorities of various criteria, so that they can decide where to devote their resources. The four main criteria listed from highest priority to lowest are: sustainable site, special design, indoor atmosphere, material and resource. Contrary to common impression, building green hotels only cost a little more than non-green hotels, while save expenses in the long-run and make good

marketing material. Building green hotel is inevitably the future that more and more hoteliers will join this efforts. Hopefully, hoteliers can refer to this study when evaluating their green hotel interior designs.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Butler J. The compelling “hard case” for “green” hotel development. Cornell. Hosp. Q. 2008;49;234-244.
2. Kibert CJ. Sustainable construction: Green building design and delivery: Wiley; 2012.
3. Vora S. Business travelers go green. Forbes; 2007.
   Available:http://www.forbes.com/2007/06/21/business-travel-environment-forbeslife-travel_cx_sv_0622green.html
4. Millar M, Baloglu S. Hotel guests’ preferences for green guest room attributes. Cornell. Hosp. Q. 2011;52: 302-311.
5. Clausing J. Survey: Boomers more likely to go green in business travel. Travel Weekly; 2008.
   Available:http://www.travelweekly.com/Travel-News/Corporate-Travel/Survey--Boomers-more-likely-to-go-green-in-business-travel/
6. Bender A. Survey: Two-third of travelers want green hotels. Here's how to book them. Forbes; 2013.
   Available:http://www.forbes.com/sites/andrewbender/2013/04/22/survey-two-thirds-of-travelers-want-green-hotels-heres-how-to-book-them/
7. Watkins E. Do guests want green hotels. Lodging Hospitality. 1994;50:70-72.
8. Frumkin H. Healthy places: Exploring the evidence. Am. J. Public Health. 2003;93: 1451-1456.
9. Younger M, Morrow-Almeida HR, Vindigni SM, Dannenberg AL. The built environment, climate change, and health: opportunities for co-benefits. Am. J. Prev. Med. 2008;35:517-526.
10. Linstone HA, Turoff M. The delphi method: techniques and applications. Reading, Mass.: Addison-Wesley Pub. Co., Advanced Book Program; 1975.
11. Rowe G, Wright G. Expert opinions in forecasting: The role of the delphi technique. In Principles of Forecasting. J. S. Armstrong, Ed., ed: Springer US. 2001;30:125-144.
12. Saaty TL, Peniwati K. Group decision making: drawing out and reconciling differences. Pittsburgh, PA: RWS Publications; 2008.
13. Huang CC, Chu PY, Chiang YH. A fuzzy AHP application in government-sponsored R & D project selection. Omega. 2008;36: 1038-1052.
14. Lee Y, Kozar KA. Investigating the effect of website quality on e-business success: an analytic hierarchy process (AHP) approach. Decis. Support Syst. 2006;42: 1383-1401.
15. Lee AH, Chen WC, Chang CJ. A fuzzy AHP and BSC approach for evaluating performance of IT department in the manufacturing industry in Taiwan. Expert Syst. Appl. 2008;34:96-107.
16. Büyüközkan G, Çifçi G, Güleryüz S. Strategic analysis of healthcare service quality using fuzzy AHP methodology. Expert Syst. Appl. 2011;38:9407-9424.
17. Tsinidou M, Gerogiannis V, Fitsilis P. Evaluation of the factors that determine quality in higher education: an empirical study. Qual. Assur. Edu. 2010;18:227-244.
18. Saaty TL. Relative measurement and its generalization in decision making why pairwise comparisons are central in mathematics for the measurement of intangible factors the analytic hierarchy/ network process. Rev. R. Acad. Cien. Serie A. Mat. 2008;102:251-318.
19. Saaty TL. Decision-making with the AHP: Why is the principal eigenvector necessary. Eur. J. Oper. Res. 2003;145: 85-91.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/11430