

Research Article

Exploring Green Hotel Competitive Strategies by Using the Hybrid Method for Complex Data Analysis

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Green hotels emphasize safety, health, and environmental friendliness and advocate for green operations, green consumption, environmental protection, and the reasonable consumption of resources in operations. In short, environmental protection and moderate resource consumption are underscored. The literature on green hotel criteria and competitive strategies has two shortcomings. Some studies assume the independence of each criterion; these criteria are not mutually influential or causally related. By contrast, other studies set equal weights for all criteria. The present study explored the criteria and competitive strategies of green hotels by combining the importance-performance analysis (IPA) and the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method into the IPA-DEMATEL model.

1. Introduction

Hotels provide their guests with comfort and convenience. Among tourism-related industries, the hotel industry has the highest energy and water consumption. Regular hotels' substantial consumption of energy, water, and various products, including nonrecyclable products, causes considerable environmental problems and produces excessive waste. Furthermore, energy and water consumption pollutes both air (e.g., in the form of CO₂ emissions) and water [1].

Green hotels emphasize safety, health, and environmental friendliness and advocate for green operations, green consumption, environmental protection, and the reasonable consumption of resources in operations. Guests stay in environmentally friendly rooms, and dining services also adhere to these concepts [2]. The longstanding societal ignorance or negligence of environmental issues is by no means unintentional. Environmental protection requires investment and the input of social resources. In today's society, these investments may take the form of relevant measures that have been developed and implemented in response to demands for environmental protection. Amid the pervasiveness and exacerbation of environmental

pollution, the capacity to act is crucial. In adopting environmentally friendly practices and incorporating environmental management into hotel operations management, green hotels embody the concepts of environmental protection, resource conservation, health, and safety; implement green management and resource conservation measures; and promote green consumption with regard to reasonable resource use [3].

The concept of green hotels originated from a German green label organization in the 1980s, initially for the purpose of academic discussion. Other implications of "green" include sustainability, environmental friendliness, and not harming the environment [4, 5]. According to Gan [6], being green implies reducing negative environmental impacts through action (e.g., recycling and green consumption). Green consumption, which has received international attention in recent years, has raised consumer awareness of environmental issues. Governments around the world have introduced mechanisms concerning environmentally or ecologically friendly hotels. For example, Green Seal, a US-based global nonprofit organization, has a certification program for green hotels, and in 1998, the Hotel Association of Canada established the Green Leaf Eco-Rating Program,

advocating for the Green Leaf Eco Standard developed by the United Nations Educational, Scientific and Cultural Organization [6].

The hotel industry has both direct and indirect impacts on the environment. Despite their high number, hotels are generally scattered around a city, providing direct service, because they have relatively smaller scales of operation. This reduces the social visibility of their environmental impacts even as they expand in scale. As external problems, environmental issues do not receive considerable corporate attention [7]. Therefore, it is difficult for governments to establish regulations or adopt measures for their management or control. With global economic growth and rising national incomes, leisure lifestyles have grown in popularity, prompting an increase in the tourist population, stimulating the tourism industry. Pollution generated by this industry has attracted attention in recent years, with consumers becoming more aware of the importance of environmental protection. Thus, green hotels have become a new industrial trend.

The present paper discusses the criteria and competitive strategies of green hotels. The importance-performance analysis (IPA) and the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method were combined into the IPA-DEMATEL model. IPA was first performed on the green performance of case hotel. Subsequently, the DEMATEL method was used to determine the degrees of influence and identify the relationships among green performance criteria. Finally, green competitive strategies were proposed for the case hotel.

2. Literature Review

2.1. Green Hotels. As mentioned, green hotels prioritize safety, health, and environmental friendliness. In this context, safety refers to an emphasis on public safety and food safety, and health refers to the provision of products and services that benefit consumers both physically and psychologically. As for environmental friendliness, green hotels strive to reduce environmental pollution, conserve energy, and lower the amount of resources consumed in the operational process. A clear consensus regarding the definition of green hotels has yet to be reached. Internationally, the terms green hotels, eco-efficient hotels, and environmentally friendly hotels are essentially interchangeable in that they indicate that environmental management is involved. The present study defines green hotels as hotels that endeavor to effectively utilize energy, water, and raw materials in providing services characterized by environmental friendliness [8, 9].

Green hotels seek opportunities for corporate growth in the market and actively take corresponding measures. To offer suggestions and determine directions of development for green hotels to capitalize on market opportunities and avoid market threats, we performed a theoretical analysis [10].

Market opportunities and strengths of green hotels are listed as follows:

- (1) Lower procurement costs for resources and energy usage

- (2) Lower waste processing costs
- (3) Opportunities to attract new green consumer groups
- (4) Provision of a safe and comfortable work environment
- (5) Reduction of employee risks concerning health or safety problems
- (6) Improvement of employee morale, which reinforces the provision of high-quality service
- (7) Improvement in relationships between the hotel and neighboring communities
- (8) Improvement of market image

Hotels that do not apply appropriate environmental protection measures may sustain the following market losses:

- (1) Loss of market shares attributable to a damaged market image
- (2) Loss of attractiveness
- (3) Risk of legal consequences caused by regulation violations amid the passing of stricter environmental protection laws
- (4) Reduced employee loyalty leading to a higher turnover rate
- (5) Lack of preparedness leading to an inability to respond to increased operational costs

Manaktola and Jauhari identified low pollution generation, energy conservation, and the use of regenerated and recycled materials as the main principles under which green hotels operate [10]. In general, the development and operations of the hotel industry hinder sustainable development because they involve the high consumption of natural resources, generating considerable amounts of waste and leading to serious water pollution. In recent years, hotels around the world have paid appreciable attention to topics linked to environmental protection, adopting relevant measures to reverse the current trend of environmental pollution. Some hotels seek to fulfill corporate social responsibility by establishing such measures; thus, green hotels have become an international trend [10]. To reduce their negative environmental impacts, green hotels adopt environmentally responsible practices (ERPs), which may constitute adherence to sustainable environmental standards, regulations, the optimization of environmental protection practices, the use of environment protection seals and environment management systems, and the consideration of environmental criteria [11]. Enterprises that implement ERPs may obtain the following benefits: cost efficiency, resource conservation, enhanced customer retention rates and customer loyalty, and improved employee morale, all of which enhance their corporate image. Studies have discussed various ERPs within the hotel industry [12].

2.2. Green Hotel Evaluation. Amid the rise in environmental awareness in recent years, the concept of green hotels has become popular in foreign countries. Because each country

holds different evaluation standards for green hotels, various assessment standards have been developed. The Green Hotel Association has identified the Green Leaf Eco-Rating Program launched in 1998 by the Hotel Association of Canada as the most mature global assessment standard for green hotels. In total, 14 criteria are involved. Green hotels meeting 5, 8, 10, 12, and 14 criteria are given scores of 1, 2, 3, 4, and 5 leaves, respectively. Green Key, an international eco-label established in Denmark, takes 11 criteria into account. To obtain this label, leisure organizations (e.g., green hotels) must conform to strict environmental requirements and ensure that their operational methods and concepts comply with emission and waste reduction standards [13, 14]. Excellent customer service is also a necessity. The standards developed by the US nonprofit Green Seal require green hotels to meet six criteria within specific guidelines. According to their performance, hotels are given ratings of gold, silver, or bronze. China's national standard for green hotels mandates the fulfillment of basic requirements, which is followed by assessment that is based on six main criteria. The maximum score is 300; hotels achieving scores of ≥ 270 , 269–240, 239–210, 209–180, and 179–160 points are rated as 5-, 4-, 3-, 2-, and 1-leaf hotels, respectively [15, 16].

We compiled the green hotel evaluation standards and management strategies obtained from the literature review and classified them into the following dimensions.

2.2.1. Energy Conservation. The energy efficiency of green hotels, which do not constitute the majority in Taiwan's hotel industry: each green hotel can conserve energy through its own methods. These methods aim to reduce energy consumption and waste (e.g., of resources) and attain co-existence with the environment. This dimension comprises the following criteria: (1) water conservation practices, (2) electricity conservation practices, and (3) energy conservation in air conditioning.

2.2.2. Waste Reduction. Reduction of generated waste and hazardous materials: green hotels strive to provide high-quality service and promote sustainable development under the principle of environmental friendliness. Regular hotels generate a considerable amount of environmental pollution; thus, waste reduction is critical in green hotels. This dimension comprises the following criteria: (1) garbage classification and recycling, (2) the prohibition of disposable products and engagement in waste reduction efforts, and (3) the use of recycled products.

2.2.3. Health. The internal and external environment and the effect of hotel facilities on the environment and on consumer health: the rise in health awareness in Taiwan has intensified the national focus on health-related topics, meaning that green hotels must promote health and safety through their facilities now more than ever. Therefore, green hotel managers must thoroughly consider criteria related to environmental protection and consumer health. This dimension comprises the following criteria: (1) the

procurement of green products, (2) environmental maintenance and protection, and (3) the use of organic food products.

2.2.4. Marketing. Marketing strategies: this refers to how green hotels promote their environmental friendliness, teach consumers the relevance of going green as leisure organizations, and use effective word-of-mouth advertising to improve brand image. This dimension comprises the following criteria: (1) brand awareness, (2) brand image, and (3) overall service quality. Table 1 presents the classification of the 12 criteria into four dimensions.

3. Research Methods

Studies on the criteria and competitive strategies of green hotels have two shortcomings. Some studies assume the independence of each criterion; these criteria are not mutually influential or causally related; others set equal weights for all criteria. The present discussion was centered on sustainability. IPA and the DEMATEL method were combined to create the IPA-DEMATEL model. The importance and performance of case hotels were determined through IPA. Subsequently, the DEMATEL method was used to calculate the degree of influence and identify the relationships among the green criteria. Finally, a competitive strategy was proposed for the case hotel.

3.1. IPA. In IPA, whose basic framework was developed by Martilla and James for practical applications, mean importance and performance scores are plotted in a two-dimensional plane, on the vertical and horizontal axes, respectively (Figure 1).

IPA considers four quadrants, which are defined as follows [17]:

- (1) Keep up the good work: representing high importance and high performance
- (2) Concentrate here: representing high importance and low performance
- (3) Low priority: representing low importance and low performance
- (4) Possible overkill: representing low importance and high performance

According to the plotting of the criteria, managers can optimize resource allocation and enhance prioritization to increase customer satisfaction. As a simple technique for evaluating the strengths and weaknesses of criteria and developing methods for improvement in the pursuit of customer satisfaction, IPA has been widely applied in various fields [18].

3.2. Decision-Making Trial and Evaluation Laboratory. Originally developed at the Battelle Memorial Institute Geneva Research Centre, the DEMATEL method was used by Gabus and Fontela to resolve various complex global

TABLE 1: Evaluation dimensions and criteria of green hotels.

Dimension	Criteria
(A) Energy conservation	(A1) Water conservation practices (A2) Electricity conservation practices (A3) Energy conservation in air conditioning
(B) Waste reduction	(B1) Garbage classification and recycling (B2) Prohibition of disposable products and engagement in waste reduction efforts (B3) Use of recycled products
(C) Health	(C1) Green product procurement (C2) Environmental protection and maintenance (C3) Use of organic food products
(D) Marketing	(D1) Brand awareness (D2) Brand image (D3) Overall service quality

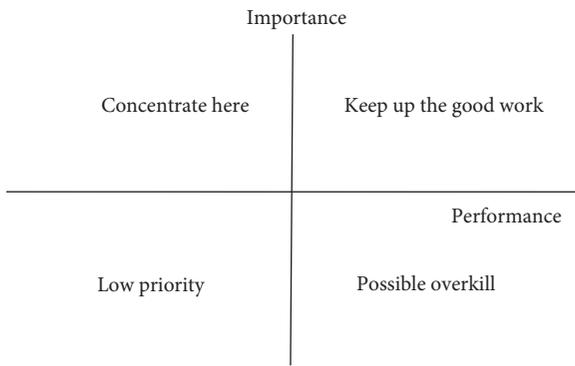


FIGURE 1: The four quadrants of importance-performance analysis (IPA).

problems, including issues concerning racism, hunger, environmental protection, and energy use [19, 20].

The DEMATEL approach uses a matrix to determine intercriteria relationships and degrees of influence. The DEMATEL framework and calculation procedures in this study are detailed as follows [21–25].

3.2.1. Define the Criteria and Propose a Scale of Measurement. By using various tools and methods, such as brainstorming, expert opinions, and literature review, list and define criteria that may influence the performance of the complex system. Subsequently, establish a scale for measuring the relationships and degrees of influence between criteria.

3.2.2. Establish the Direct-Relation Matrix. After seeking expert opinion, the n criteria that influence a complex system can be used to form a direct-relation matrix X ($n \times n$), where X_{ij} represents the degree of influence of i on j and the diagonal elements are set as 0.

$$X = \begin{bmatrix} 0 & x_{12} & \cdots & x_{1n} \\ x_{21} & 0 & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & 0 \end{bmatrix}. \quad (1)$$

3.2.3. Construct the Normalized Direct-Relation Matrix. To construct the normalized direct-relation matrix, Lin and Wu [26], used row vectors and row maximums as the normalization standard as follows:

$$\text{compute } \lambda = \frac{1}{\text{Max}_{1 \leq i \leq n} \left(\sum_{j=1}^n x_{ij} \right)}. \quad (2)$$

And then multiply the direct-relation matrix X by λ to obtain the normalized direct-relation matrix N :

$$N = \lambda X. \quad (3)$$

3.2.4. Construct the Total-Relation Matrix. Having obtained the normalized direct-relation matrix N , the identity matrix I is then used to establish the total-relation matrix T , also known as the direct-indirect matrix.

$$T = \lim_{k \rightarrow \infty} (N + N^2 + \cdots + N^k) = N(I - N)^{-1}. \quad (4)$$

3.2.5. Calculate the Influence Degree and the Dependence Degree. After obtaining T , we can calculate the influence degree and dependence degree of each criterion. Let t_{ij} represent the criteria in T , where $i, j = 1, 2, \dots, n$. D_i , the sum of row i , represents the total degree of influence of criterion i . R_j is the sum of column j and represents the total degree of dependence on criterion i . D_i and R_j obtained from T contain direct and indirect influences.

$$D_i = \sum_{j=1}^n t_{ij}, \quad i = 1, 2, \dots, n, \quad (5)$$

$$R_j = \sum_{i=1}^n t_{ij}, \quad j = 1, 2, \dots, n. \quad (6)$$

3.2.6. Plotting the Cause-and-Effect Diagram. Given $k = i = j = 1, 2, \dots, n$, let $(D_k + R_k)$ be the prominence, representing the combined degree of influence and degree of dependence [27, 28]. This value indicates the degree of centrality of criterion k in the problem. Next, define

$(D_k - R_k)$ as the relation, which refers to the difference between the degrees of influence and dependence. If the relation, which indicates the degree of causality of criterion k in the problem, is a positive value, then the criterion belongs in the cause group. Conversely, if the relation is negative, then the criterion belongs in the effect group [26, 29, 30].

In the cause-and-effect matrix diagram, $(D_k + R_k)$ and $(D_k - R_k)$ are the horizontal and vertical axes, respectively. Through the use of figures, the diagram simplifies complex relationships into easily understandable structures. Decision-makers can reference the position of each criterion to determine whether they belong in the cause or effect group, as well as the degrees of influence and dependence. Problems can be resolved through suitable decisions accordingly [31–33].

A positive and negative $(D_k - R_k)$ value indicates that criterion k falls in the cause group and the effect group, respectively. A greater $(D_k + R_k)$ value indicates that criterion k has greater degrees of influence and dependence. Based on the $(D_k + R_k)$ and $(D_k - R_k)$ coordinates of k , criterion k is classified into the following four categories:

- (a) A positive $(D_k - R_k)$ and a large $(D_k + R_k)$: the criterion belongs in the cause group and is a factor driving problem resolution
- (b) A positive $(D_k - R_k)$ and a small $(D_k + R_k)$: the criterion is independent and influences few other criteria
- (c) A negative $(D_k - R_k)$ and a large $(D_k + R_k)$: the criterion is a core problem that must be solved. However, because the criterion falls in the effect group, direct improvements cannot be made
- (d) A negative value of $(D_k - R_k)$ and a small value of $(D_k + R_k)$: the criterion is independent and is influenced by few other criteria

4. Results and Discussion

4.1. Questionnaire Design. The case hotel was company T , which is among the top 10 hotels in Taiwan. The performance of company T as a green hotel was evaluated, and the results serve as a reference for improvement.

Questionnaires involving IPA and the DEMATEL method were used. Regarding the IPA questionnaire, expert opinion was sought on the importance and performance of company T on each mentioned criterion. Each of the 12 items was scored on a 7-point Likert scale (from 7 = *very important* and to 1 = *not at all important*). Subsequently, the DEMATEL questionnaire was administered to the same panel of experts to obtain their opinions on the criteria. The items were also scored on a 7-point Likert scale (6 = *the most significant level of influence*; 0 = *no influence*; ranks between 6 and 0 were scored sequentially according to the level of significance). The two questionnaires were distributed between February 22 and March 12, 2021. The respondents comprised 15 experts: 7 hotel managers, 5 university professors, and 3 officials at principal government agencies, respectively. The author personally visited, explained the

questionnaire content, and administered the questionnaire to each participant. The valid return rate for both questionnaires was 100%.

As mentioned, the 12 criteria of green hotels were classified into 4 dimensions (Table 1). The energy conservation dimension comprises (1) water conservation practices, (2) electricity conservation practices, and (3) energy conservation in air conditioning. The waste reduction dimension comprises (1) garbage classification and recycling, (2) the prohibition of disposable products and engagement in waste reduction efforts, and (3) the use of recycled products. The health dimension comprises (1) green product procurement, (2) environmental protection and maintenance, (3) and the use of organic food products. The marketing dimension comprises (1) brand awareness, (2) brand image, and (3) overall service quality.

4.2. Results and Discussion

4.2.1. IPA Results. The mean values of importance (5.76) and performance (5.71) were used as the standard coordinates for determining the performance of each criterion (Table 2).

The IPA revealed that, in the “keep up the good work” quadrant, there were criteria B1, B2, C1, C3, and D3 (garbage classification and recycling, prohibition of disposable products and engagement in waste reduction efforts, green product procurement, use of organic food products, and overall service quality, resp.). In other words, company T should maintain its performance in these areas for effective word-of-mouth marketing.

In the “concentrate here” quadrant, there were criteria B3, C2, and D2 (use of recycled products, environmental protection and maintenance, and brand image, resp.). Company T must channel its resources into improving its performance in these areas to increase its competitiveness in green management.

Company T did not exhibit satisfactory performance on criterion A2 (electricity conservation practices) or criterion D1 (brand awareness), both in the “low priority” quadrant. Because these criteria have low importance, they should be given the least priority, to be focused on only when the company has an abundance or overabundance of resources. In the “possible overkill” quadrant, indicative of outstanding performance on matters of low importance, there were criteria A1 and A3 (water conservation practices and energy conservation in air conditioning, resp.). Efforts devoted to these criteria do not yield additional benefits to the company. Therefore, managers should consider allocating company resources to other criteria (Table 2).

4.2.2. DEMATEL Results. Table 3 presents the results from the questionnaires in the form of the initial direct-relation matrix X . Specifically, the mean scores of the 15 experts were calculated and rounded to one decimal place. These results were then used to generate the initial direct-relation matrix, which consists of 144 squares. After the elimination of the 12 diagonal elements, 132 elements remained.

TABLE 2: Importance and performance of green hotel criteria.

No.	Item	Importance	Performance	Competitive strategy
a1	Water conservation practices	5.2	5.9	Possible overkill
a2	Electricity conservation practices	5.3	5.6	Low priority
a3	Energy conservation in air conditioning	5.5	6.1	Possible overkill
b1	Classifying and recycling garbage	6.1	5.8	Keep up the good work
b2	Prohibition of disposable products and engagement in waste reduction efforts	6.0	5.9	Keep up the good work
b3	Use of recycled products	6.0	5.2	Concentrate here
c1	Green product procurement	6.1	5.9	Keep up the good work
c2	Environmental protection and maintenance	5.9	5.3	Concentrate here
c3	Use of organic food products	5.9	5.9	Keep up the good work
d1	Brand awareness	5.6	5.5	Low priority
d2	Brand image	5.9	5.6	Concentrate here
d3	Overall service quality	6.1	6.0	Keep up the good work
Mean		5.76	5.71	

TABLE 3: The initial direct-relation matrix X .

Criteria	a1	a2	a3	b1	b2	b3	c1	c2	c3	d1	d2	d3
a1	0	1.4	1.5	1.1	0.7	2.5	1.4	1.7	1.5	1.4	2.1	1.8
a2	1.3	0	1.2	1.4	1.8	3.1	1.2	1.4	1.7	1.5	1.6	1.3
a3	1.9	1.5	0	1.9	1.2	2.8	1.7	1.4	1.7	1.3	1.1	1.7
b1	1.1	1.4	1.5	0	1.4	1.2	1.2	2.9	1.5	2.2	3.3	
b2	1.4	1.6	1.4	2.5	0	2.6	1.5	1.3	1.8	2.4	2.2	2.8
b3	2.3	2.8	2.6	2.7	2.5	0	2.1	3.5	2.4	1.4	2.5	2.6
c1	2.4	2.5	3.5	2.6	2.7	2.2	0	4.7	3.1	5.5	3.5	3.7
c2	2.3	2.2	2.1	2.5	3.3	4.4	3.6	0	4.3	4.2	4.4	4.9
c3	2.8	2.6	1.2	1.8	2.5	1.5	1.6	3.3	0	3.2	3.4	3.5
d1	1.7	1.4	2.4	1.9	2.1	2.2	2.5	2.1	2.8	0	4.4	3.1
d2	2.3	2.5	3.1	4.3	3.2	2.6	2.8	4.2	4.4	5.2	0	4.6
d3	3.4	3.5	2.8	3.7	4.3	4.6	3.7	3.1	3.1	4.4	5.2	0

Subsequently, the row vectors and row maximums were used as the normalization standard, with λ denoting the reciprocal of the maximum row sum. In equation (2), the direct-relation matrix is multiplied by λ , and the influence coefficients are rounded to two decimal places to obtain the normalized direct-relation matrix N (Table 4).

Equations (3) and (4) were used to construct the total-relation matrix T . The total-relation criteria matrix is acquired in Table 5.

The D_i value for each column and the R_j value for each row were calculated using equations (5) and (6), after which the prominence ($D+R$) and relation ($D-R$) were obtained. The total influence given and received on dimensions and criteria is summarized in Table 6. Figure 2 shows the plot of the 12 criteria, with the prominence and relation as the x and y coordinates, respectively.

Table 6 and Figure 2 reveal the following relations and influences between the 12 criteria.

- (1) High relation and high prominence: C1, C2, D2, and D3 (green product procurement, environmental protection and maintenance, brand image, and overall service quality, resp.). These four criteria belong in the cause group and influence other criteria, suggesting that they constitute factors driving problem resolution.

- (2) High relation and low prominence: no criteria were found in this category.

- (3) Low relation and high prominence: B3, C3, and D1 (use of recycled products, use of organic food products, and brand awareness, resp.). These three criteria are in the effect group, meaning that they are influenced by other criteria. Although they require improvement, they cannot be directly improved because they are in the effect group.

- (4) Low relation and low prominence: A1, A2, A3, B1, and B2 (water conservation practices, electricity conservation practices, energy conservation in air conditioning, garbage classification and recycling, and prohibition of disposable products and engagement in waste reduction efforts, resp.). These five criteria are influenced by other criteria, but not to a great extent, suggesting that they are relatively independent.

Criteria C1, C2, D2, and D3 (green product procurement, environmental protection and maintenance, brand image, overall service quality, resp.) exhibit high relation and high prominence. They constitute key criteria that influence other criteria. Through improvements to these criteria, core problems can be resolved and the company's performance on other criteria can be improved.

4.2.3. IPA-DEMATEL Results. The IPA revealed that criteria B1, B2, C1, C3, and D3 (garbage classification and recycling, prohibition of disposable products and engagement in waste reduction efforts, green product procurement, use of organic food products, and overall service quality) were in the "keep up the good work" quadrant. Company T should maintain its advantage with regard to these criteria. The DEMATEL analysis classified criteria C1 and D3 as being in the high-relation, high-prominence category; thus, they belong in the cause group. Accordingly, company T should focus on these two criteria and continue investing resources to maintain its competitive advantage and enhance both its green performance and its performance on other criteria. By contrast, criteria B1, B2, and C3 are relatively independent of other

TABLE 4: The normalized direct-relation matrix T .

Criteria	a1	a2	a3	b1	b2	b3	c1	c2	c3	d1	d2	d3
a1	0.00	0.03	0.04	0.03	0.02	0.06	0.03	0.04	0.04	0.03	0.05	0.04
a2	0.03	0.00	0.03	0.03	0.04	0.07	0.03	0.03	0.04	0.04	0.04	0.03
a3	0.05	0.04	0.00	0.05	0.03	0.07	0.04	0.03	0.04	0.03	0.03	0.04
b1	0.03	0.03	0.04	0.00	0.03	0.03	0.03	0.03	0.07	0.04	0.05	0.08
b2	0.03	0.04	0.03	0.06	0.00	0.06	0.04	0.03	0.04	0.06	0.05	0.07
b3	0.06	0.07	0.06	0.06	0.06	0.00	0.05	0.08	0.06	0.03	0.06	0.06
c1	0.06	0.06	0.08	0.06	0.06	0.05	0.00	0.11	0.07	0.13	0.08	0.09
c2	0.06	0.05	0.05	0.06	0.08	0.11	0.09	0.00	0.10	0.10	0.11	0.12
c3	0.07	0.06	0.03	0.04	0.06	0.04	0.04	0.08	0.00	0.08	0.08	0.08
d1	0.04	0.03	0.06	0.05	0.05	0.05	0.06	0.05	0.07	0.00	0.11	0.07
d2	0.06	0.06	0.07	0.10	0.08	0.06	0.07	0.10	0.11	0.12	0.00	0.11
d3	0.08	0.08	0.07	0.09	0.10	0.11	0.09	0.07	0.07	0.11	0.12	0.00

TABLE 5: The total-relation criteria matrix TC .

Criteria	a1	a2	a3	b1	b2	b3	c1	c2	c3	d1	d2	d3	D_i
a1	0.06	0.10	0.10	0.10	0.09	0.14	0.10	0.12	0.12	0.12	0.14	0.13	1.30
a2	0.09	0.06	0.09	0.10	0.11	0.15	0.09	0.11	0.12	0.12	0.12	0.12	1.29
a3	0.11	0.10	0.07	0.12	0.10	0.14	0.10	0.11	0.12	0.12	0.12	0.13	1.33
b1	0.10	0.11	0.11	0.08	0.11	0.12	0.10	0.11	0.16	0.13	0.15	0.17	1.45
b2	0.11	0.12	0.11	0.15	0.09	0.16	0.11	0.12	0.14	0.16	0.16	0.17	1.60
b3	0.15	0.16	0.16	0.17	0.17	0.12	0.15	0.19	0.18	0.17	0.19	0.20	2.00
c1	0.18	0.19	0.21	0.21	0.21	0.21	0.13	0.26	0.24	0.30	0.26	0.27	2.67
c2	0.19	0.19	0.19	0.22	0.23	0.27	0.22	0.17	0.27	0.29	0.29	0.30	2.84
c3	0.16	0.16	0.13	0.16	0.17	0.16	0.14	0.19	0.13	0.21	0.22	0.22	2.05
d1	0.14	0.13	0.15	0.16	0.16	0.17	0.16	0.17	0.19	0.14	0.24	0.21	2.02
d2	0.19	0.20	0.21	0.25	0.23	0.23	0.20	0.26	0.27	0.30	0.20	0.30	2.84
d3	0.22	0.22	0.21	0.25	0.26	0.28	0.23	0.24	0.25	0.30	0.32	0.21	2.98
R_j	1.70	1.74	1.73	1.96	1.92	2.16	1.75	2.06	2.19	2.35	2.40	2.43	

criteria. In other words, they have little influence on other criteria; nor are they easily influenced by other criteria.

The “concentrate here” quadrant contained criteria B3, C2, and D2 (use of recycled products, environmental protection and maintenance, and brand image, resp.). Company T should channel its resources into improving its performance on these criteria to improve its competitiveness in green management. Subsequent DEMATEL analysis classified criteria C2 and D2 as being in the high-relation, high-prominence category; thus, they belong in the cause group. This suggests that these two criteria critically affect other criteria; they constitute factors driving problem resolution. Company T should immediately concentrate resources to resolve problems concerning its promotion of environmental protection and maintenance, as well as its brand image. Otherwise, its green performance will fall below industry standards, lagging behind that of its competitors. The location of criterion B3 (use of recycled products) in the high-relation, low-prominence category suggests that it influences few other criteria and holds little influence overall, and that it is relatively independent.

The IPA also indicated that criteria A2 and D1 (electricity conservation practices and brand awareness, resp.), on which company T underperformed, were in the “low priority” quadrant. These criteria are relatively independent; they have little influence on and are not easily influenced by other criteria. Therefore, company T is advised to give them the least priority, focusing on them only when the company has an abundance or overabundance of resources.

Company T demonstrated excellent performance on criteria A1 and A3 (water conservation practices and energy conservation in air conditioning), both of which are in the “possible overkill” quadrant, meaning that efforts in these areas do not necessarily confer additional benefits. These two criteria fall in the low-relation, low-prominence category, suggesting that they are relatively independent of other criteria and do not require the investment of a considerable amount of resources.

On the basis of the IPA-DEMATEL results, the competitive strategies of company T were comprehensively analyzed, and specific recommendations were made. The current green performance and competitive strategies of company T are compiled in Table 7.

TABLE 6: Results on prominence and relation from the DEMATEL analysis.

Criteria	D	R	$D + R$	$D - R$
a1	1.30	1.70	3.00	-0.40
a2	1.29	1.74	3.03	-0.44
a3	1.33	1.73	3.06	-0.39
b1	1.45	1.96	3.41	-0.52
b2	1.60	1.92	3.52	-0.32
b3	2.00	2.16	4.16	-0.16
c1	2.67	1.75	4.42	0.93
c2	2.84	2.06	4.89	0.78
c3	2.05	2.19	4.24	-0.13
d1	2.02	2.35	4.37	-0.33
d2	2.84	2.40	5.24	0.44
d3	2.98	2.43	5.41	0.55
Mean	2.03	2.03	4.06	0.00

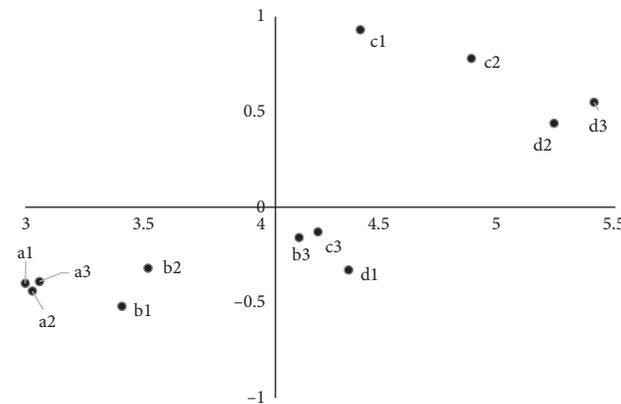


FIGURE 2: Influences between the 12 criteria.

TABLE 7: IPA-DEMATEL analysis of the performance and competitive strategies of company T as a green hotel.

Competitive strategy	Criteria	Analysis of competitive strategy through the DEMATEL approach
Keep up the good work	C1 green product procurement	High-relation, high-prominence criteria, belonging in the cause group. Company T should focus on maintaining its performance on these two criteria to maintain its competitive advantage and enhance both its green performance and its competitiveness in other criteria.
	D3 overall service quality	
	B1 garbage classification and recycling	These three criteria are relatively independent. They do not easily influence other criteria; nor are they easily influenced by other criteria.
	B2 prohibition of disposable products and engagement in waste reduction efforts	
	C3 use of organic food products	
Concentrate here	C2 environmental protection and maintenance	High-relation, high-prominence criteria, belonging in the cause group. These key criteria influence other criteria and constitute factors driving problem resolution. Therefore, company T should channel resources into these criteria immediately to resolve problems regarding its green performance. Failure to take action may cause the green performance of company T to fall below the industry standard, behind that of its competitors.
	D2 brand image	The only criterion in the high-relation, low-prominence category. This criterion influences few other criteria, has a low degree of influence, and is relatively independent of other criteria.
	B3 use of recycled products	
Low priority	A2 electricity conservation practices D1 brand awareness	These two criteria are relatively independent. They do not easily influence other criteria; nor are they easily influenced by other criteria.
Possible overkill	A1 water conservation practices A3 energy conservation in air conditioning	Low-relation, low-prominence criteria that are relatively independent of other criteria and do not require much investment.

5. Conclusion

The present study combined the IPA and DEMATEL into the IPA-DEMATEL model, through which the criteria and competitive strategies of green hotels were discussed.

The IPA classified criteria C1 and D3 (green product procurement and overall service quality) as being in the “keep up the good work” quadrant, indicating that they constitute advantages of company T. Thus, the hotel should maintain its performance in these areas. The DEMATEL analysis revealed both criteria to be located in high-relation, high-prominence category; they belong in the cause group. Therefore, company T should focus on and continue investing resources in these two criteria to maintain its competitive advantage, improve green performance, and enhance performance on other criteria.

Moreover, criteria C2 (environmental protection and maintenance) and D2 (brand image) were classified in the “concentrate here” quadrant, suggesting that company T is at a disadvantage in these areas. DEMATEL analysis revealed both criteria to be in the high-relation, high-prominence category; they also belong in the cause group. These key criteria influence other criteria and are factors that drive problem resolution. Therefore, company T should immediately channel its resources into these areas to enhance its green performance. Failure to take action may cause its green performance to fall below the industry standard and behind that of its competitors.

The present IPA-DEMATEL model can be applied in the analysis of various topics, industries, and cases, including competitive strategy analysis, facilitating the development of other criteria systems.

Data Availability

All data are included within the paper.

Conflicts of Interest

The author declares no conflicts of interest.

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